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AGE-RELATED MACULAR DEGENERATION

<i>Continuous-Wave Photocoagulation of CNV</i>																										
<p>AMD-CW1 Laser Therapy for Neovascular Macular Degeneration. Analysis of Mechanics Mainster M. Lasers Ophthalmol 1:167-176, 1987</p>	<p>Focal obliterative laser therapy is useful for treating certain cases of neovascular aging macular degeneration, but recurrence of choroidal neovascularization is common and long term visual results are poor. Experimental studies demonstrate that the retinal pigment epithelium can affect the growth and involution of choroidal neovascularization and produce or respond to numerous chemical or physical stimuli. Contemporary focal laser therapy probably fails because it emphasizes obliteration of CNV rather than elimination of its stimuli, or optimization of post-operative reparative responses. Alternative laser strategies for treating neovascular aging macular degeneration are analyzed in terms of cellular mechanisms affecting chorioretinal senescence and neovascularization.</p>																									
<p>AMD-CW2 Laser Photocoagulation of Subfoveal Neovascular Lesions in Age-Related Macular Degeneration. Results of a Randomized Clinical Trial Macular Photocoagulation Study Group Arch Ophthalmol 109:1220-1231, 1991</p>	<p>This study was designed to compare the effect on visual acuity of laser treatment versus no treatment of eyes with subfoveal choroidal neovascularization associated with ARMD. Ninety-seven eyes were assigned to an argon laser group, 92 to a krypton group and 184 to a no treatment group. The primary criterion was angiographic evidence of CNV, with well demarcated boundaries, under the geometric center of the FAZ. Follow-up was 3 and 6 months after enrollment and at 6 month intervals thereafter. Follow-up testing measured best corrected visual acuity, contrast threshold, and reading speed. Mean Results:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Visual Acuity</th> <th>Decrease in VA No. of Lines</th> <th>Reading Speed Words per Minute*</th> <th>Contrast** Threshold %</th> </tr> </thead> <tbody> <tr> <td>03 Months Treated</td> <td>20/300</td> <td>3.0</td> <td>33</td> <td>14</td> </tr> <tr> <td>03 Months Non-Treated</td> <td>20/200</td> <td>1.9</td> <td>44</td> <td>20</td> </tr> <tr> <td>24 Months Treated</td> <td>20/320</td> <td>3.0</td> <td>28</td> <td>14</td> </tr> <tr> <td>24 Months Non-Treated</td> <td>20/400</td> <td>4.4</td> <td>12</td> <td>28</td> </tr> </tbody> </table> <p>* Initial visit: Treated: 67; Non-Treated: 73 ** Initial visit: Treated: 14; Non-Treated: 14</p>		Visual Acuity	Decrease in VA No. of Lines	Reading Speed Words per Minute*	Contrast** Threshold %	03 Months Treated	20/300	3.0	33	14	03 Months Non-Treated	20/200	1.9	44	20	24 Months Treated	20/320	3.0	28	14	24 Months Non-Treated	20/400	4.4	12	28
	Visual Acuity	Decrease in VA No. of Lines	Reading Speed Words per Minute*	Contrast** Threshold %																						
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24 Months Non-Treated	20/400	4.4	12	28																						
<p> AMD-CW3 Photocoagulation of Choroidal Neovascular Membranes with a Diode Laser Ulbig M, McHugh D, Hamilton P. Br J Ophthalmol 77:218-221, 1993</p>	<p>Nine eyes with parafoveal CNV membranes due to ARMD or angioid streaks were treated with an 810 nm diode laser and were followed-up to 40 weeks (mean 26 weeks). Treatment parameters were a spot size of 100 μm, exposure duration of 0.5 seconds, and powers between 0.7 and 1 W. The endpoint was to produce a confluent greyish lesion extending to 100 μm beyond the observed limits of the membrane. During therapy, no patient perceived any sensation of bright flashes or complained about pain. The high transmission of infrared light through blood was demonstrated by the ability to treat subretinal membranes through a thin layer of preretinal blood. There was also excellent penetration through retinal edema and serous thickening. Angiographically proved closure of the membrane was achieved in seven eyes. Two eyes developed subfoveal membranes resulting in poor visual acuity. Post-treatment visual acuity ranged from 6/9 to 6/60. This pilot study suggests that diode laser photocoagulation is effective at inducing angiographic closure of CNV.</p>																									

Reference Catalog: Summaries of Studies

<p>AMD-CW4 Laser Photocoagulation of Subfoveal Neovascular Lesions of Age-Related Macular Degeneration Macular Photocoagulation Study Group Arch Ophthalmol 111:1200-1209, 1993</p>	<p>The focus of this report is on 4 year findings from the Subfoveal New CNV Study (<i>See AMD-CW2, pg. 1</i>) and 3 year findings from the Subfoveal Recurrent CNV Study. Four years after enrollment in the Subfoveal New CNV Study, 30 (47%) of 83 untreated eyes and 17 (22%) of 77 laser-treated eyes had lost six or more lines of VA from baseline levels (P=.002). At the 3 year examination in the Subfoveal Recurrent CNV Study, 21 (36%) of 58 untreated eyes and 6 (12%) of 49 treated eyes had lost six or more lines of VA from baseline levels (P=.009). Comparisons based on contrast threshold and reading speed for enlarged text also favor laser treatment in both trials.</p>
<p>AMD-CW5 A Pilot Study of Digital Indocyanine Green Videoangiography (ICG-V) for Recurrent Occult Choroidal Neovascularization in Age-Related Macular Degeneration Sorenson J, Yannuzzi L, Slakter J, Guyer D, Ho A, Orlock D. Arch Ophthalmol 112:473-479, 1994</p>	<p>A consecutive series of 66 patients were studied who presented exudative ARMD and symptoms and clinical manifestations of recurrent choroidal neovascularization (RO-CNV) in which fluorescein angiography did not reveal classic, or well-defined, neovascularization. Patients were selected for laser treatment based on conventional guidelines if ICG-V imaged a well-delineated area of recurrent CNV. ICG-V showed late staining that was consistent with recurrent CNV in 64 (97%) of these 66 patients with RO-CNV. Twenty-nine (44%) of the 66 were eligible for laser treatment, and 18 (62%) of these 29 patients experienced successful anatomic and visual results, which were defined as resolution of the exudative manifestations and improvement or stabilization (± 1 line on a Snellen chart) of vision. This study suggests that ICG-V is of value in imaging patients with RO-CNV after laser photocoagulation for CNV secondary to ARMD.</p>
<p>AMD-CW6 Visual Outcome After Laser Photocoagulation for Subfoveal Choroidal Neovascularization Secondary to Age-Related Macular Degeneration. The Influence of Initial Lesion Size and Initial Visual Acuity Macular Photocoagulation Study Group Arch Ophthalmol 112:480-488, 1994</p>	<p>The 189 eyes assigned to laser photocoagulation and the 184 eyes assigned to observation in the Subfoveal New CNV Study were divided into nine subgroups based on initial visual acuity and initial lesion size. Four patterns (A, B, C, D) of visual acuity loss in treated eyes relative to untreated eyes were identified. Eyes in group A (28% with small lesion and moderate or poor initial visual acuity or medium lesion and poor visual acuity) had the best visual outcome with treatment; treated eyes were better throughout follow-up. Eyes in group B (39% with small lesion and good initial visual acuity or medium lesion and moderate or good visual acuity) had substantial treatment benefit by 12 months, but were worse immediately after treatment. Eyes in group C (17% with large lesion and poor initial visual acuity) had a small treatment benefit throughout follow-up. Eyes in group D (17% with large lesion and moderate or good visual acuity) had the worst visual outcome with treatment; treated eyes were substantially worse for the first 18 months and were not appreciably better through 4 years of follow-up. Recommendations for treatment of subfoveal CNV should take account of the initial visual acuity and lesion size.</p>
<p>AMD-CW7 The Feeder Vessel in the Treatment of Exudative Age-Related Macular Degeneration Cuzzani O, Young P, van Westembrugge J. Video Presentation V24. XXVIIth ICO. Toronto, Canada, 1994</p>	<p>Laser treatment of subfoveal neovascular membranes implies a high risk of immediate decrease in central vision. This video presentation shows cases diagnosed with subfoveal neovascular membranes, and that indocyanine green video angiography performed with the SLO permitted the visualization of feeder vessels. Enhanced treatment within 10 minutes of the intravenous injection reduced the laser energy required for vessel ablation.</p>

Infrared Diode Laser Applications

<p>AMD-CW8 Diode and Krypton Laser Photocoagulation of Choroidal Neovascularization (CNV) Lanzetta P, Menchini U, Virgili G, Ferrari E, Soldano F*, Salati C, Miani F. *Department of Statistics; Univ. of Udine, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S235. Abstract nr 1067, 1995</p>	<p>Forty-six eyes of 46 patients affected with choroidal neovascularization (CNV) were divided into 23 matched pairs; both eyes of a matched pair had CNV with equivalent disease and clinical features (15 classic CNV, 3 occult CNV, 5 CNV with pigment epithelium detachment). One eye of each matched pair was treated with diode laser (805 and 807 nm) and the other eye with red krypton laser (647 nm). In the evaluation of visual acuity (VA), two line changes or greater of the Snellen chart were considered significant for visual improvement or worsening. The mean follow-up time was 6.2 months in the diode group and 7.8 months in the krypton group. In the group of eyes treated with diode laser, VA improved in 6 eyes, was unchanged in 14 eyes and worsened in 3 eyes. In the krypton group, VA improved in 6 eyes, was unchanged in 11 eyes and worsened in 8 eyes. Although the sample size was small and the follow-up time was brief, our preliminary evidence suggests that diode laser is useful in the treatment of CNV. The greater penetration of the wavelength and the more extensive chorioretinal atrophy induced by the diode laser could be effective in blocking CNV.</p>
<p>AMD-CW9 Macular Scatter Diode Laser Photocoagulation of Ill-Defined Subfoveal Choroidal Neovascularization in ARMD Desai VN, Olk RJ, Dhaliwal RS. Department of Ophthalmology; Washington Univ. School of Medicine; St. Louis, MO [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S235. Abstract nr 1069, 1995</p>	<p>Thirty-two eyes of 31 patients with primary ill-defined subfoveal choroidal neovascularization underwent diode infrared laser photocoagulation in a macular scatter pattern. On follow-up, 19 of the 32 eyes (59%) maintained visual acuity within two lines of pretreatment vision over an average of 3.82 months (range 0.5 - 11.0 months). Thirteen of the 32 eyes (41%) lost an average of 5.12 lines of visual acuity (range 2.5 - 9.0 lines) over an average of 5.08 months (range 1.0 - 7.5 months). Stabilization of visual acuity occurred after an average of 2.66 months. In 26 of the 32 eyes (81%) there was resolution of the exudation at an average of 2.75 months after treatment. Diode laser photocoagulation leads to the resolution of exudation in most patients with ill-defined choroidal neovascularization with stabilization of visual acuity in many cases.</p>
<p>AMD-CW10 Treatment of Choroidal Neovascular Membranes with Diode Laser Gómez-Ulla F, Suarez A, De Rojas V, Gomez M, Seoane I. Arch Soc Esp Oftalmol 69:527-534, 1995 Abstract - Spanish/English</p>	<p>Nineteen patients underwent diode laser treatment for choroidal neovascular membranes due to age-related macular degeneration, pathologic myopia and central serous choroidopathy. During a follow-up of 6 months, visual acuity was measured and Amsler grid test, biomicroscopy and angiograms were performed to evaluate the effect of the treatment. Results were evaluated according to visual acuity, efficacy, and complications of the treatment. The choroidal neovascular membranes were closed in all cases. Laser photocoagulation was only repeated in one patient in whom the choroidal neovascular membrane recurred 1 month after the first treatment. Diode laser is highly efficient over the short term in the treatment of choroidal neovascular membranes. It does not induce pain nor glare, and the size of the spot can be controlled while it is being administered, since the protective filter does not prevent the surgeon from seeing the retina.</p>

<p>AMD-CW11 Diode Laser Photocoagulation of Myopic Choroidal Neovascularization (CNV) Lanzetta P, Menchini U, Virgili G, Rapizzi E, Ferrari E. Department of Ophthalmology, Univ. of Udine, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S131. Abstract nr 621, 1996</p>	<p>The authors have previously shown that diode laser is useful in CNV during age related macular degeneration (<i>See AMD-CW8, pg. 3</i>). For this study, 12 eyes of 12 patients affected with myopic CNV were recruited. The presence of an extra-foveal, classic CNV was evaluated with fluorescein angiogram. A direct treatment of the CNV was conducted with a near-infrared wavelength diode laser (805 nm) extending 100 µm beyond the limits of the CNV. All patients were followed prospectively with clinical examination and fluorescein angiogram. In the evaluation of visual acuity (VA) two line changes or greater of the Snellen chart were considered significant for visual improvement or worsening. Expansion of diode laser induced lesion was evaluated during the follow-up time. The mean follow-up time was 12.1 months (range 3-17). Treatment parameters were a 160-200 µm spot with a power of 400-800 mW; exposure time varied from .5 to 1 second. CNVs in scarcely pigmented eyes required higher powers while in deeply pigmented CNVs, frequently seen in myopia, retinal whitening was easily obtained. All eyes but two underwent two laser treatments. At the end of the follow-up no recurrences were detectable. VA improved in 4 eyes, was unchanged in 8 eyes; the mean VA before the treatment was .43 (SD .20) and after the treatment was .53 (SD .28). The mean enlargement of the laser scar in the eyes considered was 38.3%. Conclusion: Although the sample size was small and the follow-up time was brief, the preliminary evidence suggests that the deeper penetration of the 810 nm diode laser could positively act on the CNV, and therefore plays a role in the treatment of myopic CNV.</p>										
<p> AMD-CW12 Diode Laser Photocoagulation of Choroidal Neovascular Membranes Lanzetta P, Virgili G, Menchini U. International Ophthalmology. 19:347-354, 1996</p>	<p>The authors studied 42 eyes of 41 patients affected with CNV which were treated with the OcuLight infrared diode laser. The mean follow-up was 10.12 months. Visual acuity improved in 12 eyes (28.6%), did not change in 17 eyes (40.5%), and worsened in 13 eyes (30.2%). Mean visual acuity before treatment was 0.23 and 0.21 after treatment. Recurrent CNV was seen in 13 eyes. In a subgroup of 24 well-defined juxtafoveal or extrafoveal CNVs which underwent direct photocoagulation visual acuity improved in 8 eyes (33.3%), was unchanged in 11 (45.8%), and worsened in 5 (20.9%). Five eyes showed recurrent CNV. Results appear to support the use of diode laser in the treatment of CNVs. The deeper penetration into the choriocapillaris of the diode wavelength could be effective in blocking CNV by inducing a more extensive chorioretinal atrophy.</p>										
<p>AMD-CW13 The Treatment of Macular Disease Using a Micropulsed and Continuous Wave 810-nm Diode Laser Friberg TR, Karatza EC. Ophthalmology 104:2030-2038, 1997</p> <p><i>Also listed as DME-MP5, pg. 72</i></p>	<p>Two studies are presented in this article. The objective of the first study was to determine whether the OcuLight 810 nm diode laser using continuous-wave exposures is clinically effective in the treatment of CNV from AMD. Fifty-three patients were treated in one eye for CNV (77% subfoveally) and were followed for 6 months.</p> <p>Treatment Parameters:</p> <table border="1"> <thead> <tr> <th>Power</th> <th>Exposure</th> <th>Duty Cycle</th> <th>Spot Size</th> <th>Endpoint</th> </tr> </thead> <tbody> <tr> <td>.15 - 1.2 W</td> <td>02. - 0.4 sec</td> <td>66%</td> <td>75 µ in foveal area; 125 - 200 µ outside fovea</td> <td>Very light lesions/ minimum visibility</td> </tr> </tbody> </table>	Power	Exposure	Duty Cycle	Spot Size	Endpoint	.15 - 1.2 W	02. - 0.4 sec	66%	75 µ in foveal area; 125 - 200 µ outside fovea	Very light lesions/ minimum visibility
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.15 - 1.2 W	02. - 0.4 sec	66%	75 µ in foveal area; 125 - 200 µ outside fovea	Very light lesions/ minimum visibility							

Infrared Diode Laser Applications

Results: Sixty percent (60%) of eyes treated had no persistence or recurrence at 6 months, and 74% achieved visual stabilization. Results are similar to conventional photocoagulation; except a longer duration was used (0.3-0.5 sec). Endpoint was ablative.

The second study was to determine if using a MicroPulse pulsed exposure with the OcuLight SLx 810 nm photocoagulator is clinically effective in the treatment of macular edema secondary to branch vein occlusion (BVO) (14 patients treated), or to diabetic retinopathy (59 patients treated, 40 of which were treated for the first time).

Treatment Parameters:

<u>Power</u>	<u>Exposure</u>	<u>Spot Size</u>	<u>Endpoint</u>
.2 - 1.2 W	0.3 - 0.5 sec	75 μ in foveal area; 125 - 500 μ outside fovea	Intense yellow-white lesions

Results: For Macular edema secondary to BVO: 92% of eyes treated showed clinical resolution by 6 months, and 77% had stabilization of visual acuity. For Macular edema secondary to diabetic retinopathy: 76% of newly treated patients and 67% of previously treated patients had clinical resolution. Vision was improved or stabilized in 91% of newly treated patients and 73% of retreated patients at 6 months. Despite the fact that microaneurysms were not specifically targeted, grid photocoagulation promoted the resolution of macular edema. From the authors' perspective, it appears that lesions and alterations in the retinal pigment epithelium, rather than closure of microaneurysms, play a salient role in edema fluid absorption. Although occasionally patients felt minimal discomfort during the administration of some of the laser lesions, none of them complained of pain during treatment. Conclusions: MicroPulsing in the macula is safe. Minimal threshold endpoint lesion results in resolution of edema.

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AGE-RELATED MACULAR DEGENERATION

<i>Feeder Vessel Photocoagulation of CNV</i>	
<p>AMD-FV1 Phi-Motion Angiographic Characterization of Feeder Vessel Hemodynamics and Treatment Strategies in Age-Related Macular Degeneration (AMD) Glaser BM, Flower RW, Murphy RP. Abstract. The Macula Society. San Diego, CA. February 24-27, 1999</p>	<p>This study was performed to characterize the hemodynamics and pathobiology of FVs associated with subfoveal CNV in AMD using multiple high-speed pulsed-laser ICG Phi-motion angiography. Multiple dye injections were performed through a small gauge catheter inserted into an arm vein connected to a four-way stopcock. The stopcock permitted multiple injections of 0.4 ml boluses containing 25 mg/ml ICG, followed by 5 ml saline flushes. Angiograms were obtained using either a Heidelberg SLO at 20 images/sec or a specially designed system using a pulsed 805 nm diode laser to acquire 30 images per second. The initial angiogram indicated lesion orientation, extent and rate of dye movement into the CNV. Image focus, orientation and brightness were adjusted for subsequent angiographic sequences. Three types of lesions were studied: 1) fresh, subfoveal CNV 2) recurrent subfoveal CNV 3) subfoveal fibrosis. The first series contained 27 eyes with recent (<3 months), previously untreated, subfoveal CNV. In 16 of these eyes, FVs could be identified using Phi-Motion angiography. In 15 of these 16 eyes, segments of the FVs could be treated outside the FAZ. In the second series of 8 eyes with recurrent subfoveal CNV, FVs emanated from the previous extrafoveal laser scar. In the third series containing 7 eyes with subfoveal fibrosis, 2 eyes had subfoveal areas of leakage within the fibrosis emanating from FVs. Leakage often resolved and vision improved after treating FVs. Conclusion: FVs outside the foveal avascular zone can be found in the majority of previously untreated cases of CNV in AMD. Eyes in recurrences usually have FVs emanating from within the previous laser scar. In addition, more investigations are warranted to determine if there is efficacy in treating certain eyes with subretinal fibrosis.</p>
<p>AMD-FV2 Improved Identification and Treatment of CNV Feeder Vessels, Using Phi-Motion Angiography (A Macula Society Research Grant Status Report) Flower RW, Glaser BM, Murphy RP. Abstract. The Macula Society. San Diego, CA. February 24-27, 1999</p>	<p>The purpose of this study was to determine the frequency with which potentially treatable FVs of juxta- and subfoveal AMD-associated CNV can be detected by analysis of multiple sequences of ICG angiogram images acquired with high-speed pulsed-laser fundus illumination. Secondly, to demonstrate the efficacy of treating identified CNV FVs with laser photocoagulation. To facilitate multiple dye injections, an I.V. catheter with a flexible connector loop (for comfortable manipulation) is inserted in an arm vein; patency is maintained by periodic infusion of isotonic saline, via a four-way stopcock. The other stopcock arm permits injection of 0.4 boluses of 25 mg/ml ICG dye, followed by 5 ml saline flushes. Each angiogram image is acquired during a 2 msec interval when the fundus is illuminated by a pulse of 805 nm diode laser light; images are recorded at the rate of 30/sec. The initial angiogram indicates lesion orientation and extent, rate of dye movement into the CNV, and rates of fluorescence intensity increase in potential CNV-related vessels. Image focus, brightness, rate, and other image parameters are adjusted for acquisition of subsequent angiograms. In patients for whom conventional treatment was likely to cause significant, irreparable damage to retinal foveal tissue and where disease progres-</p>

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	<p>sion is highly likely, krypton red laser photocoagulation of CNV FVs was performed. To date, potentially treatable FVs are being found in more than 60% of patients. Phi-motion angiography (after the phenomenon of smooth motion in a sequence of individual images showing discontinuous motion), viewing HSPL angiogram segments in loop-like fashion, makes visible FVs and the direction of blood flow through them that are not obvious in the individual images. A hallmark of many FVs is greater-than-heart-rate pulsatile flow. Conclusion: Phi-motion angiography, coupled with more sophisticated analysis than by-eye-only examination of individual images, can identify potentially treatable CNV FVs.</p>
<p>AMD-FV3 Dye Enhanced Photocoagulation: Interest of ICG Blood Clearance Monitoring for Reproducible 810 nm Diode Laser Coagulation of Blood Vessels Desmettre T,^{1,2} Soulié-Bégu S,³ Devoisselle JM,³ Mordon S.² ¹Centre d'Imagerie & Laser, Clinique de Lambersart, 59130 Lambersart, ²INSERM EA 2084 IFR22, CH&U Lille 59037 Lille, ³Laboratoire de TPI, UFR Pharmacie Montpellier, 34060 Montpellier, France [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S321. Abstract nr 1702, 1999</p>	<p>The purpose of this study was to evaluate a method of control of infrared diode laser fluence leading to a reproducible ICG-enhanced selective photocoagulation of blood vessels. This method uses the chromophore clearance, i.e. ICG blood concentration decay to adapt the laser fluence. A skin flap window was used on hamsters. After a 15 mg/kg ICG solution injection, photocoagulation of vessels was performed. Selective photocoagulation of blood vessels was obtained only during the first 10 minutes (related to the dose of ICG). The fluence required to obtain a selective photocoagulation of vessels (F) was modeled using a one compartment pharmacokinetic equation: $F = F_0 (1 - e^{-t/\tau})$. The best fit was obtained for a time constant $\tau = 4.8$ min and $F_0 = 300$ J/cm² (correlation coefficient $r^2 = 0.996$). During the first 10 minutes, the fluence required for selective photocoagulation of vessels was increased by a factor of 4.5. Conclusion: Fluence required for a selective photocoagulation of vessels was correlated to ICG blood concentration decay. The time constant was equivalent to ICG half-life time in human blood. These results demonstrate that diode laser ICG-enhanced photocoagulation can be controlled by monitoring the laser fluence according to ICG blood clearance.</p>
<p>AMD-FV4 Indocyanine Green Enhanced Laser Treatment of Feeder Vessels of Choroidal Neovascularization Staurenghi G,^{1,2} Orzalesi N,² Massacesi A,² Migliavacca L,² Maestroni L,² Gandolfo E.¹ ¹University Eye Clinic, Spedali Civili, Brescia, Italy, ²University Eye Clinic, San Paolo Hospital, Milan, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S178. Abstract nr 930, 2000</p>	<p>Fifteen consecutive patients with FVs identified using ICG and FA were treated using an IRIS Medical 810 nm diode laser in the course of intravenous injection of 20% ICG solution. FVs larger than 100mm diameter, with a power of 500-600 mW and an exposure time of 200 msec in a micropulsed way (100 msec laser and 100 msec interval) were applied on the FVs. Angiographies were performed immediately after the laser treatment and during the follow-up visits. Follow-up visits were scheduled at 1 week, 3 weeks and 2 months. The mean width of FVs was 160 mm (90-200 mm). Ten minutes after treatment obliteration of FVs was achieved in 40% of the vessels; 1 and 3 weeks after treatment it was maintained in 30%. A localized choroidal edema was visible immediately after the treatment in 80% of the treated eyes, reaching a maximum after 1week. These results seem to indicate that ICGELT allows treatment also of larger FVs (up to 200 mm width) with respect to those successfully treated with 532 nm laser (Staurenghi et al. Ophthalmology Dec 1998, Invest Ophthalmol Vis Sci 1999).</p>

Infrared Diode Laser Applications

<p>AMD-FV5 Pilot Study to Examine the Outcomes Following Laser Treatment of Modulating Choroidal Vessels Associated with Pigment Epithelial Detachments Baudo TA, Glaser BM, Lakhanpal RR, Lin SB, Gould DM, Murphy RP. Glaser Murphy Retina Treatment Center Chevy Chase/Towson, Towson, MD. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S179. Abstract nr 931, 2000</p>	<p>Seven eyes of 7 patients with serous PEDs associated with AMD were investigated with high-speed phi-motion indocyanine green (HSICG) and FA in order to identify vessels that would modulate choroidal leakage and sub-RPE fluid accumulation. HSICG was performed using a SLO. The role of the identified choroidal blood vessels in modulating sub-RPE fluid accumulation was determined by the effect of laser treatment. All patients were followed for a 6 month interval beginning with the first laser treatment. Results of VA, FA, and HSICG were documented for each visit. All except one of the modulating choroidal vessels that were treated emanated from outside the PED and appeared at or slightly before dye filled the retinal vasculature. The average number of vessels treated per eye was 3.4. The average number of treatments per eye was 4.14. FA and biomicroscopy showed decreased leakage and flattening of the PED in 5 of 7 (71.4%) patients and was unchanged in 2 of 7 (28.6%) patients. Snellen VA improved in 5 of 7 patients (71.4%), and worsened in 2 of 7 (28.6%) of patients at 6 month follow-up. The average change in VA at 6 months was an improvement of 0.86 lines. The best-measured visual improvement post laser therapy averaged 2.21 lines. The maximum improvement in VA post laser therapy occurred at an average of 3.39 months. No patients developed a retinal pigment epithelial rip after laser treatment. Conclusions: Further studies may enhance our understanding of the vascular architecture of PEDs and determine whether HSICG guided modulating vessel treatment may offer a low risk therapeutic option for the treatment of PEDs.</p>
<p>AMD-FV6 Identification and Treatment of Modulating Choroidal Vessels Associated with Occult Choroidal Neovascularization Glaser BM, Murphy RP, Lakhanpal RR, Lin SB, Baudo TA. Glaser Murphy Retina Treatment Center, Chevy Chase/Towson, MD. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S320. Abstract nr 1687, 2000</p>	<p>The role of the choroidal blood vessels identified by high-speed phi-motion indocyanine green (HSICG) in modulating sub-retinal fluid accumulation and FA leakage in 37 consecutive eyes with occult CNV was determined by studying the effect of laser treatment on each vessel. HSICG was performed using a SLO. The characteristics of these modulating choroidal vessels (MCV) were catalogued and compared. Results of VA, FA, and HSICG were documented for each visit. Results: Linear, small diameter choroidal vessels were noted on HSICG at the time of retinal vascular filling or shortly thereafter. Of the 37 eyes in which these modulating choroidal vessels (MCVs) were treated with laser, 31 had successful closure demonstrated on HSICG angiography. The average number of laser treatments required to close an MCV was 1.6 (range 1-4). Of the 37 treated eyes, 28 (76%) had resolution of retinal thickening and SRF clinically and 29 (78%) had resolution or diminution of leakage on FA. Utilizing LOGMAR acuities based on ETDRS standards, visual improvement occurred in 29/37 (78%) patients following treatment. A total of 25/37 (68%) improved by at least one line of vision, 16/37 (43%) improved by at least two lines, and 11/37 (30%) improved by at least three lines of vision. These patients improved overall post-treatment by an average of 1.5 lines of vision. Recurrence was defined as re-perfusion of a vessel that was closed for at least 1 month. The recurrence rate was 27% over 6 months. Conclusions: Laser treatment of modulating vessels in eyes with occult CNV results in decreased SRF and decreased leakage on FA followed by some improvement in vision. Further evaluation will determine what role these findings will have in the management of occult CNV.</p>

<p>AMD-FV7 Pigment Epithelial Detachments: Visual Improvement After Laser Treatment of Modulating Choroidal Vessels Baudo T, Glaser B, Lin SH, Lakhanpal R, Murphy R. AAO Poster. 134. Dallas, TX, 2000</p>	<p>Eight eyes of 8 patients with serous PEDs associated with AMD were investigated using clinical examination, FA, and high-speed indocyanine green angiographic (HSICG) (performed using a Scanning Laser Ophthalmoscope (SLO); (Heidelberg Engineering, Heidelberg, Germany) to identify the presence of modulating choroidal vessels(s). HSICG images were captured during the initial filling of the choroid at a rate of 6 to 12 images per second. Laser treatment was applied to the modulating choroidal vessels (MCV) using the 810 nm diode laser. Results of VA, clinical examination, FA, and HSICG were documented for each visit. All patients were followed for a minimum of 6 months beginning with the first laser treatment. Results: All except one of the MCV that were treated emanated from outside the PED and appeared at or slightly before dye filled the retinal vasculature. The average number of vessels treated per eye was 3.75. The average number of treatments per eye was 3.6. FA and biomicroscopy showed decreased clinical leakage and flattening of the PED in 7 of 8 (87.5%) patients and was unchanged in 1 of 8 (12.5%) patients. Snellen VA improved in 6 of 8 patients (75%), was unchanged in 1 of 8 (12.5%) patients, and worsened in 1 of 8 (12.5%) patients at a minimum of 6 months follow-up. Mean follow up was 7.1 months. The average change in VA at 6 months was an improvement of 0.75 lines with a range of 1 to 2 lines improvement. No patients developed a retinal pigment epithelial rip after laser treatment. Conclusions: Further studies may enhance our understanding of the vascular architecture of PEDs and determine whether HSICG guided modulating choroidal vessel treatment may offer a low risk therapeutic option for the treatment of PEDs.</p>
<p>AMD-FV8 Combining Photodynamic Therapy and Feeder Vessel Photocoagulation: A Pilot Study Staurenghi G,^{1,2} Sickenberg M,³ Massacesi AL,² Orzalesi N.² ¹Department of Ophthalmology, University of Brescia, Brescia, Italy; ²University Eye Clinic, Institute of Biomedical Science, San Paolo Hospital, Milan, Italy; ³Lausanne, Switzerland. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S230. Abstract nr 1241, 2001</p>	<p>The aim of this study was to test the possibility of improving the extent and duration of photodynamic therapy (PDT) using the FV treatment technique. Fifty consecutive CNVM patients who had received PDT and experienced a recurrence after 7-60 days were studied by means of dynamic indocyanine green angiography (d-ICGA) using a confocal scanning laser ophthalmoscope (Heidelberg Engineering, Heidelberg, Germany), which allowed the identification of a racquet-like FV in 20 cases, ten of whom were randomly assigned to FV treatment with an IRIS Medical OcuLight 532 nm laser. VA was evaluated using ETDRS charts and metamorphopsia by means of the standardized Amsler test. The FVs were obliterated in 7/10 eyes (70%), with persistent obliteration for more than 3 months being achieved in five cases (50%). The mean VA in the treated group was 50/200 before FV treatment and 64/200 after 3 months; in the untreated group, VA was 40/200 when the recurrence was detected and 32/200 after 3 months. Metamorphopsia in the obliterated FVs decreased after 1-4 days. Conclusions: The possibility of closing recurrent CNVMs with FV treatment seems to be feasible. The immediate decrease in metamorphopsia, the limited treatment-induced damage and the better outcome of these patients suggest the need for further research.</p>

<p>AMD-FV9 Feeder Vessel Identification: The Learning Curve Salvetti P,¹ Massacesi AL,² Viola F,¹ Musicco I,¹ Staurengi G.^{1,2} ¹Department of Ophthalmology, University of Brescia, Brescia, Italy; ²University Eye Clinic, Institute of Biomedical Science, San Paolo Hospital, Milan, Italy. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S231. Abstract nr 1242, 2001</p>	<p>The aim of this study was to evaluate the training of unexperienced observers in FV identification. Sixty-five consecutive patients with AMD with or without CNVM underwent dynamic fluorescein angiography (d-FA) and dynamic indocyanine green angiography (d-ICGA) performed using a confocal scanning laser ophthalmoscope (Heidelberg HRA, Heidelberg, Germany). All of the angiographies were performed by F.V. and I.M. following previously published methods (G. Staurengi et al. Ophthalmology 1998;105:2297-2305) and then studied by three independent observers: one with 5 years (G.S. - S), one with 1 year (A.M. - W) and one with no experience (P.S. - D). The identification of the FV was recorded together with the number of repeat evaluations of the recorded angiographies needed for its identification. Kappa statistics were used to evaluate the inter- and intraobserver agreement measured at the beginning of the study (time 0) and after 1 year of training. Results: The inter-observer agreement between S and W J was K = 0.87 at time 0 (K0) and 0.93 after 1 year (K1), and that between S and D was K0 = 0.27 and K1 = 0.81. The intraobserver agreement in S was 0.98. The number of repeat evaluations needed decreased over time from 1.6 to 1.15 (S), from 1.8 to 1.37 (W) and from 2.2 to 1.75 (D). Conclusions: Inter- and intraobserver agreement was excellent after one year even in the unexperienced observer. The duration of the learning curve is about 12 months. FV identification does not seem to be a difficult technique to learn.</p>
<p> AMD-FV10 Feeder Vessel Treatment for Age-Related Macular Degeneration (AMD) with Classic Choroidal Neovascularization (CNV) Glaser BM, Baudo TA, Velez G, Luu JK, Murphy RP. Glaser Murphy Retina Treatment Centers, Chevy Chase/Towson, MD. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S231. Abstract nr 1243, 2001</p> <p>MIP</p>	<p>To report on the effects of FV treatment for AMD with classic CNV, consecutive patients with FA evidence of classic CNV were evaluated. VAs were Snellen and/or ETDRS and were converted to ETDRS equivalents. Initial VA was 20/63 or worse. FVs were identified and monitored using high-speed ICG angiography guided by FA. FV closure was accomplished using an 810 nm laser, set at a 75-200 micron spot size, pulse duration of 100 ms, 50% duty cycle (millipulse mode), for a total average duration of 90 seconds. Laser energy was gradually increased to create graying of the RPE without visible retinal reaction. Endpoint of treatment was closure of the FV(s) on High-speed ICG angiography. At an average 6 months follow-up of 33 eyes of 33 patients, only 6/33 (18%) eyes lost the equivalent of ≥3 lines of vision and 3/33 (9%) lost ≥6 lines. Vision improved by ≥3 lines in 11/33 (33%) eyes. Conclusions: Patients receiving FV treatment for AMD with classic CNV fared better than the natural history. In a recent report, 36% of patients with classic CNV lost ≥3 lines after 6 months (Arch Ophthalmol 1999; 117:1329-1345). In contrast, only 18% of eyes receiving FV treatment in our current series lost ≥3 lines.</p>
<p> AMD-FV11 Feeder Vessel Treatment for Age-Related Macular Degeneration (AMD) with Subfoveal Fibrovascular Choroidal Neovascularization (CNV) Murphy RP,¹ Lin SB,² Glaser BM.¹ ¹Glaser Murphy Retina Treatment Centers, Chevy Chase/Towson, MD; ²The Eye Care Center, Pottsville, PA. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S231. Abstract nr 1244, 2001</p> <p>MIP</p>	<p>Eleven eyes of 10 patients with clinical and FA evidence of subfoveal fibrovascular CNV were evaluated. FV were identified and monitored using high-speed ICG angiography guided by FA. FV closure was accomplished using an 810 nm laser, set at a 75-200 micron spot size, pulse duration of 100 milliseconds, 50% duty cycle (millipulse mode), for an average total duration of 2 to 3 minutes. Laser energy was gradually increased during treatment to create a mild gray RPE effect without visible retinal reaction. Endpoint of treatment was closure of the FV(s) on high-speed ICG angiography. VAs were Snellen and/or ETDRS and were converted to ETDRS equivalents. Initial VA ranged from 20/200 to 20/800. Results: Eleven eyes of 10 patients were followed for an average of 11 months after treatment. The</p>

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	<p>amount and extent of subretinal fluid and hemorrhage decreased with a concomitant decrease in fluorescein leakage in 10 of 11 eyes. VA improved in 7 of the 11 eyes and remained unchanged in 4. Mean VA improvement was 3.22 lines. Conclusions: Eyes with longstanding subfoveal fibrovascular CNV receiving FV treatment for AMD can improve. Closure of the FVs with resolution of all or most of the overlying serous retinal detachment was presumed to be the mechanism.</p>
<p>AMD-FV12 Measurement of Flow Velocities in Feeder Vessels Yamamoto Y, Shiraga F, Tuchida Y, Ohtuki H. Dept Ophthalmology, Okayama University Medical School, Okayama, Japan. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S800. Abstract nr 4288, 2001</p>	<p>To measure flow velocities in FV of CNV secondary to AMD, early images of ICG angiography in 29 eyes with CNV secondary to AMD, in which FV could be identified, were examined. ICG videoangiographic images recorded at 30 frames per second with a scanning laser ophthalmoscope were installed in a personal computer. With original software, optical density measurements by an image analyzer were performed on ICG videoangiograms for determination of dye-dilution curves. The time (T50) from the beginning of a dye-dilution curve to the ascending parts of the curve at 50% of the peak intensity was calculated. A flow velocity in a FV was obtained by dividing the distance between two points by the circulation time between T50s at the two points on the FV. Results: The mean flow velocity in FVs was 33.8/32.5 mm/sec. The mean velocity in the FVs of large CNV with greatest linear diameter of 1 disc diameter (DD) or larger was 43.4/30.6 mm/sec; while the mean velocity in the FV of small CNV with greatest linear diameter smaller than 1DD was 20.3/20.2 mm/sec. There was a significant difference between them. Conclusions: The flow velocity in FVs of CNV could be measured with ICG angiography and a computer-based image analysis system. The flow velocity in FVs might be lower than choroidal arterioles and vary with CNV size.</p>
<p>AMD-FV13 High-Speed Phi-Motion ICG Characteristics and Feeder Vessel Treatment of Polypoidal Choroidal Vasculopathy in Age-Related Macular Degeneration Somaiya MD, Glaser BM. Glaser Murphy Retina Treatment Centers, Towson/Chevy Chase, MD 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2509, 2002</p>	<p>To study the dynamic vascular pattern of polypoidal choroidal vasculopathy (PCV) in a consecutive series of elderly multi-ethnic patients using High-speed, Phi-motion indocyanine-green angiography (HS-ICG), a consecutive series of 451 eyes of 335 multi-ethnic patients were evaluated. All patients were diagnosed with exudative AMD. The CNV was further characterized by FA and HS-ICG in all patients. Results: Ten of 451 (2.2%) consecutive eyes presenting with CNV and AMD were diagnosed with PCV via HS-ICG, static ICG and FA imaging. The PCV tended to occur in clusters with a total of 15 clusters in the 10 eyes evaluated. Of the 15 clusters of PCV, 9 (60%) had a subfoveal location, 4 (26.7%) were located in the macula with foveal sparing, and 2 (13.3%) were peripapillary. FVs were identified in 7 of the 10 PCV eyes. Five of the 7 FVs directly supplied the PCV. Regression of subretinal fluid, hemorrhage and lipid, with attenuation or resolution of the polypoid dilatations 6 months after 810 nm FV treatment occurred in 6 of the 7 treated PCV eyes. A mean number of 4.6 treatments were required to obtain the reported results. VA at the last follow-up of 1.5 to 22 (mean = 13.5 months) months following initial treatment remained within +/- 2 lines of pre-treatment vision in all eyes. Conclusion: HS-ICG is a useful tool for the identification and characterization of PCV as well as the identification of associated FVs. FV treatment can result in regression of the PCV lesions that are supplied directly by the FV. Interestingly, even in cases where the FV supplied a larger lesion containing PCV, treatment of the FV caused regression of the PCV. These findings provide a better understanding of the angio-architecture of PCV.</p>

New

Infrared Diode Laser Applications

<p> New</p>	<p>AMD-FV14 Feeder Vessel Treatment of Recurrent Choroidal Neovascularization (CNV) Luu JK,¹ Baudo TA,² Glaser BM.¹ ¹Glaser Murphy Retina Treatment Centers, Towson/Chevy Chase, MD; ²Florida Eye Institute, Vero Beach, FL 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2510, 2002</p>	<p>To evaluate FV treatment of recurrent CNV associated with the scar of previous MPS-type treatment, FVs were treated in 16 consecutive eyes based on FA and High-Speed ICG images. Fifteen of 16 eyes had classic CNV. All had 810 nm FV treatment within the scar. One had additional FV treatment outside the scar. Vision was measured at 6 months and 12 months and compared to baseline VA prior to treatment. Results: Treatment of FVs attenuated or closed the CNV in all patients. Vision improved ≥ 2 lines in 7/16 (44%) and remained stable (± 2 lines) in 9/16 (56%) eyes at 6 months. Twelve patients were followed for 12 months or more. In this group, 4/12 (33%) improved ≥ 2 lines, 7/12 (58%) remained stable and 1/12 (.8%) had vision decrease by 6 lines. No patients experienced a loss of more than 6 lines at any point during the study period. Conclusion: Recurrent CNV can be safely and effectively treated using the FV technique.</p>
<p> New</p>	<p>AMD-FV15 Anatomic and Flow Characteristics of Feeder Vessels in Choroidal Neovascular Membranes Staurengi G, Musicco I, Salvetti P, Viola F. Department of Ophthalmology, University of Brescia, Brescia, Italy. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2512, 2002</p>	<p>To determine how the results of FV treatment depend on the anatomic and flow characteristics of FVs in CNVM, a group of 50 consecutive patients in which FVs could be identified and immediately obliterated using a laser treatment with 532 nm or 810 nm were studied. A confocal scanning laser ophthalmoscope was used to perform dynamic indocyanine green angiography (d-ICGA) and dynamic fluorescein angiography (d-FA) in order to characterize FV size, shape, visibility, flow characteristics and location relative to the RPE. Two independent observers who were masked for visual and anatomic outcomes independently evaluated FV characteristics and treatment results retrospectively. Results: Lesion size ranged from 80 μm to 125 μm. There were two primary FV classes: (1) linear regular vessels, more common in the occult lesions, and (2) tortuous beading vessels. Flow was considered to be delayed if FVs filled after retinal vessels. Patients with slow-filling, tortuous beading vessels of small size had the best treatment outcomes. Conclusion: The anatomic and flow characteristics of FVs are potentially useful for predicting clinical outcomes in FV treatment and for optimizing patient selection and treatment strategy.</p>
<p> New</p>	<p>AMD-FV16 Feeder Vessel (FV) Treatment of Choroidal Neovascularization (CNV) With Sub-Tenon's Corticosteroid Injection as Adjuvant Therapy <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">MIP</div> Tuller RE, Glaser BM, Luu JK. Chevy Chase/Towson, MD 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2513, 2002</p>	<p>The charts of 7 patients (7 eyes), who underwent FV treatment and received sub-Tenon's corticosteroid injection for CNV, were studied. Patients evaluated in this retrospective chart review were treated with sub-Tenon's corticosteroid injection(s) after receiving multiple FV laser treatments for recurrent or persistent CNV with subretinal fluid. Endpoint of treatment was regression of CNV and resolution of SRF as noted by clinical exam, FA and high-speed ICGA. Two retina specialists performed the clinical exam and angiographic interpretation. FV laser treatment was performed using an 810 nm laser, set at a 75 micron spot size, pulse duration of 100 milliseconds, 50% duty cycle (millipulse mode), for an average total duration of 400 to 800 spots. The sub-Tenon's corticosteroid injection consisted of 0.5 cc of dexamethasone 4 mg/ml and 0.5 cc of triamcinolone 40 mg/ml with a 1ml TB syringe and 25 g needle. Proparacaine HCl 0.5% was used for topical anesthesia. Results: In the 7 patients, multiple FV treatments had been applied before considering sub-Tenon's steroids. Patients in this group had received a mean of 10.4 laser treatments (range 3 – 14) without regression of CNV and resolution of SRF. However, in all 7 cases, the subsequent combination of sub-Tenon's steroids with FV treatment resulted in ensuing regression of CNV and resolution of SRF requiring only a mean of</p>

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New

	<p>2.7 additional FV treatments (range 1 – 6). Conclusions: In these patients, a trend was noted towards enhanced regression of CNV and resolution of SRF with the addition of corticosteroid sub-Tenon's injection to FV treatment. Corticosteroids have an antiangiogenic capacity that may prove useful in the treatment of CNV. The role of sub-Tenon's or even intravitreal corticosteroids as an adjunct to treatments for CNV warrants further study.</p>
<p>AMD-FV17 Clinical Observations Supporting a Theoretical Model of Choriocapillaris Blood Flow in Treatment of Choroidal Neovascularization Associated With Age-related Macular Degeneration Staurengi G, Flower RW. Am J Ophthalmol 133:801–808, 2002</p>	<p>An interventional case series was conducted to report clinical observations consistent with conclusions from a previous theoretical investigation (Flower RW et. al: Theoretical investigation of the role of choriocapillaris blood flow in treatment of subfoveal choroidal neovascularization associated with age-related macular degeneration. <i>Am J Ophthalmol</i> 2001;132:85-93.) indicating that photocoagulation of CNV efferent vessels can be, in some instances, an effective treatment. Five eyes with AMD required treatment of CNV. In each case, the appropriate treatment was location and photocoagulation of the CNV efferent vessels, since the afferent vessels were not identifiable or were located beneath the fovea. A 532 nm OcuLight photocoagulator was used. Targeted vessels were determined to be draining vessels by analysis of pretreatment high-speed ICG angiograms, and successful vessel closure by photocoagulation was demonstrated by post-treatment ICG angiograms.</p> <p><u>Treatment Parameters</u> Photocoagulation treatment of the targeted CNV efferent vessels varied somewhat from patient to patient, depending on the size and location of each vessel. Photocoagulation energy was delivered as a train of laser light pulses falling within the following range of parameters:</p> <p>Laser spot diameter: 75–125 µm Laser pulse power: 90–150 mW Laser pulse duration: 200 ms Interval between pulses: 200 ms Number of laser pulses: 120–600</p> <p>The eyes were followed from 2 to 12 months. After photocoagulation of efferent vessels, CNV-related retinal edema was significantly reduced or resolved within 1 to 4 days. VA became stabilized in 3 eyes and improved in 2 eyes. In a few days, metamorphopsia disappeared in 4 of the eyes and was stable for a period longer than the duration of the associated efferent vessel closure. Initial efferent vessel closure by photocoagulation persisted on average for 7 to 15 days, after which additional treatment was required. It is significant that in no case did hemorrhage result from the photocoagulation treatment. Conclusions: These observations are consistent with the earlier theoretical study prediction that photocoagulation of efferent CNV vessels can be effective in reducing CNV-associated edema. That no hemorrhage was induced by photocoagulation is consistent with the theoretical concept that there appears to be no direct hydrostatic connection between the CNV and its afferent vessels. Rather, that connection appears to be a functional one made through the choriocapillaris, which may dissipate excess CNV hydrostatic pressure produced by occlusion of a draining vessel. However, this finding is not intended to be a recommendation to attempt CNV efferent vessel photocoagulation.</p>

AGE-RELATED MACULAR DEGENERATION

LongPulse™, Low Irradiance Transpupillary Thermotherapy (TTT) Photocoagulation of CNV	
<p>AMD-TTT1 Transpupillary Thermotherapy Reichel E. MIP Abstract. Advanced Ophthalmic Laser Surgery Course. Interlaken, Switzerland, June, 1997 <i>Also listed as OCU-TTT12, pg. 158</i></p>	<p>TTT was used to treat choroidal lesions with the infrared 810 nm diode laser (OcuLight SLx photocoagulator and Haag-Streit slit lamp adapter with adjustable beam widths of 1.2, 2.0 and 3.0 mm.) Treatment parameters – Power: start at 300 mW (average power of 500 to 700 mW), Spot Size: 2 or 3 mm, Duration: 1 minute, Endpoint: a very subtle gray-brown discoloration. The conditions treated included choroidal melanoma, idiopathic polypoidal choroidal vasculopathy, and well-defined and occult choroidal neovascularization (CNV). Treating choroidal melanomas may require multiple sessions and can treat tumors 5.0 mm in height. Fifty percent tumor thickness reduction can be seen within 6 months. Complications may include overlying BRAO/BRVO, retinal, choroidal, or vitreous hemorrhage, and retinal neovascularization. Closure in well-defined CNV can be obtained. A serous PED can be flattened in occult CNV. In all CNV, no thermal damage to the retina was observed and in most cases visual acuity was preserved.</p>
<p>AMD-TTT2 Transpupillary Thermotherapy of Subfoveal Choroidal Neovascularization in ARMD Desai V, Reichel E, Kroll A, Duker J, Puliafito C. MIP New England Eye Center, Tufts Univ. School of Medicine, Boston, MA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S385. Abstract nr 1793, 1998</p>	<p>Twenty-nine eyes of 28 patients with subfoveal choroidal neovascularization, secondary to age-related macular degeneration, were treated with TTT using a modified infrared diode laser at 810 nm and adjustable beam width with 1 minute exposure time. Twenty-seven of 29 eyes (93%) maintained visual acuity within ± 2 lines of pretreatment vision over an average of 5.41 months (range 1 – 14 months). Nineteen of 29 eyes (66%) had a decrease or resolution in exudation following treatment. The average number of treatments was 1.21. TTT leads to stabilization of visual acuity in most patients with subfoveal choroidal neovascularization secondary to age-related macular degeneration. Many patients with subfoveal neovascularization will have a decrease or resolution in exudation after transpupillary thermotherapy.</p>
<p>AMD-TTT3 Transpupillary Thermotherapy Reichel E. MIP Abstract. The Royal Hawaiian Eye Meeting. Hawaii, January 24 – 29, 1999</p>	<p>TTT is a technique whereby hyperthermia is delivered to the choroid and RPE through the pupil using a modified, 810 nm diode laser. TTT results in a lower temperature being delivered to the RPE/choroid; therefore collateral damage to the neurosensory retina is minimized. A series of patients who had occult CNV, and best corrected pre-operative visual acuity of 20/400 or better, received TTT treatment through a slit lamp (with an adjustable beam width of 1.2 mm, 2.0 mm, and 3.0 mm) and modified 810 nm OcuLight photocoagulator. Treatment was initiated with one spot for 60 seconds and a power setting of 500 to 700 mW. Typically, there was no visible color change to the retina after treatment. After an average follow-up of 1 year, more than 90% of patients had a marked improvement in subretinal exudation and visual acuity improved in 50% of the patients and stabilized in 25%. A mild decline of vision was observed in 25% of the patients. TTT represents a novel technique for treating occult CNV. This pilot study suggests its efficacy; however, larger randomized, prospective studies are necessary to prove the effectiveness of this treatment technique.</p>



<p>AMD-TTT4 Transpupillary Thermotherapy (TTT) of Occult Subfoveal Choroidal Neovascular Membranes in Patients with Age-Related Macular Degeneration</p> <p>MIP</p> <p>Reichel E, Berrocal AM, Ip M, Kroll AJ, Desai V, Duker JS, Puliafito CA. Ophthalmology 106:1908-1914, 1999</p>	<p>In this case series, 16 eyes of 15 patients were treated with TTT. All patients underwent pre-treatment fluorescein angiography. TTT was delivered using the 810 nm OcuLight diode laser. A variable spot size of 1.2 mm, 2.0 mm and 3.0 mm was used depending on the size of the CNV. The diode laser was delivered through a contact lens and treatment was initiated in one spot for 60 seconds duration at a power range between 360 mW and 1000 mW. The endpoint was an area of no visible color change to a light-gray appearance. Preoperative and postoperative Snellen chart visual acuities were compared. In 10 eyes, preoperative and postoperative fluorescein angiography and OCT were compared for exudation. In the remaining 6 eyes, exudation was measured by postoperative clinical exam alone. Results: Fifteen eyes or 94% demonstrated decreased exudation on fluorescein angiography, OCT, and/or clinical exam. Twelve eyes (75%) showed stabilization and/or a two-or-more-line improvement in their VA over a period ranging from 6 months to 25 months. The remaining 4 eyes (25%) showed a decline (equal to one-line worsening or greater) in VA. Conclusion: TTT shows no deleterious side effects and may stabilize vision and decrease exudation in patients with occult subfoveal CNV secondary to AMD. A randomized, prospective study is necessary to evaluate treatment efficacy.</p>
<p>AMD-TTT5 Transpupillary Thermotherapy of Occult Choroidal Neovascularization</p> <p>MIP</p> <p>van Hogerwou AJM, Tigchelaar-Besling OAM, Deutman AF Abstract. Netherlands Society of Ophthalmology (NOG) Annual Meeting. March 2000</p>	<p>To evaluate the treatment of occult subfoveal CNV, a retrospective, non-comparative case series of 14 eyes of 14 patients were treated with TTT. All patients underwent preoperative and postoperative visual acuity examination. A FA was made in preoperative and postoperative state. The exudation was measured by clinical examination and by FA.</p> <p><u>Treatment Parameters</u> Power: 600 – 850 mW Duration: 60 seconds Spot Size: 3 mm Retreatments: 1 eye received 2 treatments</p> <p>The mean follow-up was 8 months. In 1 eye (7%) there was an improvement in VA. In 6 eyes (43%) the VA remained stable and in 7 eyes (50%) there was a decline in VA. Five eyes (36%) demonstrated decreased exudation, 9 eyes (64%) showed a persistent subretinal exudation. Conclusion: In 50% of the treated eyes, the VA remained stable or improved.</p>
<p>AMD-TTT6 Transpupillary Thermotherapy in the Treatment of Occult and Classic Choroidal Neovascularization</p> <p>MIP</p> <p>Miller-Rivero NE, Kaplan HJ. Hudson Retina, Poughkeepsie, NY. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S179. Abstract nr 932, 2000</p>	<p>Thirty eyes in 29 patients were treated with TTT, to evaluate the efficacy of TTT in the treatment of subfoveal CNV not eligible for conventional laser treatment as described in the MPS. TTT was performed with an IRIS Medical 810 nm infrared diode laser equipped with a modified slit lamp adapter with an adjustable beam width of 1.2, 2.0 and 3.0 mm. Spot size was chosen so that the treatment beam entirely encompassed the lesion. For a 3mm spot size, up to 800 mw was delivered to the treatment area using a contact lens. Power was adjusted such that a barely detectable light-gray appearance or no visible color change was seen after 60 seconds. For a smaller spot size, power was decreased proportionally. In the case of very large lesions, overlapping treatments were performed. Patient follow-up was at 2-4 weeks and retreatment considered at 8 weeks if there was persistence or worsening in the appearance of the</p>

	<p>lesion. Results: Of the 30 lesions treated, 22 were predominantly occult CNV and 8 predominantly classic CNV. Pre-treatment VA ranged from 20/40 to CF. 8 eyes (26.7%) showed an improvement in VA (≥ 2 lines). 13 eyes (43.3%) showed stable VA (+/- 1 line) and 9 eyes (30%) showed a decline in vision over a follow-up period of 3-8 months. 26 eyes (86.7%) demonstrated a decrease in the amount of exudation on FA and/or clinical examination. Seven eyes (23.3%) underwent one retreatment. Conclusions: TTT delivers heat to the choroid and RPE using a modified diode laser. Because of this concentration of energy, collateral damage to the overlying neurosensory retina may be minimized. In this study, large subfoveal lesions were treated with preservation of good visual acuity. TTT appears to be effective in decreasing exudation in both occult and classic CNV. A randomized, prospective clinical trial will best determine the role of TTT in the treatment of CNV.</p>																				
<p>AMD-TTT7 Transpupillary Thermotherapy for Subfoveal Choroidal Neovascularization in Age-Related Macular Degeneration MIP Petrone S,¹ Staurengi G,^{1,2} Migliavacca L,¹ Ottochian M,¹ Orzalesi N.¹ ¹University Eye Clinic, San Paolo Hospital, Milan, Italy, ²University Eye Clinic, Spedali Civili Brescia, Italy. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S320. Abstract nr 1689, 2000</p>	<p>To evaluate TTT in the treatment of subfoveal CNV in AMD, 30 consecutive patients with "predominantly classic" subfoveal CNV were treated using the IRIS Medical 810 nm diode laser. CNV was assessed by means of ICG and FA with a confocal SLO. The entire lesion was treated with a single spot (range 1200-3000 μm) whose size was planned on the basis of pretreatment angiograms. The used power was between 500 and 800 mWatt with an exposure time of 60 seconds. Angiographies were repeated immediately after the laser treatment and during the follow-up visits and at 1 week, 3 weeks and 2 months.</p> <p>Results:</p> <table border="1"> <thead> <tr> <th></th> <th colspan="3">Time after Treatment</th> </tr> <tr> <th></th> <th>10 minutes</th> <th>1 week</th> <th>3 weeks</th> </tr> </thead> <tbody> <tr> <td>Retinal Edema</td> <td>0%</td> <td>65%</td> <td>0%</td> </tr> <tr> <td>CNV Closure</td> <td>9%</td> <td>75%</td> <td>40%</td> </tr> <tr> <td>CNV Vessels Dilation</td> <td>85%</td> <td>0%</td> <td>0%</td> </tr> </tbody> </table> <p>VA was stable after one week in 91% of cases and improved (3 lines) in 4%. After 3 weeks VA remained stable in 65% of cases and no case showed improvement.</p> <p>Conclusions: Short term results obtained with TTT in predominantly classic subfoveal CNV indicate obliteration of CNV in 40% with stable VA in 65% of cases. Longer follow-up is advisable to confirm the efficacy of this new treatment for AMD.</p>		Time after Treatment				10 minutes	1 week	3 weeks	Retinal Edema	0%	65%	0%	CNV Closure	9%	75%	40%	CNV Vessels Dilation	85%	0%	0%
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<p>AMD-TTT8 Transpupillary Thermotherapy of Occult Choroidal Neovascularization Secondary to Age-Related Macular Degeneration MIP Quentel G, Cohen SY, Delhoste B, Guiberteau B, Delahaye-Mazza C. Centre d'Imagerie et de Laser, Paris Abstract. Congrès De La Société Française d'Ophthalmologie. May 2000</p>	<p>The authors conducted a prospective, single center, non-randomized pilot study on the efficacy of TTT for occult CNV secondary to AMD. The inclusion criteria included patients 55 years of age or older who were diagnosed with AMD complicated with occult CNV certified through FA and/or ICG, and visual acuity greater or equal to 0.1 (20/200). The exclusion criteria included occult CNV associated with manifest visible CNV, previous ocular radiation, and refusal of signing an informed consent. TTT treatment consisted of inducing a localized hyperthermia through the use of a diode laser using a large spot (3 mm at 800 mW or 2 mm at 530 mW) and prolonged exposure time of 1 minute. Doses were diminished by 20% in case of pseudophakia with very clear ocular media or during the treatment if patients felt a sensation of ocular burn or pain. No whitening of</p>																				

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	<p>the treated area was observed. The efficacy of the treatment was measured on visual acuity and on the evolution of the exudation judged on the masked analysis of angiographies. Best corrected visual acuity was determined by an independent observer according to the ETDRS protocol at inclusion, 1, 3, 6, and 12 months. Results: Preliminary results on visual acuity were obtained at 1 and 3 month follow-ups. Of 23 patients evaluated at 1 month, 5 (22%) patients improved (≥ 2 lines), 14 (61%) stabilized (± 1 line), and 4 (17%) worsened. Of 10 patients evaluated at 3 months follow-up, 2 (20%) improved, 6 (60%) stabilized, and 2 (20%) worsened. Conclusion: TTT represents an important therapy for patients because it can address a clinically frequent form of the disease for which today, no treatment has shown efficacy. The results from this pilot study should be evaluated and compared with results from other controlled randomized studies to confirm whether pilot studies can give results in agreement with randomized controlled studies.</p>
<p>AMD-TTT9 Transpupillary Thermotherapy for Age-Related Macular Degeneration: Long-Pulse Photocoagulation, Apoptosis, and Heat Shock Proteins Mainster MA, Reichel E. Ophthalmic Surg Lasers 31:359-373, 2000</p> <p>MIP</p>	<p>The objective of this study was to provide a biophysical foundation for using TTT to manage CNV in AMD. Retinal temperature rise in laser therapy is proportional to retinal irradiance (laser power/area) for a particular spot size, exposure duration, and wavelength. TTT is a low irradiance, large spot size, prolonged exposure (long-pulse), infrared laser photocoagulation protocol. Results from an experimentally confirmed, finite element model of retinal light absorption and heat conduction are used to analyze laser parameter selection and its consequences. Results from apoptosis, heat shock protein and hyperthermia research are used to examine how chorioretinal damage from clinical procedures might be reduced. Results: Chorioretinal thermal equilibration occurs during long-pulse TTT photocoagulation. Retinal temperature increases are similar in the RPE where laser radiation absorption is significant and in the adjacent neural retina where there is negligible radiation absorption. For parameters used to treat occult choroidal neovascularization in lightly-pigmented fundi (800 mW, 810 nm, 3 mm retinal spot diameter, 60 sec exposure duration), the maximum chorioretinal temperature elevation is calculated to be roughly 10° C, significantly lower than the 20° C temperature elevations measured in threshold, conventional short-pulse retinal photocoagulation. Conclusions: To achieve a preselected temperature rise, TTT laser power must be increased or decreased in proportion to the diameter rather than the area of the laser spot. Clinical power settings should be adjusted for fundus pigmentation and media clarity because both of these factors affect absorbed retinal irradiance, and thus retinal temperature rise. Low temperature, long-pulse photocoagulation is a potential strategy for decreasing neural retinal damage in subsequent TTT or short-pulse photocoagulation and perhaps even for treating glaucoma or retinal degenerations.</p>
<p>AMD-TTT10 Transpupillary Thermotherapy for Subfoveal Choroidal Neovascularization in Japan Okada AA, Morimura Y, Hayashi A, Hirakata A, Tano Y, Hida T. AAO Scientific Poster #307. Dallas, TX, 2000</p> <p>MIP</p>	<p>The authors studied the effects of TTT on 30 Japanese eyes: 20 eyes with occult subfoveal choroidal neovascularization (CNV) in association with AMD, 2 eyes with classic CNV due to AMD, and 8 eyes with other causes such as high myopia. Results for occult subfoveal CNV at 8.75 months (mean) follow-up: VA improved (≥ 2 lines) in 1 eye (5%), stabilized (± 1 line) in 15 eyes (75%), and worsened (≥ 2 lines) in 4 eyes (20%). Exuda-</p>

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	<p>tion decreased in 15 eyes (75%). Reduced exudation was generally observed within 2 to 3 months of treatment and was achieved with lower power settings than previously reported in American patients. Conclusion: TTT reduced the exudation of both occult and classic subfoveal CNV in a majority of eyes. Settings used for classic CNV associated with high myopia resulted in subretinal fibrosis in some eyes. Three-quarters of all eyes treated experienced stable or improved VA (mean follow-up > 8 months).</p>
<p> AMD-TTT11 Transpupillary Thermotherapy for the Treatment of Choroidal Neovascularization</p> <p>MIP</p> <p>Newsom RSB, McAlister JC, Saeed M, McHugh JDA. Br J Ophthalmol 85:173-179, 2001</p> <p><i>For 29 month follow-up, see AMD-TTT65, pg. 47.</i></p>	<p>LongPulse, low irradiance TTT photocoagulation was performed in 44 eyes of 42 patients using the IRIS Medical 810 nm OcuLight SLx and large spot slit lamp adapter delivery system. Of the 44 eyes treated, 32 eyes were predominantly occult and 12 eyes were predominantly classic CNV membranes. Laser settings were adjusted to give faint retinal graying following 1 minute of treatment. Beam diameters varied between 800 and 3000 microns, and a Volk Area Centralis contact lens was used in all cases. The predominantly occult results are comparable to those by Reichel. (See AMD-TTT4) The predominantly classic results are the first published results using TTT for the treatment of predominately classic CNV.</p> <p><u>Results - Predominately Occult CNV</u> At an average follow-up of 7.2 months, predominantly occult membranes closed in 78% (25/32) of eyes and were recurrent in 5% (3/32) of eyes. This high closure rate was associated with vision stabilization (+/- 1 line) or vision improvement (≥ 2 lines) in 71% of eyes.</p> <p><u>Results - Predominately Classic CNV</u> At an average follow-up of 6.7 months, predominantly classic membranes closed in 75% (9/12) of eyes with no recurrences and were associated with vision stabilization (+/- 1 line) or vision improvement (≥ 2 lines) in 67% of eyes.</p> <p>Conclusion: TTT is a potential treatment for CNV. It is able to close CNV while maintaining visual function in patients with classic and occult disease. The precise role of TTT in the treatment of CNV needs to be further defined. However, the clinical improvement found in several of our patients and the high closure rate of occult CNV, with little recurrence, suggest that this treatment will have a role in the management of some patient groups. Prospective, randomized controlled trials will further clarify the role of TTT in the treatment of CNV.</p>
<p> AMD-TTT12 Photodynamic Therapy and Transpupillary Thermotherapy for Age-Related Macular Degeneration</p> <p>MIP</p> <p>Morimura Y, Okada AA. Japanese Journal of Ophthalmic Surgery 14(3):337 – 341, 2001</p>	<p>Photodynamic therapy (PDT) and TTT represent two novel treatments for subfoveal CNV in patients with AMD. This paper provides an overview of the principles and methods of PDT and the results obtained in Europe and the U.S., followed by a discussion of TTT, including interim results obtained in the ophthalmology department at Kyorin University School of Medicine, Japan.</p> <p>TTT is easier than PDT to implement, and to that extent its applications and correct settings remain unclear. Because complications may result if the treatment is not administered carefully, a multicenter clinical trial also is planned in Japan in the near future. Because the hyperthermia effect of TTT</p>

naturally varies greatly depending on the amount of pigment present in the fundus, the appropriate power setting differs for Caucasian patients and patients of more strongly pigmented races, such as Japanese. The authors typically perform TTT using a power setting of approximately 1/2 that used by Reichel et al.

Treatment Parameters

Power:	140 – 160 mW	260 – 270 mW	400 mW
Spot size:	1.2 mm	2.0 mm	3.0 mm

The spot size used is generally large enough to cover the entire CNV. With a CNV greater than 3 mm in diameter, however, multiple irradiation spots are used according to a predetermined design. In this case, although adjacent spots are made to overlap slightly, the fovea is covered by a single irradiation.

Duration: 60 seconds. However, the irradiation may be suspended if necessary and resumed, after the cause of suspension is eliminated, to bring the overall irradiation time to 60 seconds, with no resulting problems.

Although there have been rare complaints of mild pain on irradiation, there have been no cases in which post-irradiation changes were seen ophthalmoscopically. Thus, both in this respect and in regard to efficacy, this power setting appears to present no problems in treating AMD.

Because no special agents are used, TTT is relatively simple and can be performed in a short time on an outpatient basis. Because a decrease in exudative changes is obtained in almost all cases, the frequency of repeat treatment is low. The mechanism of TTT has not been elucidated, and its best implementations for particular conditions have therefore not yet been established. Thus, a multicenter clinical trial is also needed to address this point. Although there have been no reports of major complications with TTT for CNV, there have been reports of complications such as retinal vascular occlusion with the use of TTT for tumors.

Conclusions: PDT and TTT are comparable in numerous aspects. Neither therapy is necessarily superior to the other; they should be used appropriately as the applications of each are elucidated. Because the nature of AMD differs greatly between Europe and the U.S. and Japan, the results of the ongoing trial in Japan must be obtained before the applications and results in Japanese patients can be ascertained. TTT requires no special equipment other than a semiconductor laser and adapter and can therefore be performed with relative ease.



New

<p>AMD-TTT13 Transpupillary Thermotherapy in the Treatment of Occult and Classic Choroidal Neovascularization Singer MA, Willerson Jr. D. Presentation. The Vitreous Society 18th Annual Meeting. Cancun, Mexico. January 7-11, 2001</p> <p>MIP</p>	<p>To determine if TTT is useful in the treatment of classic and occult subfoveal CNV, 64 patients received 810 nm TTT with the IRIS Medical OcuLight SLx photocoagulator and Slit Lamp Adapter. Of the 64 patients treated, 43 patients had occult CNV with a pre-op VA range from HM to 20/50, and 21 patients had classic CNV with a pre-op VA range from HM to 20/100⁻¹. Based upon lesion size, 3 mm spots at 800 mW for 1 minute or 6 mm spots at 1490 mW for 1 minute were used. Power was decreased in increments of 20% if retinal whitening was noted or patient experienced discomfort. All patients were followed-up at approximately 3-month intervals with fluorescein and assessment.</p> <p>Results: <i>Occult</i>: At a median of 7.25 months follow-up, VA improved (≥ 2 lines) in 10/43 patients (23%); stabilized (± 1 line) in 31/43 patients (72%); and worsened in 2/43 patients (5%). Fluid resolved in 72% of patients after 1 treatment. Ten patients (23%) received a second treatment; 1 patient (2%) received a third treatment. <i>Classic</i>: At a median of 6.5 months follow-up, VA improved (≥ 2 lines) in 3/21 patients (14%); stabilized (± 1 line) in 18/21 (86%) patients (72%); and worsened in 0 patients. Fluid resolved in 71% of patients after 1 treatment. Five patients (24%) received a second treatment; 1 patient (5%) received a third treatment.</p> <p>Conclusions: <i>Occult</i>: There was no specific difference in VA between large (> 3 mm) and small (< 3 mm) lesions. VA stabilized or improved in 95% of patients. <i>Classic</i>: A higher percentage of small lesions had better VA than larger lesions; however, no patient with a classic lesion had worse vision. VA stabilized or improved in 100% of patients. <i>Overall</i>, 70% of eyes required only one treatment. TTT has been shown to be effective in both occult and classic CNV, regardless of size. A double-blinded study with a larger population is necessary to confirm results found in this pilot study.</p>
<p>AMD-TTT14 Transpupillary Thermotherapy for Juxtafoveal Recurrent Choroidal Neovascularization Piccolino FC, Eandi CM, Ventre L, Grignolo FM. Torino, Italy Abstract. The Macula Society. Scottsdale, AZ. February 28, 2001</p> <p>MIP</p>	<p>The purpose of this study was to evaluate the effectiveness of TTT for treatment of juxtafoveal recurrent CNV after laser photocoagulation. An 810 nm diode laser was used: 350 mW, 2 mm spot size, 1 minute duration. Eight patients with juxtafoveal recurrent CNV were treated with TTT after obtaining informed consent. Basic disorders were AMD in 6 eyes, pathologic myopia in 1 eye and vitelliform dystrophy in 1 eye. VA ranged from 20/200 to 20/40 before treatment. The effect of TTT was evaluated by FA and ICGA in a follow-up ranging from 3 to 9 months. VA measurements were obtained at each visit using the ETDRS charts. Results: Retinal damage was not visible ophthalmoscopically at treatment time in any patient. Seven eyes had obliteration of CNV at the angiographic examination performed within 1 week from treatment. The myopic CNV remained unchanged. A subfoveal recurrence occurred in 4 eyes after 1 to 2 months. A second TTT application in one of these eyes was followed by new obliteration of CNV, but by worsening of VA of 6 lines. A final closure of CNV with TTT was obtained in 4 of 8 eyes. VA resulted unchanged in 2 of these eyes, improved and worsened in the other 2 eyes. Conclusion: TTT appears to be able to close juxtafoveal recurrent CNV. Further studies with a larger number of cases and longer follow-up are needed to verify if TTT may benefit patients with juxtafoveal recurrent CNV.</p>

<p>AMD-TTT15 Transpupillary Thermotherapy of Occult Subfoveal Choroidal Neovascularization in Patients with Age-Related Macular Degeneration</p> <p>MIP</p> <p>Bandello F, Lanzetta P, Michieletto P, Pirracchio A, Menchini F, Tedeschi M. Udine, Italy Abstract. The Macula Society. Scottsdale, AZ. February 28, 2001</p>	<p>A prospective, nonrandomized case series of 56 eyes of 54 patients with subfoveal CNV secondary to AMD was conducted. TTT was delivered through a contact lens using an 810 nm diode laser with a 360 – 800 mW; 1.2, 2.0, or 3.0 mm spot diameter, and 60 second exposure. The endpoint was a nonvisible treatment with no color change at the retina level. Outcome was assessed with ETDRS chart VA, FA and ICGA, and clinical examination. OCT was performed in selected cases. Mean follow-up was 3 months (range 2 – 24 weeks). VA improved (≥ 3 lines) in 4 eyes (7.1%), remained stable (no change or < 3 line improvement) in 26 eyes (46.4%), declined (1 to 2 lines) in 16 eyes (28.5%), and declined (≥ 3 lines) in 10 eyes (17.8%). FA and ICGA after treatment showed a characteristic pattern. OCT demonstrated decreased exudation. Conclusion: TTT may stabilize VA in occult CNV due to AMD. A prospective, randomized study is mandatory.</p>
<p>AMD-TTT16 Dose-Dependent Histology and Heat Shock and Other Protein Expression in Transpupillary Thermotherapy of Normal Pigmented Rabbit Eyes</p> <p>MIP</p> <p>Morimura Y,¹ Okada AA,¹ Hayashi A,² Fujioka S,² Kawahara S,¹ Hida T.¹ ¹Department of Ophthalmology, Kyorin University School of Medicine, Tokyo, Japan; ²Department of Ophthalmology, Osaka University Medical School, Osaka, Japan [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S226. Abstract nr 1218, 2001</p> <p><i>Also listed as HIST18, pg. 238</i></p>	<p>We performed TTT in normal pigmented rabbit eyes to study dose-dependent histological changes and examine expression of heat shock proteins (HSPs), tumor necrosis factor (TNF)-a and vascular cell adhesion molecule (VCAM)-1. TTT was performed using an 810 nm diode laser with spot size 1.2 mm, power 50 mW, and varying durations of 15, 30 or 60 seconds. Eyes were enucleated 4 weeks after treatment and examined by light and electron microscopy. Immunohistochemical staining for HSP60, HSP70, TNF-a, and VCAM-1 were performed. Fundus examination both immediately and 4 weeks after treatment revealed no discernable changes at TTT sites. Electron microscopy revealed photoreceptor outer segment and retinal pigment epithelial (RPE) cell disruption; these changes were more prominent with longer durations of treatment. Eyes treated for 30 or 60 seconds also showed partial closure of the choriocapillaris. Immunohistochemical staining showed that RPE cells and anterior choroidal vessels in the area treated by TTT stained positively for HSP60, HSP70, TNF-a, and VCAM-1. Conclusions: Despite the lack of funduscopically visible changes to the retina and choroid, TTT resulted in dose-dependent changes at the cellular level in the photoreceptor outer segments, RPE cells and anterior choroid. Furthermore, positive immunohistochemical staining for HSP60, HSP70, TNF-a and VCAM-1 in the RPE and anterior choroidal vessels indicates that induction of these molecules plays a role in the tissue response to TTT in normal pigmented rabbit eyes.</p>
<p>AMD-TTT17 Is Low Intensity Long Duration Laser Therapy Effective in Treatment of Wet AMD?</p> <p>MIP</p> <p>Nazari K,^{1,2,3} Friberg TR.¹ ¹Dept Ophthalmology, Univ Pittsburgh MC, Pittsburgh, PA; ²Eye & Ear Foundation of Pittsburgh, Pittsburgh, PA; ³Research to Prevent Blindness [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S229. Abstract nr 1233, 2001</p>	<p>To determine if low intensity long duration laser therapy reduces leakage of macular CNV and SRF, 29 eyes with wet AMD and significant SRF who did not qualify for PDT, received one treatment in each eye. Pre-treatment and post-treatment FA were obtained and carefully reviewed. Initial clinical exam and 3-month post-treatment exams were also compared. The amount of SRF and leakage of CNVM were assessed. At 3 months, 13.7% (4/29) of eyes had increased SRF and leakage. 3.4% (1/29) of eyes did not show any improvement in the amount of SRF or leakage. However 82.7% (24/29) had measurable decrease of SRF on clinical exam. FA also showed decrease in amount of leakage. 13.7%(4/29) of patients received a second treatment.</p>

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	<p>79.3% of eyes retained their pre-treatment VA. 4 of 6 eyes that had decreased VA had less SRF and leakage. Conclusion: Low intensity long duration laser therapy could be an option for patients with wet AMD that do not qualify for PDT. However further studies with more participants and longer follow-ups are needed to adequately arrive at a definitive conclusion.</p>
<p>AMD-TTT18 Transpupillary Thermotherapy (TTT) for Occult Subretinal Neovessels: Importance of Patient Pigmentation in Adjusting Diode Laser Power Setting MIP Auer C,¹ Tran VT,¹ Chiou AGY,^{1,2} Herbot CP.^{1,3} ¹La Source Eye Center, Lausanne, Switzerland, ²Louisiana State University, New Orleans, USA, ³University of Lausanne, Lausanne, Switzerland [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S442. Abstract nr 2385, 2001</p>	<p>Thirty-three eyes of 32 patients with occult subretinal neovascular membranes (OSRNVM) underwent TTT after having given an informed consent. Indications to treat were diffuse exudative membranes, limited subfoveal OSRNVM with a VA of less than 0.4, or a drop of VA of 3 Snellen lines or more since the previous examination, or a very deleterious previous evolution in the fellow eye. Dual FA and ICCA were used for angiographic follow-up. Treatment parameters were a 60 second exposure time, variable spot size according to the size of the lesion and variable laser power setting according to spot size, ICG fluorescence and pigmentation. The group of patients that presented choroidal atrophy after TTT was analyzed in this study. Results: Five eyes (15%) presented a limited or spot-size related post-TTT chorioretinal atrophy. Pre-laser VA was 0.34 ± 0.13 and excentric post-TTT VA was 0.25 ± 0.15. The OSRNVM had disappeared in all cases. The common denominator in these patients was that they were white haired, but upon questioning all happened to be originally dark-haired. Conclusions: Evolution towards atrophy can occur after TTT and probably depends on several factors. We showed that pigmentation is a parameter to be evaluated carefully before TTT and that laser power setting should progressively be diminished with increasing patient pigmentation. In white haired persons, that original pigmentary status should be part of the patient history.</p>
<p>AMD-TTT19 Transpupillary Thermotherapy for Subfoveal Occult CNVM: Effect on Ocular Perfusion and Mechanistic Implications MIP McNulty LA,¹ Ciulla TA,¹ Harris A,¹ Maturi R,¹ Kagemann L,¹ Pratt LM,¹ Weinberger D,² Criswell MH.¹ ¹Ophthalmology, Indiana University Medical Ctr, Indianapolis, IN, ²Rabin Medical Center, Petach-Tikva, Israel [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S442. Abstract nr 2386, 2001</p>	<p>Eleven subjects with occult subfoveal CNVM due to AMD were assessed in a masked fashion by color Doppler imaging (CDI) within 24 hours before and within 24 hours after, as well as 1 month after, undergoing TTT. TTT was delivered through a slit lamp using a modified infrared diode laser at 810 nm with a beam width of 3.0 mm and treatment was initiated with one spot for a 60 second duration and a power setting of 800 mW. Results: In the posterior ciliary arteries which supply the choroid, there were no statistically significant changes observed in the Peak Systolic Velocity (PSV), End Diastolic Velocity (EDV), or Resistive Index (RI) at 24 hours. In the nasal posterior cerebral artery (PCA), the mean EDV decreased 36% one month after treatment ($p = 0.0105$). The mean RI in the nasal PCA increased 3.8% one month after treatment ($p = 0.0305$). Although there was a similar trend in the temporal PCA, the differences did not reach statistical significance. In the central retinal artery (CRA), the mean PSV decreased 16% 24 hours after treatment ($p = 0.0137$). The mean EDV in the CRA decreased 21% 24 hours after treatment ($p = 0.0222$). There were no statistically significant differences in the CRA blood flow indices at one month after treatment. In the ophthalmic artery, there were no statistically significant differences observed in the mean PSV, EDV, or RI at 24 hours or 1</p>

	<p>month after treatment. Conclusions: TTT is associated with transiently decreased volumetric blood flow in the retinal circulation at 24 hours post treatment. In the posterior ciliary arteries, which supply the choroid, there were no changes observed at 24 hours, but at one month, there was a decrease in the mean EDV and increase in the RI in the nasal and temporal PCA, reaching statistical significance in the nasal PCA only. Although this study suggests that TTT can lead to alterations in choroidal blood flow, possibly by causing complete or partial occlusion of occult subfoveal CNVM, further study is warranted.</p>
<p>AMD-TTT20 The Use of Transpupillary Thermotherapy in the Treatment of Wet Age-Related Macular Degeneration</p> <p>MIP</p> <p>Tang J,¹ Ferrone PJ,^{1,2} Harrison SA,^{1,2} Fastenberg DM,^{1,2} Shakin EP,^{1,2} Shakin JL,^{1,2} Golub BM.^{1,2}</p> <p>¹North Shore University Hospital, New York, NY, ²Long Island Vitreoretinal Consultants, Great Neck, NY</p> <p>ARVO Poster nr 2387. Ft. Lauderdale, FL. April 29, 2001</p>	<p>In this consecutive series, 124 eyes with primarily occult CNV with worsening vision and worsening SRF at time of treatment were treated with TTT after first being evaluated with biomicroscopy and FA. All patients had at least 3 months follow-up. Average follow-up was 6 months. Treatment success of TTT on eyes with AMD was defined as either an improvement of VA of 2 lines or more, or a stabilization of VA within 1 line. Treatment failure was defined as loss of VA of two lines or more. Results: <u>At 3 to < 6 months follow-up (124 eyes)</u>, VA improved (≥ 2 lines) in 20 eyes (16%), stabilized (± 1 line) in 57 eyes (46%), and worsened (≥ 2 lines) in 47 eyes (38%). Decreased SRF was demonstrated in 96 eyes (77%). <u>At 6 to < 9 months (70 eyes)</u>, VA improved in 6 eyes (9%), stabilized in 40 eyes (57%) and worsened in 24 eyes (34%). Decreased SRF was demonstrated in 60 eyes (86%). <u>At ≥ 9 months (28 eyes)</u>, VA improved in 5 eyes (18%), stabilized in 18 eyes (64%), and worsened in 5 eyes (18%). Decreased SRF was demonstrated in 24 eyes (86%). Conclusions: TTT appears to have some benefit for patients with worsening of primary occult subfoveal CNV. Further research is needed to evaluate this treatment.</p>
<p>AMD-TTT21 Transpupillary Thermotherapy of Occult Choroidal Neovascularization Associated to Age-Related Macular Degeneration</p> <p>MIP</p> <p>Campos CC,^{1,2} Nehemy MB,^{1,2} Moraes JG,² Rodrigues RP,² Magalhes EP,¹ Passos E.^{1,2}</p> <p>¹Federal University of Minas Gerais, Sao Geraldo Eye Hospital, Belo Horizonte, MG, Brazil, ²Institute of Vision, Belo Horizonte, MG, Brazil</p> <p>[ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S443. Abstract nr 2388, 2001</p>	<p>Fifteen eyes of 14 patients with occult CNV lesions due to AMD were treated by TTT. General ophthalmologic examination (including measurement of Snellen VA and macula slit-lamp biomicroscopy), color fundus photography, and FA were used to evaluate the baseline and results of treatment. TTT was delivered using a diode laser of 810 nm wavelength with the following parameters: power ranging from 170 to 1200 mW, 60 seconds duration and variable spot size of 0.8, 1.2, 2.0, 3.0, 4.0 and 6.0 mm, depending on the area of CNV. Follow-up was 3 months. Results: At the third month examination, 1 eye (6.7%) showed two lines improvement of VA. In 7 eyes (46.6%) the vision remained stable (no changes or 1 line improvement/decrease) and in seven eyes (46.6%) had lost two or more lines in VA. The FA showed reduction of leakage in 4 eyes (26.7%), in 3 eyes (20%) the exudation remained the same and in 8 eyes (53.3%) there was an increase in the exudation area. One day after laser treatment there was whitening of retina in 2 eyes and one eye developed retinal hemorrhage. Conclusions: Three months after laser treatment, it was shown that TTT was able to avoid the development of CNV in approximately 45% of cases. In many eyes, despite the treatment, there was a progression of CNV.</p>

<p>AMD-TTT22 Transpupillary Thermotherapy With and Without ICG Enhancement in Exudative AMD: Clinical, Angiographic and OCT Features Immediately and Three Months After Treatment</p> <p>MIP</p> <p>Quaranta M, Mauget-Fay�sse M, Millet JY. Centre Ophtalmologique Rabelais, Lyon, France. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S443. Abstract nr 2389, 2001</p>	<p>Thirty-nine patients, 2 with classic CNV; 30 with occult CNV (12 with type 1 occult CNV, 18 with type 2), and 7 with mixed CNV were treated by TTT. Patients were divided into two groups. Group 1 (ICG-enhanced group): 19 patients received TTT treatment 30 minutes after ICG injection and then repeated 1 hour after treatment. Group 2: 20 patients received ICG only after treatment. OCT scans passing through the fovea were performed before and 3 months after TTT, and foveal thickness was determined. Results: The 2 groups were comparable for age (Group 1: 77.9 years; Group 2: 77.5 years), type of neovascular lesions, mean VA (Group 1: 0.29; Group 2: 0.22) and Pelli-Robson contrast sensitivity (Group 1: 0.98; Group 2: 0.94). Initial foveal thickness on OCT scans was moderately higher in Group 2 (350 μm vs 314 μm). Immediately after TTT, ICG angiographic features do not differ in the two groups: the treated area appeared early hypofluorescent and crossed only by choroidal arteries. Choroidal veins showed a delayed filling and appeared 10 to 20 seconds after arteries. In the late phase, the treated zone was markedly by hypofluorescent, but in 5 eyes, CNV largely leaked in the center of the treated zone. Three months follow-up disclosed no difference in mean VA as compared with the initial one and between the 2 groups. Pelli Robson mean contrast sensitivity improved only in group 1. OCT scans demonstrated that foveal thickness was reduced in both groups. Conclusion: At 3 months, TTT results suggest that the ICG-enhanced technique can be safely performed in exudative AMD patients. Moreover, the improvement in contrast sensitivity in Group 1 can be considered as a favorable outcome when managing with low-vision patients. Further long-term studies are needed to support these preliminary findings.</p>
<p>AMD-TTT23 Transpupillary Thermotherapy (TTT) of Occult Choroidal Neovascularization in Age-Related Macular Degeneration</p> <p>MIP</p> <p>Fuisting B, Richard G. Univ Eye Clinic, Hamburg, Germany ARVO Poster nr 2390. Ft. Lauderdale, FL, April 29, 2001</p> <p><i>For 12-Month Follow-up, see AMD-TTT68, pg. 49</i></p>	<p>Fifty patients with uni- or bilateral predominantly occult CNV were treated with TTT. Infrared light at 810 nm delivered from a diode laser was used to apply spots with a size of 3000 μm for about 60 seconds duration. A complete ophthalmologic examination including VA, slit-lamp biomicroscopy, funduscopy, FA and OCT was performed prior to and 3 and 6 months after the treatment. At 6 months follow-up, VA improved (≥ 2 lines) in 6 patients (12%), remained stable (± 1 line) in 30 patients (60%), and worsened in 14 patients (28%). There was a significant relief of metamorphopsia. Forty percent of eyes showed a rapid decline of CNV activity and retinal edema formation as assessed by OCT. In eyes with persistent CNV activity, an additional treatment was performed 3 months after first TTT. As visible on FA, the effect of TTT results from the occlusion of small choroidal vessels. Rare complications include the occlusion of retinal vessels (4 patients) and subretinal hemorrhage (2 patients). Conclusions: A controlled multicenter study began in March 2001 to examine the efficacy, possible indications, and side effects of TTT.</p>

<p>AMD-TTT24 Comparison of the Effects of Transpupillary Thermotherapy (TTT) of Pigmented and Albino Rabbit Retina</p> <p>MIP</p> <p>Jim KH, Park TK, Yu SY, Kwak HW. Kung Hee University; Department of Ophthalmology, Seoul, Korea [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S444. Abstract nr 2398, 2001</p> <p><i>Also listed as HIST19, pg. 239</i></p>	<p>TTT was delivered using the IRIS Medical diode laser at 810 nm and applied with 3 mm spot size, 50 sec duration, and 100 – 600 mW (pigmented rabbits) and 200 – 1200 mW (albino rabbits). At 1 week and 4 weeks after TTT, fundus photographs and simultaneous FAG/ICG angiogram with SLO were taken before sacrifice. Light and electron microscopic examination were performed. Results: In pigmented rabbits, visible fundus change was identified at funduscopy finding even with minimal power setting (100 mW). Obliteration of choroidal vessels was shown on ICG angiogram. In microscopic examination, entire layers of neural retina, RPE cells, and deep choroid were severely damaged at center of treated field. Whereas, in albino rabbits, fundus changes were not observed at any power setting; however focal thrombosis at margin of lesion was identified on ICG angiogram after power of 300 mW. In microscopic examination, tissue damage was developed up to 600 mW and the lesion extended into the superficial choroid posteriorly and outer neural retina anteriorly. Conclusion: The effect of TTT was increased with fundus pigmentation. Clinically, TTT power setting should be adjusted according to the amount of melanin pigmentation.</p>
<p>AMD-TTT25 The Histopathologic Effects of Transpupillary Thermotherapy in Human Eyes</p> <p>MIP</p> <p>Connolly BP,¹ Regillo CD,¹ Eagle RC,² Shields CL,³ Shields JA,³ Moran H.⁴ ¹Retina Service, ²Pathology Dept, ³Oncology Service, ⁴Retina Research, Wills Eye Hospital, Philadelphia, PA, [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S513. Abstract nr 2763, 2001</p> <p><i>Also listed as HIST20, pg. 239</i></p>	<p>A prospective, dose-response study of TTT using an infrared diode laser at 810 nm, 2 mm spot size, 60-second duration, and power levels of 430, 530, or 630 mW. Treatment was directed to otherwise normal retinal tissue in eyes with uveal melanoma that were within 10 days of enucleation. Serial sections through the treatment sites were examined by light microscopy. Results: A total of 8 TTT spots were applied in 3 eyes. Full-thickness alterations were evident in high dose (630 mW) and medium dose (530 mW) treatment areas, especially in eyes with greater fundus pigmentation. The low dose (430 mW) treatment sites had either no damage or limited outer retinal changes. Patients described pain or had visible retinal changes (during or after treatment) only at dose levels that resulted in full-thickness histopathologic changes. Conclusions: Variable histopathologic retinal changes occur with TTT. The degree of tissue damage appears to be related to both dose level and fundus pigmentation.</p>
<p>AMD-TTT26 Role of Indocyanine Green Angiography in the Appraisal and Follow-Up of Transpupillary Thermotherapy (TTT) for Occult Subretinal Neovessels</p> <p>MIP</p> <p>Büchi ER,¹ Auer C,¹ Tran VT,¹ De Courten C,¹ Chiou A,² Herbort CP.^{1,3} ¹La Source Eye Center, Lausanne, Switzerland, ²Louisiana State University, New Orleans, USA, ³University of Lausanne, Lausanne, Switzerland. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S796. Abstract nr 4266, 2001</p>	<p>Thirty-three eyes of 32 patients with occult subretinal neovascular membranes (OSRNVM) underwent dual FA and ICG angiography before and during the follow-up of TTT of subfoveal OSRNVM. Indications to treat were diffuse exudative membranes, limited subfoveal OSRNVM with a VA of less than 0.4, or a drop of VA of 3 Snellen lines or more since the previous examination or a very deleterious previous evolution in the fellow eye. An IRIS Medical diode laser with a large-spot delivery system was used. Treatment parameters were a 60 second exposure time, variable spot size according to the size of the lesion and variable laser power settings according to spot size, ICG fluorescence and pigmentation. Results: Pre-laser ICGA was helpful in determining the treatment area by considering the area of ICGA hyperfluorescence. It confirmed the treatment area chosen on the basis of FA in 22 of 33 eyes and</p>

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	<p>was at the origin of a change of the planned treatment area (increased in 6 eyes and reduced in 5 eyes) in a total of 11 eyes. On follow-up angiograms ICGA was essential in determining treatment resistant OSRNVM remaining strongly hyperfluorescent, needing additional TTT (n=19/33) and cases with signs indicating choroidal atrophy (n = 5) not seen by FA and in which retreatment was contraindicated. Conclusions: ICGA was essential in determining the area of the initial treatment in 30% of cases and determined therapeutic decisions (retreatment or observation) in 57% of cases, appearing as an essential element in determining TTT intervention in OSRNVM.</p>
<p>AMD-TTT27 Transient Appearance of Classic Choroidal Neovascularization After Transpupillary Thermotherapy for Occult Choroidal Neovascularization  Kaga T, Fonseca RA, Dantas MA, Spaid RF. Retina 21(2):172-173, 2001</p>	<p>This is a case report of a woman who presented with AMD and VA 20/200 in the right eye with a macular neurosensory detachment associated with late leakage of an undetermined source during FA; and 5/400 in the left eye with a consolidated disciform scar. TTT treatment was delivered through a slit lamp using a modified 810 nm diode laser (IRIS Medical) and a TransEquator lens (Volk Optical). Parameters included 800 mW, 4.5 mm spot size delivered for 90 seconds. At 1 month follow-up, VA suddenly declined 5/400 in the right eye. She had a small focus of classic CNV with hyperfluorescence in the early phase and with leakage in the late phase of FA directly under the fovea. There were RPE folds inferior to area of the classic CVN and a triangular area of hypofluorescence in the inferotemporal macula in the early phase of the FA. Three months after TTT, VA improved to 20/80. The early FA showed that the classic CNV had disappeared and the occult component showed less leakage. There were more RPE folds in the area of the occult CNV. The area of hypofluorescence in the inferotemporal macula was smaller. Four months after TTT the patient had only occult CNV. There was no leakage during the FA. Conclusion: This patient developed a classic CNV after TTT and the classic CNV disappeared with no additional treatment in parallel with the resolution of other effects induced by TTT. The elaboration of the classic CNV may have been related to cytokines released because of induced ischemia or as part of a healing response. The findings of this case may suggest that specific treatment for classic CNV in the immediate post-operative period after TTT may not be necessary in all patients.</p>
<p>AMD-TTT28 Our Experience with TTT for Neovascular AMD  Algreve P. St. Eriks Eye Hospital, Karolinska Institute, Stockholm, Sweden Abstract. European Meeting on Macular and Vitreoretinal Diseases. Hamburg, Germany. May 25 – 27, 2001</p>	<p>To evaluate TTT for treating subfoveal CNV in AMD, 58 patients with visual deterioration due to neovascular AMD were treated with TTT using the OcuLight 810 nm diode laser. Patients had occult CNV, and mixed classic and occult CNV affecting the fovea (according to FA). Preoperative VA ranged from 0.05 to 0.5 as determined by the ETDRS chart. All patients underwent a clinical examination, color fundus photography, FA and in selected cases, OCT. Follow-up was at 1, 3, and 6 months.</p> <p><u>Treatment Parameters</u> Power: 400 – 800 mW Duration: 60 seconds Spot Size: 2.0 – 3.0 mm</p>

	<p>Results: At 3 months postoperatively, VA had improved in 11/58 (19%) cases, was stable in 34/58 (59%), and deteriorated in 13/58 (22%) according to ETDRS criteria. At 6 months, VA had improved in 7/43 (16%) and deteriorated in 10/43 (23%); fluorescein leakage had disappeared and staining only was present in 33/43 (77%), but leakage persisted in the rest of cases. The main complications encountered were exacerbation of exudation and/or transient hemorrhage; therefore, retreatment with TTT was given at 2 or 3 months. Regression of retinal edema, subretinal fluid and PED was demonstrated on OCT. Conclusion: This pilot study shows that TTT treatment is feasible in neovascular AMD resulting in stabilization of VA and occlusion of the CNV in a majority (77%) of eyes. An exudative AMD can be converted to a dry AMD. These observations warrant further evaluation.</p>
<p>AMD-TTT29 Short-Term Results of Transpupillary Thermotherapy (TTT)</p> <p>MIP</p> <p>Kaskel S,¹ Maier JJ,¹ Nita M,² Holi H¹ ¹Eye Clinic, Neubrandenburg, Germany, ² Eye Clinic Katowice, Katowice, Poland Abstract. German Retina Society Meeting, Innsbruck, Austria. June 22-23, 2001</p>	<p>Between December 1999 and January 2001, 125 eyes of 111 patients were treated with TTT. Indications for treatment were subfoveal subretinal neovascular membranes, that could be demonstrated in FA. The majority of patients suffered from typical AMD. Occult membranes accounted for 84% of the membranes. One patient had a neovascular membrane due to blunt trauma with choroidal rupture. VA before treatment was between 0.01 and 0.8 (1/100 and 20/25), mean VA 0.24 (20/80). TTT was carried out by one surgeon (HH) using the 810 nm OcuLight SLx. The first 57 patients were evaluated with the following criteria: VA before and after treatment, patients subjective impression (better, worse, unchanged); Amsler test and size of membrane and amount of exudation demonstrated on FA. In 14 patients, TTT had to be repeated once. Follow-up was at 2 weeks, 2 months after the first TTT treatment (TTT I) and after repeat TTT treatment (TTT II).</p> <p><u>Treatment Parameters</u> Power: 480 mW (average) in the first treatment; 529 mW in the second treatment Duration: 60 seconds Spot size: 1.500 and 2.000 μm Number of exposures: 1 to 9</p> <p>Results: At 2 weeks/2 months follow-up, VA improved 2 lines in 8%/16% patients; and was stable in 66%/53% of patients. FA criteria improved in 40%/48% of patients after a single TTT treatment. Complications were few. There was an RPE tear in 1 patient, some weeks after treatment. Two patients suffered from subretinal hemorrhage several weeks after therapy. One of these 2 patients had been on Dicumarol treatment, starting again 2 days after the TTT procedure. Conclusion: VA improved in 16% of patients, 2 months after TTT and was stable in additional 53%. About half the patients had morphological improvement, which could be demonstrated in FA. Another 35% showed stable morphological criteria. TTT could be shown to be a safe treatment for occult subretinal membranes. A substantial proportion of patients showed improvement or stabilization of VA and FA findings in the short-term. However, long-term results are not yet available.</p>



AMD-TTT30 Transpupillary Thermotherapy for Age-Related Macular Degeneration: Principles and Techniques
 Mainster MA, Reichel E.
 Semin Ophthalmol 16(2):055-059, 2001

MIP

TTT is a subthreshold, low irradiance, long exposure duration, large spot size, infrared diode laser protocol. Retinal temperature increases in TTT for CNV are substantially lower than those in conventional short-pulse photocoagulation, but they are maintained for 60 seconds to achieve therapeutic results. Treatment power is adjusted for retinal lesion size, chorioretinal pigmentation, macular elevation and media clarity. TTT uses 810-nm diode laser infrared radiation, which has no significant retinal phototoxicity. A parfocal laser delivery system is required to assure uniformity of irradiance across large diameter treatment spots.

A typical TTT power setting is 800 mW for a 3 mm diameter, elevated, occult choroidal neovascular membrane in a lightly pigmented individual with exudative AMD. Treatment power selection should be reduced in TTT for a 1.5 mm diameter, flat, occult choroidal neovascular membrane in a darkly pigmented patient with AMD. For example, since treatment power is proportional to treatment spot diameter, it should be reduced from 800 mW for the 3 mm lesion to 400 mW for the 1.5 mm lesion. It should be reduced another 50% for dark pigmentation, to 200 mW. It should be reduced another 10% for the absence of serous elevation. Thus, an appropriate power selection is 180 mW for this darkly pigmented individual's 1.5 mm lesion. Other parameters that affect power selection include local pigment clumping, subretinal hemorrhage, RPE atrophy and neovascular morphology. It is important to maintain a circular, uniform aiming beam throughout TTT. Exaggerated lens tilts can cause astigmatism of the laser spot on the retina, with higher irradiance and over-treatment on one side of the long axis of the spot, and lower irradiance and under-treatment on the other side of the laser spot. It is also important to avoid pressing on a contact ophthalmoscopic lens, which can increase pressure on the eye. Increased pressure can slow choroidal circulation and increase chorioretinal heating for a particular laser irradiance. Relative contraindications for TTT include dense subretinal hemorrhage, prior focal photocoagulation and serous RPE detachment. Adverse events are rare, and include decreased vision and retinal arteriole occlusion. Randomized, prospective multi-center trials are underway to compare the results of TTT for occult CNV in age-related macular degeneration to the natural history of the disorder. Imaging, electrophysiologic or thermometric techniques may ultimately provide intra-operative or post-operative monitoring to assure the adequacy of TTT for CNV, despite the absence of ophthalmoscopically visible lesions.



AMD-TTT31 Ophthalmoscopic Contact Lenses for Transpupillary Thermotherapy
 Mainster MA, Reichel E, Harrington PG, Erickson PJ, Graham RD.
 Semin Ophthalmol 16(2):060-065, 2001

MIP

Ophthalmoscopic contact lenses for TTT must provide an effective transmission of infrared (810 nm) diode laser radiation, an appropriate field of view for accurately localizing large treatment spots, and an adequate magnification for detecting subtle intraretinal changes should they occur during TTT therapy.

Selection and proper use of retinal laser lenses requires knowledge of their lateral magnification, laser beam magnification factor, field of view and resolution. Optical performance is analyzed for Goldmann-type lenses and a series of inverted

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	<p>image lenses of differing magnification. Goldmann lenses have the highest resolution, but inverted image lenses of comparable magnification have 2.5 times or more their field of view. Inverted image lenses of similar magnification can differ in resolution. They require 2-4% more incident laser power to produce the same retinal irradiance as a Goldmann lens, but this difference is small in comparison to other clinical variables. Tilting an ophthalmoscopic contact lens up to 15° causes little distortion in the circularity of the retinal spot formed by a laser beam or difference in retinal irradiance across the spot. Inverted image lenses produce higher anterior segment irradiances than Goldmann-type lenses, but anterior segment injuries are less likely in TTT than conventional visible light, short-pulse retinal photocoagulation because of the comparatively low irradiances used in TTT and the decreased absorption of diode laser infrared radiation in ocular media and melanin.</p>
<p> AMD-TTT32 TTT of Occult Choroidal Neovascularization: A Retrospective, Noncomparative Case Series of Fifty-Seven Eyes  Park CH, Duker JS, Mainster MA, Puliafito CA, Reichel E. Semin Ophthalmol. 16(2):066-069, 2001</p>	<p>To evaluate the efficacy of TTT using the 810 nm OcuLight SLx and large spot size slit lamp adapter for the treatment of occult CNV, a retrospective, noncomparative case series of 57 eyes of 52 patients, who presented with predominantly occult subfoveal CNV, were treated with TTT.</p> <p><u>Treatment Parameters</u> Power: 270 mW to 800 mW (average: 670 mW) Duration for each spot: 0.7 to 1.5 minutes (average: 1 minute) Number of spots: 1 to 4 per session with a tendency for a greater number of spots to be used for larger CNV in order to make sure that they were adequately treated. (average spot size used: 2.7 mm) Contact lens: Goldmann Retreatments: 8 eyes – 1 retreatment; 1 eye – 2 retreatments</p> <p>The average follow-up time was 9.7 months (± 7.2 months). Eighty-three percent of eyes were either stable (+/- 1 line) or showed improvement in VA. [Ten eyes (17.5%) gained ≥ 2 lines, 16 eyes (28.1%) gained ≥ 1; 38 eyes (66.7%) maintained or gained lines; 10 eyes (17.5%) lost ≥ 2, and 5 eyes (8.8%) lost ≥ 3 lines.] Eighty-three percent of eyes showed stabilization of their exudative process after one TTT treatment as evidenced by resorption of subretinal and/or intraretinal exudate or hemorrhage. Nine percent of eyes developed classic CNV. Conclusions: TTT appears to stabilize the exudative process in eyes with occult CNV. A prospective, sham-controlled, randomized study (TTT4CNV Clinical Trial) is currently underway to directly compare TTT to the natural history of occult CNV.</p>
<p> AMD-TTT33 Transpupillary Thermotherapy (TTT) for Age-Related Macular Degeneration  Friberg TR, Pandya A, Nazari K. Semin Ophthalmol 16(2):070-080, 2001</p>	<p>To review the results of TTT on choroidal neovascular membranes associated with AMD, 35 eyes of 35 patients with AMD, CNV, and exudation were treated with TTT using the 810 nm OcuLight SLx and large spot size SLA. Fundus photographs and FA were taken before and at least 6 months after TTT. Twenty-eight eyes had predominantly occult lesions as seen on FA, while 7 demonstrated primarily classic lesions. Fifteen eyes had lesions</p>

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	<p>< 2 disc diameters; 20 were > 2 disc diameters. VA, lesion size, and amount of subretinal fluid were determined by results of examination and review of photographs and FAs.</p> <p><u>Treatment Parameters</u> Power: 650 mw power or less; 450 – 550 mW for a darkly pigmented fundus; 550 – 650 mW for most other fundi. Duration: 60 seconds Spot size: 3 mm Contact lens: Mainster High Magnification Retreatments: 7 (20%) eyes = 1 retreatment</p> <p>At a minimum of 6 months follow-up (average follow-up was 11.7 months), a 50% reduction in subretinal fluid was achieved in 23 of 35 eyes (66%) of treated eyes overall, with stabilization of vision (< 3 lines of VA lost) in 30 of 35 eyes (86%). In eyes with occult or predominately occult lesions, 20 of 28 (71%) responded with a reduction of subretinal fluid. In eyes with classic or predominantly classic lesions, 3 of 7 (43%) responded with a substantial reduction of subretinal fluid. Complications from treatment were infrequent (9%) and involved hemorrhage noted in the region of treatment upon follow-up. Conclusion. TTT promotes resolution of subretinal fluid and appears to stabilize VA in patients with exudative AMD.</p>
<p> New</p> <p>AMD-TTT34 Efficacy of Transpupillary Thermotherapy (TTT) in the Treatment of Occult Subfoveal Choroidal Neovascularization in Age-Related Macular Degeneration Ahuja RM, Benner JD, Schwartz JC, Butler JW, Steidl SM. Semin Ophthalmol 16(2):081-085, 2001</p> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-top: 10px;">MIP</div>	<p>To determine the efficacy of TTT in the treatment of occult subfoveal CNV in patients with AMD, the authors conducted a retrospective review of 81 eyes of 77 patients with AMD treated with TTT from June, 1999 through July, 2000. TTT was delivered through a slit-lamp using the 810 nm OcuLight SLx. Pretreatment vision was less than or equal to 20/200 in 54% of eyes.</p> <p><u>Treatment Parameters</u> Power: 720 – 850 mW Duration: 60 seconds Spot size: 3 mm. For smaller spot sizes, the power was decreased proportionally. If the lesion size was greater than 3 mm, overlapping treatments were applied. The end-point for treatment was an area of no visible color change throughout the course of treatment. If retinal whitening was observed during treatment, power was adjusted by a decrease of 10% and the treatment was re-started. The process was repeated as needed until no visible color change was seen at the treatment site, and the treatment was completed for the full duration. Re-treatment: 1 to 4 (average 1.37) Four retreatments were required in 1 patient only. Retreatments were performed at 2-month intervals if indicated.</p> <p>At a mean of 9 months follow-up (range: 6 – 17 months), vision improved > 1 line in 18 eyes (22%), vision was stable within 1 line in 38 (47%), and worsened > 1 line in 25 (31%). Subretinal fluid resolved biomicroscopically in 56 eyes (69%). One eye (1.2%) suffered a macular infarction with an acute decline in vision immediately after TTT and retinal vascular occlusion seen on FA. This patient eventually recovered vision to pre-treatment values. The patient had an area of pre-existing geographic RPE atrophy in the macula adjacent to the area of TTT treatment, which may have predisposed him to this complication. Complica-</p>

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	<p>tions were limited with none that impacted on the final level of visual acuity. Conclusions. TTT may stabilize VA in a majority of patients with occult sub-foveal CNV secondary to AMD. Proof of therapeutic benefit is best determined by a randomized clinical trial that is currently underway (TTT4CNV).</p>
<p>AMD-TTT35 Transpupillary Thermotherapy of Occult Choroidal Neovascularization in Age-Related Macular Degeneration MIP Kim JE, Perkins SL, Schwiesow T, Connor Jr. TB, Han DP. Semin Ophthalmol 16(2):086-089, 2001</p>	<p>To evaluate the efficacy of TTT in the management of occult subfoveal CNV in exudative AMD, a retrospective chart review of 48 eyes of 49 patients who were treated with TTT, with at least 12 weeks of follow-up, was conducted. Baseline and final ETDRS VA and FA were compared. Mean pre-operative VA was 20/128 (range: 20/50-20/500).</p> <p><u>Treatment Parameters</u> Power: 800 mW Duration: 60 seconds Spot Size: 3 mm If a smaller spot size was used, the power was decreased appropriately. No retinal whitening was noted during treatment for the entirely Caucasian patient population. Contact lens: Yanuzzi-type fundus Retreatments: 5/48 eyes (11%) (3 eyes = 2 retreatments; 2 eyes = 3 retreatments)</p> <p>Average follow-up was 27 weeks (range: 12 weeks-55 weeks). At 3 months after treatment, 12 eyes (25%) improved > 2 lines, 18 eyes (37.5%) had no change or 1 line of visual improvement, and 18 eyes (37.5%) worsened > 1 lines. No significant adverse event was noted during treatment. Three eyes developed large submacular hemorrhage within 2 months of treatment. Based on clinical examination and FA, 61% of the eyes appeared to have reduction of subretinal fluid compared to pre-operative evaluations. Complications such as retinal vascular occlusion or retinal pigment epithelial rip did not occur. Conclusion: VA was stable or improved in 62.5% of eyes and the treatment was well tolerated. Longer follow-up and larger number of patients would be required to evaluate the ultimate benefit of TTT in management of occult CNV due to AMD.</p>
<p>AMD-TTT36 Transpupillary Thermotherapy of Occult CNV With No or Minimally Classic CNV in Age-Related Macular Degeneration MIP Algreve PV, Libert C, Seregard S. Semin Ophthalmol 16(2):90-96, 2001</p>	<p>This prospective study was comprised of 66 consecutive patients referred for exudative AMD with predominantly occult subfoveal CNV. All patients were Caucasian, most often with minimally or moderately pigmented fundi. Based on FA, there were 38 cases with occult CNV only, and 28 eyes with minimally classic CNV. VA was determined using the logarithmic ETDRS chart. Baseline VA ranged from 20/40 to 20/400. TTT was administered using the 810 nm OcuLight SLx and large spot size SLA.</p> <p><u>Treatment Parameters</u> Power: 800 mW or 500 – 600 mW The power was reduced in relation to smaller spot sizes: (i.e. 400 mW for 2.0 mm and 240 mW for 1.2 mm spots). In addition, heavy pigmentation of the iris and fundus indicated a further reduction of the laser power. Duration: 60 seconds Spot size: 3 mm Retreatment: 21 (32%) eyes = 1 retreatment</p>

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	<p>Follow-up included clinical examination with biomicroscopy and FA at 2-3 months and 6 months in all cases. In all 66 patients, the mean VA was preoperatively 20/125 (47.4 letters) and post-operatively 20/160 (41.8 letters) yielding a decay of 5.6 letters (1 line). VA improved (12 letters) in 8 cases (12.1%), deteriorated (11 letters) in 17 (25.8%), and remained stable (± 7 letters) in 74.2%. In purely occult CNV, VA remained stable in 81.6% as compared to 64.3% in occult & minimally classic CNV; the former subgroup lost on the average 3.6 letters, the latter 8.3 letters (close to 2 lines) over 6 months. The proportion of eyes losing at least 15 letters was 13.2% in purely occult CNV versus 35.7% in the occult & minimally classic subgroup. In 39 of 66 cases (59.1%), fluorescein leakage regressed to staining only concomitant with absorption of subretinal fluid. Complications associated with deterioration of VA (17 cases) included postoperative hemorrhage, increase of exudation on angiography, and progressive fibrosis. Conclusion: The results indicate that TTT stabilizes VA concomitant with regression of exudation and resorption of subretinal fluid in the majority of cases with predominantly occult CNV. Cases with occult CNV only, seem to do better than those with minimally classic CNV. The safety and complication rates appear to be acceptable. The results achieved compare favorably with the natural history of AMD.</p>
<p style="color: green;">✓ New</p> <p>AMD-TTT37 Optical Coherence Tomography of Subfoveal Choroidal Neovascularization Treated with Transpupillary Thermotherapy MIP Lanzetta P, Pirracchio A, Bandello F. Semin Ophthalmol 16(2):97-100, 2001</p>	<p>TTT has been proposed as a new treatment modality for CNV. Most studies conducted show decreased exudation due to CNV and reduction of subretinal elevation. Optical coherence tomography (OCT) is a relatively new technique for noninvasive cross-sectional visualization of the human retina. Early after TTT treatment, OCT shows a dynamic sequence of changes: within 1 hour after TTT, OCT shows increased retinal thickness and intraretinal fluid with retinal elevation; 1 week after treatment and during follow-up, OCT shows decreased subretinal and intraretinal fluid and diminished retinal elevation due to decreased permeability of new vessels. Many of the biomicroscopic and angiographic signs of exudative AMD can be visualized and quantified with OCT. Minimal subretinal fluid appears as a nonreflective space between the RPE and neuroretina, while retinal edema is visualized as increased retinal thickness and a diffuse decrease in retinal reflectivity. Serous detachment of the RPE is characterized by elevation of the hyper-reflective layer corresponding to the RPE. OCT can also detect CNV in cross-section in selected cases. However, OCT is most useful in assessing intraretinal and subretinal fluid and monitoring their changes after treatment. OCT can be a valuable method to assess the early effect of TTT.</p>
<p style="color: green;">✓ New</p> <p>AMD-TTT38 Fluorescein and Indocyanine Green Angiography after Transpupillary Thermotherapy of Choroidal Neovascularization. Early Vascular Changes MIP Lanzetta P, Michieletto P, Pirracchio A, Chiodini RG, Bandello R. Semin Ophthalmol 16(2):101-105, 2001</p>	<p>To improve the knowledge about TTT on the vascular integrity of CNV and choroid, FA and ICGA were performed at baseline and after TTT within 1 hour and at 1 week. FA and ICGA after TTT showed a reproducible pattern. Within 1 hour after TTT, FA and ICGA revealed increased leakage activity from CNV. This initial acute damage of the vascular endothelium and subsequent increased dye leakage correspond to a hyperfluorescent area where the laser spot has been placed. Once the thrombogenic cascade has started, the changes in perfusion dynamics induce the</p>

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	<p>progressive occlusion of the neovascular complexes. Angiographic hypofluorescence seen at 1 week after treatment testifies that exposure to hyperthermia results in CNV closure. OCT confirmed the angiographic findings. The early vascular changes after TTT of CNV are similar to those observed after PDT of CNV. TTT and PDT might share common mechanisms of action.</p>
<p>AMD-TTT39 Transpupillary Thermotherapy for Occult Choroidal Neovascularization in Age-Related Macular Degeneration Escoto R. 14th International Cataract Implant Microsurgery & Refractivekatoplasty Meeting (ICIMRK). Barcelona, Spain. June 28 – July 2, 2001</p> <p>MIP</p>	<p>To determine the effectiveness of TTT in the treatment of occult subfoveal CNV, secondary to AMD, 16 eyes of 16 patients affected by occult CNV were treated using TTT. Pre-operative tests carried out: visual acuity logMAR (VA), FA and colour photography of the back of the eye. TTT was performed using an 810 nm OcuLight system fitted to a slit lamp.</p> <p><u>Treatment Parameters</u> Power: 320 to 800 mW Duration: 60 seconds Spot size: 1.2, 2, 3 mm (alone or in combination) taking in all the lesion visible angiographically. For a spot 3 mm in diameter the power used was 800 mW, without resulting in secondary additional retinal coloration. In the cases where a spot of a smaller size was required, the power emitted was reduced proportionally.</p> <p>Control visits were done in weeks: 4, 12, and 24. In cases where exudation persisted, the treatment was repeated after an interval of at least 3 months. Results: Mean VA: initial, 19 letters; final, 21 letters (the same or better in 11 eyes [66.7%]; worse in 5 eyes [33.4%]). Post-treatment exudation: 81% less than the initial; 19% more than the initial. Conclusions: With the application of TTT it is possible to minimize the collateral damage to the highly sensitive part of the retina, since the power emitted is concentrated at the level of the retinal pigment epithelium and choroids. Subfoveal CNVs were treated with resulting preservation and even improvement of the VA. The application of TTT appears to be effective in causing a reduction and cessation of exudation in the short term in occult CNV.</p>
<p>AMD-TTT40 Transpupillar Thermotherapy (TTT) in AMD (Alternative Treatment Of Choroidal New Vessels- Early Results) De Souza RP, Quintao T, Rosa P, Cotrim A, Martins M, Mendonca PS, Barrao S. Gomes LT. Abstract 272. European Association for Vision and Eye Research (EVER). Alicante, Spain. October 10 – 13, 2001</p> <p>MIP</p>	<p>To study retinal macular changes and choroidal new vessels behavior after TTT, 12 patients with predominantly occult membranes were studied using FA, ICGA and OCT, before and after performing TTT with the 810 nm OcuLight laser. Studies were carried out immediately after and 1-2-4 weeks after treatment.</p> <p><u>Treatment Parameters</u> Power: 300-700 mW Duration: 40 to 60 seconds Spot size: 1.2, 2.0, and 3.0 mm. Contact lens: Goldmann Treatment parameters were selected based mainly on the amount of pigmentation of the retina, exudation of new vessels and size of PED.</p> <p>During the first 2 weeks, there was either no change on OCT and angiography or an increase of exudation and edema of the retina. After 4 weeks, there was a reduction of exudation on angiogra-</p>

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	<p>phy, regression of retinal oedema or fibrosis of vascular membrane. In some cases, there was the same amount or an increase of exudation, suggesting that the therapy was not successful. These patients have been retreated and will be followed.</p>
<p style="text-align: right;">New </p> <p>AMD-TTT41 Transpupillary Thermotherapy for Subfoveal Occult Choroidal Neovascularization: Effect on Ocular Perfusion</p> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">MIP</div> <p>Ciulla TA, Harris A, Kagemann L, Danis RP, Maturi R, McNulty L, Pratt LM, Xiao M, Criswell MH, Weinberger D. Invest Ophthalmol Vis Sci 42:3337–3340, 2001</p>	<p>To perform a descriptive analysis of the effects on ocular blood flow of TTT for occult subfoveal CNVMs in AMD, 11 subjects with occult subfoveal CNVM due to AMD were assessed in a masked fashion by color Doppler imaging (CDI) within 24 hours before, 24 hours after, and 1 month after undergoing TTT. Results: In the posterior ciliary arteries (PCAs), there were no statistically significant changes observed in the peak systolic velocity (PSV), end diastolic velocity (EDV), or resistive index (RI) at 24 hours. At 1 month, the mean EDV decreased 36% (P = 5 0.0105) and the mean RI increased 3.8% (P = 5 0.0305) in the nasal PCA. Although there was a similar trend in the temporal PCA, the differences did not reach statistical significance. In the central retinal artery (CRA), the mean PSV decreased 16% (P = 5 0.0137), and the mean EDV decreased 21% (P = 5 0.0222) at 24 hours after treatment. There were no statistically significant differences in the CRA blood flow indices at 1 month after treatment. In the ophthalmic artery, there were no statistically significant differences observed in the mean PSV, EDV, or RI at 24 hours or 1 month after treatment. Conclusions: TTT is associated with transiently decreased volumetric blood flow in the retinal circulation 24 hours after treatment. In the posterior ciliary arteries that supply the choroid, there were no changes observed at 24 hours, but at 1 month, there was a decrease in the mean EDV and an increase in the RI in the nasal and temporal PCAs, reaching statistical significance in the nasal PCA only. This study suggests that TTT could lead to alterations in choroidal blood flow, as assessed by CDI.</p>
<p style="text-align: right;">New </p> <p>AMD-TTT42 Transpupillary Thermal Therapy for the Treatment of Occult Choroidal Neovascularization Associated with Macular Degeneration</p> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">MIP</div> <p>Thach AB, Sipperley JO, Dugel PU, Sneed SR, Park DW, Garda JA. American Academy of Ophthalmology. Retina Free Paper Session, New Orleans, LA. November 14, 2001</p>	<p>One hundred four patients with occult CNVM associated with wet AMD were treated with TTT in a prospective, non-randomized, non-masked case study using the 810 nm OcuLight SLx and large spot SLA.</p> <p><u>Treatment Parameters</u> Power: 900 – 1000 mW Duration: 60 seconds Spot size: 3 mm</p> <p>Patients were evaluated for VA (stable or improved vision was defined as a loss of 1 line, improvement or no change in vision) and the need for additional treatment. Of the 83 patients available for 6-month follow-up (80%), VA stabilized or improved in 63 patients (76%) and worsened (2 or more line loss) in 20 patients (24%). Of the 48 patients followed for 9 months (46%), VA stabilized or improved in 38 patients (79%). Conclusions: Patients with occult CNVMs and AMD may benefit from TTT.</p>



AMD-TTT43 A Comprehensive Overview of Transpupillary Thermotherapy (TTT)
 Ali F.
 Japanese Society of Ophthalmic Surgeons Congress. Hiroshima, Japan. January 25 – 27, 2002

MIP

Ninety eyes of 88 patients with wet AMD received TTT treatment with the 810 nm OcuLight SLx and large spot SLA. Sixty-five eyes of 64 patients had predominately occult CNV; 25 eyes of 24 patients had predominately classic CNV.

Standard Treatment Parameters-N. American Caucasian Patients

Power/Diameter ratio = 247 mW/mm

3.0 mm	800 mW	
2.0 mm	530 mW	
1.2 mm	320 mW	
3.85 mm	955 mW	(2.0 mm spot with QuadrAspheric)
5.77 mm	1430 mW	(3.0 mm spot with QuadrAspheric)

Using a larger spot is superior to using multiple smaller spots. It eliminates over-treatment due to “overlap” and treatment takes less time.

TTT Power Modifications

Lesion/Patient Characteristics to increase TTT power

- If there is extensive fluid elevation (10% increase)
- If there is thick subfoveal blood (maximum of 10% increase)
- If the patient has a “blonde” fundus (10-20% increase)

Lesion/Patient Characteristics to reduce TTT Power

- If there are any retinal changes during treatment, patient discomfort, or intra-retinal blood.
- Asian/Indian = 10-20% reduction.
- Black = 20-40% reduction.
- Middle Eastern/Mediterranean = 10% reduction.
- If there is very minimal fluid elevation (10-15% reduction)
- Aphakia/pseudophakia (10% reduction)
- If there is subretinal fibrosis/heavy RPE clumping (10-20% reduction)

Power for classic CNV is 68% of power used for occult CNV.

Results: *Predominately Occult CNV*: At 5 months (average) follow-up of 64 patients, VA improved (> 2 lines) in 10 patients (16%), stabilized (\pm 1 line) in 51 patients (79%), and worsened (> 2 lines) in 3 patients (5%). *Predominately Classic CNV*: At 9 months (average) follow-up of 25 eyes, VA improved in 7 eyes (28%), stabilized in 13 eyes (52%), and worsened in 5 eyes (20%). Conclusion: TTT clearly alters the natural history of CNV in a favorable way. These results are similar to other results that have been presented worldwide.



AMD-TTT44 Transpupillary Thermotherapy for Treatment of Choroidal Neovascularization Secondary to Age Related Macular Degeneration in Indian Eyes
 Nagpal M, Nagpal K, Sharma S. Puri J, Nagpal PN.
 International Congress of Ophthalmology. Sydney, Australia. April 21 – 25, 2002

MIP

A prospective, nonrandomized study including 160 eyes of 144 patients with subfoveal CNV (99 classic; 61 occult), which underwent TTT was conducted to evaluate the efficacy of TTT for treatment of CNV secondary to AMD and to define the accurate power settings for this procedure in the Indian eyes.

Treatment Parameters

Power: 300 mW for a 2 mm spot size; 400 – 600 mW for a 3 mm spot size
 Duration: 60 seconds

	<p>The mean follow-up was 12 months. Of the classic membranes, regression was seen in 79/99 (79.8%) eyes. Improvement of vision by > 2 lines was noted in 29 eyes (29.3%). Stabilization of vision (same as pretreatment or ± 1 line) was noted in 39 eyes (39.39%). There was a drop of acuity by more than 1 line in 31 eyes (31.31%) Of the occult membranes, regression was observed in 52/61 eyes (85%). Improvement of acuity by 2 or more lines was noted in 12 eyes (19.67%). Stabilization of vision (same as pre-treatment or ± 1 line) was noted in 35 eyes (57.37%). There was a drop of acuity by more than 1 line in 14 eyes (22.95%). One patient suffered from a foveal burn.</p> <p>Conclusion: TTT is effective in the management of subfoveal membranes in Indian eyes, which respond to lesser energy levels as compared to the western eyes.</p>
<p> AMD-TTT45 Clinic and Histopathologic Study of Transpupillary Thermotherapy in Pigmented Rabbits  Rodrigues RP,¹ Magalhães E,^{2A} Nehemy MB,³ Campos C,^{2A} Passos E^{2A}, Salgado M.^{2B} ¹Instituto da Visão, Belo Horizonte, Brazil; ^ASao Geraldo Eye Hospital, ^BPathology, ²Federal University of Minas Gerais, Belo Horizonte, Brazil; ³Sao Geraldo Eye Hospital, Federal University of Minas Gerais/Instituto da Visao, Belo Horizonte, Brazil. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2621, 2002 <i>Also listed as HIST25, pg. 242</i></p>	<p>TTT was delivered in 40 eyes of pigmented rabbits to evaluate the macroscopic and histologic effects induced by temperature elevation of TTT in the retina and choroid. Each eye received 4 laser pulses below the medullary fibers layer, using the 810 nm wavelength with fixed spot size of 3 mm. The exposure time was variable from 17 to 66 seconds, and interrupted if there was any retinal change during the procedure. The initial power was fixed in 300 mW and reduced 20, 40, and 60%. When retinal whitening was observed on the retina, 20% of laser pulse was reduced, until there was no macroscopic alteration. Histologic examination by light microscopy was performed 24 hours and 4 weeks after treatment. Results: All lesions with even minimal macroscopic whitening during TTT showed retinal and choroidal damage. 24 hours after TTT, the histologic study showed acute retinal necrosis, interstitial edema and choroidal vessel thrombosis. Four weeks after TTT, the histologic study of the lesions showed a glial scar. Conclusion: Clinical and histologic examinations by light microscopy showed correlate results. This experimental study in pigmented rabbits shows that it is important to interrupt the TTT application before any clinical change in the fundus.</p>
<p> AMD-TTT46 Transpupillary Thermotherapy (TTT) for Minimally Classic and Occult CNV in AMD  Algvere PV, Lindgärde B, Seregard S. St. Eriks Eye Hospital, Karolinska Institutet, Stockholm, Sweden. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2822, 2002</p>	<p>To evaluate TTT as a treatment for occult CNV in AMD, a prospective study comprised of 109 patients referred for occult CNV in exudative AMD was conducted. FA at baseline disclosed 51 eyes with occult CNV and 58 eyes with minimally classic CNV. VA was assessed using the ETDRS logMAR chart. TTT was carried out with the 810 nm OcuLight photocoagulator.</p> <p><u>Treatment Parameters</u> Power: 550-800 mW Duration: 60 seconds Spot Size: 3 mm</p> <p>Follow-up included clinical examination with biomicroscopy and FA at 2-3 and 6 months. The mean preoperative VA was 20/100 (49.3 letters) and postoperative VA 20/160 (40.8 letters) yielding a decay of 8.5 letters. Eyes with purely occult CNV (n=51) lost on average 4.8 letters (from 20/125 to 20/160), whereas those with minimally classic and occult CNV lost 11.8 letters (from 20/100 to 20/160) (p=0.016). TTT was delivered on average 1.3 times to the former group, 1.6 times to the latter one. In occult CNV, the</p>

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	<p>VA improved in 14% and deteriorated in 31%, as compared to 3% and 48%, respectively, in the minimally classic group. The proportion of eyes losing at least 15 letters was 22% in the occult versus 38% in the minimally classic group. A subgroup of minimally classic and occult lesions with a greatest linear dimension of >3.0 mm responded poorly in this study setting. Stabilization of VA was achieved in 69% of the occult and in 52% of minimally classic CNV, in most cases concomitant with regression of fluorescein leakage to staining only. Conclusion: This pilot study indicates that eyes with purely occult CNV respond significantly better to TTT than those with minimally classic and occult CNV. This difference was most pronounced when the minimally classic and occult lesion had a greatest linear dimension exceeding 3.0 mm. To define the most efficacious laser power and optimal treatment intervals, further evaluation is warranted. A randomized controlled trial is in progress.</p>
<p>AMD-TTT47 The Treatment of Predominantly Occult Choroidal Neovascularization Secondary to Age Related Macular Degeneration Using Transpupillary Thermotherapy MIP Sanders JB,¹ Hoskins JC,² Funderburk RL,² Googe JM,² Miller JH,² Stone JL,² Gunn JM,² McMillan TA,² Cummings HL,² Franklin AJ.² ¹Dept. of Ophthalmology, Univ TN HSC, Chattanooga Unit, Chattanooga, TN; ²Southeastern Retina Associates, Chattanooga, TN. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4406, 2002</p>	<p>Patients with AMD, ETDRS VA between 20/60 and 20/800 and subfoveal CNV with at least 51% component of occult disease were initially eligible for the study to determine the efficacy of TTT for the treatment of predominately occult subfoveal CNV membranes secondary to AMD. Upon IRB approval, completion of screening and informed consent, eligible patients were enrolled in the prospective multi-center study. TTT was delivered to the subfoveal CNV via slit lamp using the 810 nm OcuLight infrared diode laser. Patients were evaluated preoperatively and at 1,3,6,9,12 and 18 months after initial treatment. Dilated ophthalmoscopy, VA, standardized fluorescein photography and FA were obtained and evaluated. Results were compared to the published natural history of the disease. Seventy-eight of the 114 initial patients have completed the 1 year follow up interval, and 35 patients have completed the 18 month interval. To date, 43.3% of patients have suffered loss of at least 3 lines of vision at 12 months. Median VA was 20/285 and 20/250 at 12 and 18 months, respectively. Conclusion: Despite 18% of patients with the loss of 3 or more lines of vision at 1 month post-treatment, only 43.3% of patients have lost 3 or more lines after 12 months. Post-TTT VA stabilized after 6 months at 20/250.</p>
<p>AMD-TTT48 Focal ERG Monitoring of Transpupillary Thermotherapy: Potential Use for Optimizing Subthreshold Laser Treatment of Choroidal Neovascularization MIP Falsini B,¹ Focosi F,¹ Piccardi M,¹ Pirozzi E,¹ Coccimiglio F,¹ Molle F,¹ Manganeli C,¹ Mainster MA.. ¹Ophthalmology, Catholic Univ, Rome, Italy; ²Ophthalmology, Univ of Kansas Medical Center, Kansas City, MO. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4409, 2002</p>	<p>To evaluate the potential use of focal electroretinography for monitoring and optimizing TTT for occult CNV in AMD, 24 eyes of 24 patients undergoing TTT for occult CNV due to AMD were evaluated. TTT was performed according to the Reichel et al. protocol (800 mW, 3 mm spot size, 60 second duration). A 630 nm photocoagulator aiming beam was modified for use as a 41 Hz square-wave focal electroretinogram (FERG) stimulus. It was presented on a light-adapting background, using a Goldmann-type lens (visual angle, 18°; mean luminance, 100 cd/m²). FERGs were continuously monitored before, during and after TTT. The amplitude and phase of the FERG's fundamental harmonic were measured. TTT outcomes were evaluated 1 and 3 months after treatment by VA testing, ophthalmoscopy and FA. Results: Stabilization or improvement of VA occurred in 23 of 24 eyes treated with TTT. A reduction in exudation was observed in the FAs of 14 of the 24 eyes. There were no suprathreshold or adverse clinical events. Mean FERG amplitudes decreased</p>

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	<p>transiently during TTT ($-16.4\% \pm 6.6$, $p < 0.05$), returning to pre-TTT values within 60-sec after treatment ended. TTT did not alter FERG phase. Post-TTT changes in VA (i.e., the ratio of post-to pre-TTT VA) were positively correlated ($r = 0.55$, $p = 0.02$) with FERG amplitude changes (i.e., the percentage change from the pre-TTT value) during TTT. The best angiographic outcomes were associated with the smallest decreases in FERG amplitude during TTT ($p = 0.01$). Conclusion: In patients undergoing TTT for occult CNV in AMD, improved visual and angiographic outcomes are correlated with lower reductions in intraoperative FERG amplitudes, suggesting the potential use of focal electroretinography for monitoring and modulating laser parameters for individual eyes and macular lesions.</p>
<p> AMD-TTT49 Pulsatile Ocular Blood Flow of Choroidal Neovascularization in Asymmetric Age-related Macular Degeneration after Transpupillary Thermotherapy</p> <p>MIP</p> <p>Chen S,¹ Cheng CY,² Lee AF,² Lee FL,² Hsu WM,² Liu JH.² ¹Ophthalmology, Veterans General Hospital, Taipei, Taiwan Republic of China; ²Taipei, Taiwan Republic of China. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4410, 2002</p>	<p>A previous study had shown that the pulsatile ocular blood flow (POBF) in eyes with asymmetric AMD was different. While eyes with drusen had higher POBF than their fellow eyes with disciform scar, the POBF of eyes with drusen were lower compared to their fellow eyes with CNV. This study was designed to see if the POBF of eyes with CNV changed after TTT in comparison to their fellow eyes of drusen or scar. Twenty-seven patients with asymmetric exudative AMD were enrolled in this prospective case observation study. Among them, 18 of the 29 patients with CNV in one eye and drusen or scar in the other were treated with TTT in the eyes with CNV. Nine patients with drusen in 1 eye and scar in the fellow eye were also followed for comparison. Monthly POBF were measured in both eyes of each subject for 6 months. After TTT, the POBF of eyes with CNV gradually decreased at 2 months of follow-up but increased thereafter when comparing to their fellow eyes with drusen or scar. The difference of POBF in patients with drusen in one eye and scar in the other maintained stabilized through the follow up period. Conclusion: This finding suggests that hemodynamic differences between fellow eyes in individuals with CNV are variable in a short time period after TTT intervention. POBF may be used as a modality to monitor the therapeutic effect of CNV in asymmetric exudative age-related macular degeneration.</p>
<p> AMD-TTT50 Determination of Retinal Thermal Dosimetry from Transpupillary Thermotherapy</p> <p>MIP</p> <p>Ibarra MS,¹ Madjarov B,¹ Glazer-Hockstein C,¹ Mainster MA,² Maguire AM,¹ Bennett J,¹ Tolentino MJ.¹ ¹Ophthalmology, Scheie Eye Institute, Univ of Pennsylvania, Philadelphia, PA; ²Ophthalmology, Univ of Kansas, Kansas City, KS. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4412, 2002</p> <p><i>Also listed as HIST26, pg. 242</i></p>	<p>The purpose of this study is to determine the effect of pigmentation, choroidal blood flow, and subretinal blood on TTT-induced temperature change on the retina. Direct retinal temperature measurements were performed using an ultra-fine thermocouple on New Zealand White (albino) and Dutch Belted (pigmented) rabbit eyes undergoing TTT. TTT was performed with an 810 nm OcuLight laser on a slit lamp delivery system using a 1.2 mm spot, 60 seconds duration, and a range of power settings between 50-1000 mW. Temperature measurements were taken in eyes in the presence or absence of choroidal blood flow and in eyes with subretinal blood. Results: Threshold power settings for albino and pigmented rabbits were 950 mW and 90 mW, respectively. When albino subthreshold power settings were applied to pigmented rabbits, temperature rise was greater than 1.5 fold higher than that of albino rabbits. Temperature rise in albino eyes with subretinal blood was at least two-fold higher than in eyes without subretinal blood. There was no change in temperature rise when choroidal blood flow was occluded.</p>

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	<p>Conclusion: Performing TTT on pigmented individuals or in the presence of subretinal blood should warrant a relative decrease in power setting. The presence or absence of choroidal blood flow does not alter TTT temperature rise.</p>
<p>New</p> <p>AMD-TTT51 Retinal Changes After Transpupillary Thermotherapy for Choroidal Neovascularization</p> <p>MIP</p> <p>Yamaji H,¹ Shiraga F,² Endo J,³ Kato M,³ Nomoto H³, Ohtsuki H.³ ¹Dept Ophthalmology, Okayama Univ Medical School, Okayama, Japan; ²Okayama University Medical School, Dept. of Ophthalmology, Okayama, Japan; ³Okayama University Medical School, Dept. of Ophthalmology, Okayama, Japan. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4414, 2002</p>	<p>To evaluate retinal damages shortly after TTT for AMD and polypoidal choroidal vasculopathy (PCV), 14 consecutive eyes of 14 patients with occult or classic CNV secondary to AMD and 11 consecutive eyes of 11 patients with PCV underwent TTT. TTT was delivered through a slit lamp with an 810 nm OcuLight laser. For a 3.0 mm beam the settings were between 300 – 400 mW, for a 2.0 mm between 200 – 270 mW. FA was performed before the treatment, and 1 day and 1 month after the treatment. At 1 day after TTT, FA showed leakage from retinal capillary or occlusion of retinal capillary in the treated area in 6 eyes (43%) of the 14 eyes with AMD and 6 eyes (55%) of the 11 eyes with PCV. At 1 month after treatment, these angiographic changes completely disappeared. Conclusion: Although TTT is administered as a subthreshold photocoagulation with no visible endpoint and no ophthalmoscopically apparent chorioretinal change during the treatment, the damage to the overlying retina may occur temporarily after the treatment.</p>
<p>New</p> <p>AMD-TTT52 Transpupillary Thermotherapy of Occult Choroidal Neovascularization: 18 Month Follow-up</p> <p>MIP</p> <p>White MF,¹ Mason JO,² Feist RM,² McGwin G,² Emond TL.² ¹Ophthalmology, Retina Consultants of AL PC, Birmingham, AL; ²Birmingham, AL. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4415, 2002</p>	<p>A retrospective review of 39 consecutive patients (39 eyes) who underwent TTT for greater than 50% occult CNV secondary to AMD between December 1999 and February 2000 was conducted to assess the long term efficacy and safety of TTT for the treatment of greater than 50% occult subfoveal CNV in patients with AMD. TTT was delivered using an 810 nm OcuLight laser. VA, subfoveal exudation, laser spot size, laser power and retreatment were analyzed using Fischer's Exact test.</p> <p><u>Treatment Parameters</u> Power: 400 mW to 800 mW Duration: 60 seconds Spot size: 2 mm or 3 mm of one subfoveal spot Treatment was delivered as a subthreshold treatment, i.e., doctors did not treat to a visual endpoint.</p> <p>At 18 months follow-up, 26 of 39 patients (67%) had stable or improved (no change or equal to or greater than 1 line) VA. Thirty-three of 36 patients (92%) exhibited stable or decreased subfoveal exudation. Thirteen patients (33%) underwent retreatment secondary to worsening exudation within 3 months of the initial treatment. Using the Fischer's Exact test, there is no significant statistical correlation between those receiving retreatment and those having one treatment with regards to VA at the 18-month follow-up visit. Laser spot size and laser power setting did not appear to influence the visual outcome using Fischer's Exact test. Conclusion: TTT shows no deleterious side effects over 18 month follow-up and may decrease subfoveal exudation and stabilize VA in patients with greater than 50% occult subfoveal CNV. Retreatment does not appear to reduce the chances of good visual outcome.</p>


New

AMD-TTT53 **Transpupillary Thermotherapy for “Classic” Extrafoveal Choroidal Neovascular Membrane: A Randomised Pilot Study**

MIP

Musicco I, Veronese C, Salvetti P, Viola F, Staurengi G. Department of Ophthalmology, University of Brescia, Brescia, Italy.
2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4416, 2002

To evaluate TTT in the treatment of “classic” extrafoveal choroidal neovascular membranes (C-CNV) and verify the possibility of minimizing collateral damage to normal retina, 20 consecutive patients with C-CNV were randomly assigned to treatment with direct photocoagulation using the MPS parameters or using TTT with the laser setting suggested by Reichel for occult lesions (800 mW, 3 mm spot size, 60 second duration). The follow-up visits were scheduled after 7, 15 and 30 days, with recurrence being as the appearance of a new CNV after 30 days. The patients were re-treated using the same parameters if the lesion maintained its pretreatment fluorescein characteristics after 1 week. The main endpoints were stabilization of VA (± 3 ETDRS lines) and C-CNV obliteration. Alternative treatment was given after 3 retreatments or if the lesion grew. Results: *MPS group*: Immediate C-CNV obliteration in 9/10 patients; VA was stable in 3, increased in 1 and worsened in 6. Seven patients experienced a recurrence. *TTT group*: Immediate obliteration in 7/10 patients; VA was stable in 4, increased in 3 and worsened in 3. An average of 1 retreatment was necessary during the first 3 weeks, and 3 patients experienced a recurrence. Even in the case of stable or increased VA, the angiographic appearance was different: in the MPS group, the anatomical result was always an area of atrophy; in the TTT group, the lesion decreased in size and showed “granular” fluorescence. No chorioretinal atrophy was visible at the treatment site. Conclusion: TTT obliterated C-CNV even after multiple treatments in the first weeks, with functional results comparable with those after MPS. However, the anatomical results were characterized by the persistence of angiographically silent C-CNV. These preliminary data suggest the need for further research.


New

AMD-TTT54 **Transpupillary Thermotherapy of Retinal Angiomatic Proliferation in Age-Related Macular Degeneration**

MIP

Midena E, de Belvis V, Lo Giudice G, Zaltron S, Pilotto E, Piermarocchi S. Department of Ophthalmology, University of Padova, Padova, Italy.
2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4417, 2002

To report on the treatment of retinal angiomatic proliferation (RAP) in AMD by means of TTT, 20 consecutive patients affected by RAP in AMD were treated using a one session, two-shot, subthreshold TTT technique, developed according to the principle of thermoresistance of tissues. Treated eyes were examined 1 week and 1 month after treatment, and then at 3 month intervals. BCVA fundus photographs, dynamic fluorescein and ICG angiography were performed at each follow-up examination. Mean follow-up was 6 months (range 3-24 months). BCVA decreased (> 3 lines) in 30% of eyes (6 eyes), and remained stable in 14 eyes (70%). No eye had improvement of BCVA. Reduced leakage and closure of RAP were observed in all eyes at early follow-up. After 3 months, RAP was patent in 75% of eyes, but leakage was significantly and permanently reduced. Conclusion: One session, subthreshold, two-shot TTT may prove useful in the treatment of RAP in AMD, a currently untreatable clinical condition.

New

AMD-TTT55

MIP

Transpupillary Thermotherapy for the Treatment of Occult Subfoveal Choroidal Neovascularization in Age Related Macular Degeneration
 Kim SH, Kim JE, Connor TB, Wirostko WJ, Han DP.
 Ophthalmology, The Eye Institute, Medical College of Wisconsin, Milwaukee, WI.
 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4418. 2002

To evaluate the efficacy of TTT for the treatment of occult subfoveal CNV in AMD, 58 eyes in 55 patients were treated with the 810 nm OcuLight SLx laser. A complete ophthalmologic examination, fundus color photographs and an FA were obtained on each patient. Pre-treatment VA ranged from 20/40 - 20/400.

Treatment Parameters

Power & Spot Size: 800 mW & 3.0 mm
 530 mW & 2.0 mm

Spots: Single or multiple spots were used in a single session to encompass the entire CNV.

Number of treatments: Between 1 and 3. 11 of 58 (19%) eyes received more than one treatment.

The main outcome measures were proportion of eyes with less than 3 lines of Snellen VA loss, number of retreatments and final exudative response based on clinical examination and FA. Follow-up was 6 - 16 months (mean = 9 months). Seventeen of 58 eyes had an RPE detachment on pre-treatment FA. Ten of 58 eyes received multiple spot treatment for large CNV. Forty-two of 58 (72%) eyes lost fewer than 3 lines of Snellen VA. Of the eyes treated with a single laser spot, 34 of 48 (71%) eyes lost fewer than 3 lines of VA, while 8 of 10 (80%) eyes treated with multiple laser spots lost fewer than 3 lines of VA. Five of 58 (8.6%) eyes lost greater than 6 lines of vision. In 4 of 58 (7%) eyes, the initial occult CNV became predominantly classic after TTT and subsequently underwent photodynamic therapy (3) or macular translocation (1). Five of 58 eyes developed submacular hemorrhage during the follow-up period. In the final examination, there was no active CNV exudation in 46 of 58 (79%) eyes. Conclusion: TTT appears to be a safe treatment for preserving vision and reducing exudation in eyes with occult subfoveal CNV in AMD. Larger CNV may also be eligible for treatment using multiple laser spots in a single TTT session.

New

AMD-TTT56

MIP

Comparative Study of Visible and Infrared Light in Transpupillary Thermotherapy
 Ito Y,¹ Sodeyama T,¹ Mori K,¹ Anzail K,¹ Takita Y,¹ Imai D,¹ Shibuya M,¹ Yoneya S,¹ Moshfeghi DM,² Peyman GA.³
¹Ophthalmology, Saitama Medical College, Saitama, Japan; ²Ophthalmology, Cleveland Clinic Foundation, Cleveland, OH; ³Ophthalmology, Tulane University Health Sciences Center, New Orleans, LA.
 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4419, 2002

Also listed as HIST27, pg. 243

TTT was performed on eyes of Japanese monkeys to study a potential effect of TTT on the retina and choroid. Seven eyes were treated with a 635-nm wavelength and 5 eyes with the 810-nm wavelength. An area of the posterior fundus 1 mm in diameter was irradiated with 635 nm with varied exposure durations ranging from 30 to 80 seconds, eventually achieving 20, 50, and 79.2 J/cm². Irradiation with the 810 nm diode laser was also performed on the posterior fundus 2 mm in diameter. The duration was set at 60 seconds and the total energy alternated between 96, 115, and 153 J/cm². Clinical evaluations were made with funduscopy and FA and ICGA before and after treatment. The animals were sacrificed either immediately or 2 weeks after the treatment and the eyes were processed for histopathological study. Results: Laser lesions were not visible by funduscopy or angiography throughout the follow-up period. The light microscopy study, however, revealed that the outer nuclear layer showed pyknotic changes which were more significant with the 810 nm wavelength. The inner segments of the photoreceptors (IS) were swollen and vacuolated. The RPE also demonstrated vacuoles. Using electron microscopy, the cytoplasm of the IS appeared watery and had vacuolated

Infrared Diode Laser Applications

	<p>mitochondria. The intercellular spaces of the IS were enlarged. The mitochondria in the RPE were vacuolated. The chorio-capillaris and large choroidal vessels were attenuated or closed in some areas 2 weeks after treatment. These findings were common at all power settings with both the 635 nm and 810 nm laser wavelengths. Conclusion: TTT with 635 nm and 810 nm wavelength diode lasers occluded choroidal vessels; however, some damage to the inner retina occurred. Therefore, the indications and irradiation settings for TTT must be chosen with careful consideration.</p>																														
<p> AMD-TTT57 Transpupillary Treatment of Occult Choroidal Neovascularization: Preliminary Results  Rougier MB, Isber R, Alami M, Fourmaux E, Korobelnik JF. Ophthalmology, University Hospital, Bordeaux, France. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4420, 2002</p>	<p>To assess the efficacy of TTT for the treatment of occult CNV, a prospective, non-randomized, study of 45 eyes of 45 patients with occult CNV due to AMD treated with the 810 nm OcuLight laser was conducted. Occult CNV were defined with FA and ICGA prior to treatment. ETDRS VA ranged from 20/200 to 20/40.</p> <p>Treatment Parameters Power: 450 – 800 mW Duration: 60 seconds Spot size: 2500 to 4000 μm No visible color change of the retina was seen at the end of the treatment.</p> <p>The visual outcomes and the size of the lesion were evaluated at 3 months. A VA change of 2 lines (10 letters) in the ETDRS chart was considered clinically significant. No eyes demonstrated any retinal scar. VA remained unchanged in more than 60% of the eyes, even if the CNV membrane remained partly persistent. Visual outcomes were better when the size of the membrane was less than 3000 μm. Conclusion: Despite limited follow-up, TTT seems to preserve VA in cases of AMD with occult CNV. Preliminary results suggest that occult CNV must be treated early, when the size of the CNVM is small. Ongoing trials are needed to compare TTT with the natural history of occult CNV.</p>																														
<p> AMD-TTT58 Transmission of Thermal, PDT and TTT Laser Wavelengths Through Blood  Glazer-Hockstein C, Stoltz RA, Tolentino MJ, Dunaief J, Maguire AM. Retina Service, Scheie Eye Institute, Philadelphia, PA. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4426, 2002</p>	<p>This study was conducted to compare the penetration through blood of various laser wavelengths used in thermal photocoagulation, photodynamic therapy (PDT), and TTT. Laser light (200 mW, 0.5 sec duration for visible light wavelengths; 200 mW, 83 second duration for PDT; and 200 mW, 30 second duration for TTT) was directed through 2.1 mm normal saline (control), 2.1 mm whole blood with a hematocrit of 40%, and serial dilutions of whole blood. Laser power output was measured with an Orion Laser Power/Energy monitor, Ophir Optronics LTD. Laser power was measured in units of milliWatts and expressed as a percentage of control. Results: Laser power transmission was expressed as a percentage of saline control in all laser wavelength subsets.</p> <table border="1"> <thead> <tr> <th><u>Treatment</u></th> <th><u>Whole Blood</u></th> <th><u>1:16</u></th> <th><u>1:32</u></th> <th><u>1:64</u></th> </tr> </thead> <tbody> <tr> <td>Green (521 nm)</td> <td>0</td> <td>0.4</td> <td>6</td> <td>18.6</td> </tr> <tr> <td>Yellow (568 nm)</td> <td>0</td> <td>0.5</td> <td>6.2</td> <td>19.8</td> </tr> <tr> <td>Krypton Red (647 nm)</td> <td>1.2</td> <td>7.4</td> <td>16.8</td> <td>30.3</td> </tr> <tr> <td>PDT (689 nm)</td> <td>0</td> <td>7.1</td> <td>14.0</td> <td>38.6</td> </tr> <tr> <td>TTT(810 nm)</td> <td>1.6</td> <td>4.5</td> <td>11.1</td> <td>23.5</td> </tr> </tbody> </table>	<u>Treatment</u>	<u>Whole Blood</u>	<u>1:16</u>	<u>1:32</u>	<u>1:64</u>	Green (521 nm)	0	0.4	6	18.6	Yellow (568 nm)	0	0.5	6.2	19.8	Krypton Red (647 nm)	1.2	7.4	16.8	30.3	PDT (689 nm)	0	7.1	14.0	38.6	TTT(810 nm)	1.6	4.5	11.1	23.5
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	<p>Conclusion: 521 and 568 wavelengths penetrated the least through all dilutions of blood tested. 689 and 647 wavelengths penetrated most effectively through blood but were still significantly attenuated. This suggests that retinal hemorrhage may have a significant effect on the delivery of laser energy to choroidal neovascular membranes. This may affect parameters used in thermal and non-thermal laser treatments of AMD.</p>
<p>AMD-TTT59 TTT with AMD: Visual Acuity and Visual Fields (mean defect in Humphrey 10-2 threshold test) Weber U. Norddeutsche Augenaerzte at Schwerin, May 2002</p> <p>MIP</p>	<p>Eight-three patients with occult CNV were treated with an 810 nm OcuLight photocoagulator using treatment parameters suggested by Reichel (800 mW, 3.0 mm spot size, 60 second duration). Retreatments ranged from 1 to 3 times. FA, VA, and visual fields (mean defect (MD) in 10 degree threshold test, Humphrey) were documented for up to 15 months. Results were evaluated statistically using linear regression analysis. Results: Linear regression for VA is defined by $y = -0.1801 - 13.388$ with $R^2 = 0.0025$. Linear regression for MD is defined by $y = 0.002x + 0.1212$ with $R^2 = 0.002$. Conclusion: In statistical terms, TTT is a suitable method for preventing a decline of VA and visual field.</p>
<p>AMD-TTT60 Transpupillary Thermotherapy (TTT) of Occult CNV in Age-Related Macular Degeneration: 2 Years Results of A Prospective Non-Randomized Case Study Vesti Nielsen N. University Eye Clinic, Rigshospitalet Copenhagen, Denmark Euretina Symposium. Barcelona, Spain, May 31 – June 1, 2002</p> <p>MIP</p>	<p>Eighty-nine patients with wet AMD, who did not fulfill the morphological inclusion criteria for PDT were proposed TTT with the 810 nm OcuLight photocoagulator. Exclusion criteria for TTT comprised submacular hemorrhage, more than 50% subretinal fibrosis above 25% and serous PED above 25% of the total lesion assessed by FA. Number of “pure” occult CNV 52 (58%) and minimal classic (under 50%) CNV 37 (42%).</p> <p><u>Treatment Parameters</u> Power: 500 mW – 800 mW Duration: 1 minute Spot size: 3.0 mm or Power: 1000 – 1500 mW Duration: 1 minute Spot size: 6.0 mm</p> <p>Fifty-six patients had 2 or more years follow-up; 33 patients had 1 – 2 years follow-up. VA improved (> 2 lines on Snellen chart) in 11 %, was unchanged in 64% and worsened (> than 2 lines) in 25% of all patients. The same results were found in the 56 patients with a follow-up for 2 years and more. Pre-treatment VA (mean) 0.25 (0.05-0.6) and post-treatment VA 0.16 (0.01-1.0). In the group with impairment of VA, 46% had a loss of VA above 3 lines. Morphologically, all patients with a bettered or stabilized VA had angiographical reduction of exudation. A convincing observation of this study was a remarkable improvement of metamorphopsia /central scotoma in 87% of all patients, irrespectively of VA. TTT retreatments occurred in 41% of all patients, most often in cases with minimal classic CNV (under 50%). In the latter group 15% converted to predominantly classic CNV requiring PDT. Conclusion: TTT for occult CNV seems to stabilize and improve VA in 75% for a period of 2 years. Metamorphopsia /scotoma were markedly improved in 87%.</p>

New

New

New

AMD-TTT61 **Study of Retinal Sensitivity following Treatment of Occult Choroidal Neovascularization with Transpupillary Thermotherapy (TTT)**
 Escoto R.
 Clinica Barraquer Barcelona, Spain
 Euretina Symposium. Barcelona, Spain, May 31 – June 1, 2002

MIP

To assess retinal sensitivity following the use of TTT for treating occult subfoveal CNV secondary to AMD, 40 eyes in 40 patients with occult CNV were treated with TTT using the 810 nm OcuLight laser with a large spot size slit lamp adapter. Preoperative tests were logMAR VA, FA and computerized static perimetry.

Treatment Parameters

Power: 320-800 mW

Spot size: 1.2, 2.0, 3.0 mm.

The spot diameter was set to cover the entire angiographically visible lesion. Energy delivered was 800 mW through a contact lens for a spot diameter of 3 mm. The energy parameters were reduced accordingly for a smaller spot diameter.

Static perimetry was used to assess retinal sensitivity, analyzing a total of 81 points limited to the central 10° in two different stages. Taking into account VA and leakage after treatment, the following efficacy parameters were established: Healing (disappearance of exudation with ?VA), success (persistence with >VA / disappearance of exudation with VA stabilized or diminished <1 line), failure (vision diminished >1 line). Follow-up was at 1, 3, 6 and 9 months. In cases of persistent leakage treatment was repeated after a minimum interval of 3 months. Results: Mean sensitivity: The mean increase was +3.46 dB (20 eyes: 50%) and -4.62 dB (20 eyes: 50%). Mean defect: The mean increase +4.54 dB (20 eyes: 50%) and -3.42 dB (20 eyes: 50%). According to the study's efficacy parameters, the results were healing in 16 eyes (40%), success in 12 eyes (30%) and failure in 12 eyes (30%). Conclusions: TTT can be used to achieve stabilization or improvement in retinal sensitivity because it reduces the exudation secondary to subretinal occult CNV.

New

AMD-TTT62 **The Effect of Transpupillary Thermotherapy on the Human Macula**
 Robertson DM, Salomão DR.
 Arch Ophthalmol 120:648-652, 2002
 Also listed as HIST30, pg. 244

MIP

A case report of a 65 year old woman who had a growing pigmented choroidal lesion in her left eye that had been observed to increase in thickness from 2.3 to greater than 4 mm during an interval of 9 years. Her VA was 20/20 OD and 20/25⁺³ OS. The right eye was normal. After therapeutic options were discussed, the patient chose enucleation. She agreed to have her retina exposed to light from the infrared laser for 60 seconds using a power of 800 mW. She also agreed to undergo color fundus photography and FA of the retina before and after light exposure. Five days after laser exposure, her eye was re-examined; 3 hours thereafter, her eye was enucleated. Laser exposure of the macula failed to produce a clinically recognizable reaction in the retina during the treatment, and no changes were recognized on results of a careful clinical examination 5 days after exposure. A FA 6 days after treatment showed no difference from the FA obtained immediately before the laser exposure. Although the central VA was reduced to 20/100 immediately after exposure, 5 days after TTT, the central VA had recovered to the pretreatment VA. The authors were unable to identify TTT-induced adverse effects in the retina or the RPE by means of clinical examination or FA. However, they observed histological and ultrastructural abnormalities in the tissue after the eye was enucleated, which may be explained by the presence of the preexisting retinal edema; however, some of the observed abnormalities could have

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	<p>been caused by light alone. No evidence of vascular closure or coagulative necrosis in the small capillaries in the choroid was found. The absence of recognizable destruction of the retina and retinal vasculature observed in the single experiment does not ensure that vascular closure and retinal destruction will not occur when TTT is used to treat occult CNV. However, in this case, with clinical and angiographic evidence of mild retinal edema and no retinal or subretinal blood, a 60 second exposure of 800 mW using a 3 mm beam diameter did not cause clinically recognizable damage to the macular retina, the retinal vessels or the underlying choriocapillaris and other choroidal vessels.</p>
<p> AMD-TTT63 Early Vascular Changes Induced by Transpupillary Thermotherapy of Choroidal Neovascularization <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-top: 5px;">MIP</div> Lanzetta P, Michieletto P, Pirracchio A, Bandello F. <i>Ophthalmology</i> 109:1098-1104, 2002</p>	<p>To study early direct effects of TTT on CNV and choroid, 64 eyes with subfoveal CNV received TTT treatment with the 810 nm OcuLight SLx photocoagulator. Fifty-two eyes had predominately occult CNV, and 12 eyes had predominantly classic membranes.</p> <p><u>Treatment Parameters</u> Power/Diameter ratio of 247 mW/mm (800 mW for a 3.0 mm laser spot, 530 mW for 2.0 mm, 320 mW for 1.2 mm, 210 mW for 0.8 mm) For occult CNV, no visible color change was detectable at the end of hyperthermia. For classic CNV, power was reduced by 1/3. For CNV caused by PM or angioid streaks, power was reduced by 1/2. Contact lens: 3-Mirror Goldmann lens (used in 61 eyes); QuadrAspheric Volk lens (used in 3 eyes). In the case of any retinal whitening, the irradiation was immediately stopped and abandoned.</p> <p>After an accurate measurement of the lesion, the spot of the laser was set to fully cover the CNV and to extend at least 100 μm beyond its border. The green illumination of the slit lamp was selected with a low-medium intensity, and the aiming beam of the laser was minimally visible to check for any color change during laser irradiation.</p> <p>Within 1 hour after TTT, FA and ICGA showed increased leakage of CNV and choroidal vessels. Follow-up at 1 and 2 weeks, demonstrated a hypofluorescent area corresponding to the laser spot and absence of angiographic leakage seen on FA and ICGA. At 4 weeks after TTT, FA showed mottled hypofluorescence-hyperfluorescence of the TTT-treated area and absence of angiographic leakage. Conclusion: Vascular damage and remodeling are consequences of TTT of CNV. The observation of hyperfluorescence and hypofluorescence seen on FA and ICGA after TTT results from a combination of damage to sensitive sites within the microvasculature and the resulting physiologic responses to this damage. The early changes after TTT of CNV are comparable to those observed after PDT of CNV. TTT and PDT might share common mechanisms of action.</p>


New

AMD-TTT64 Subthreshold Subfoveal Diode (810 nm) Laser Photocoagulation for Treatment of Occult Choroidal Neovascularization (CNV) in Exudative Age-Related Macular Degeneration (AMD)
Olk RJ, Olk NW, Olk MW, Lucas M. The Macula Society XXVth Annual Meeting. Barcelona, Spain. June 12 – 15, 2002

MIP

A consecutive case series of 212 eyes of 162 patients with occult CNV in AMD were treated with subthreshold, subfoveal 810 nm diode laser photocoagulation using the OcuLight laser.

Treatment Parameters

Power: 535, 800, 1200, and 1600 mW

Duration: 1 minute

Spot size: 2.0, 3.0, 4.5, and 6.0 mm

Retreatments: 107 eyes (50%) received a second treatment; 50 eyes (24%) received a third treatment, 20 eyes (9%) received a fourth treatment; and 3 eyes (1%) received PDT.

Results:

Follow-up	# of eyes	Avoided ≥ 3 line loss	Reduction of Exudation
6 months	182	142 eyes (78%)	122 eyes (67%)
12 months	172	133 eyes (77%)	129 eyes (75%)
18 months	133	101 eyes (76%)	115 eyes (86%)
24 months	105	82 eyes (78%)	97 eyes (92%)

Conclusion: Subthreshold, subfoveal 810 nm diode laser photocoagulation is effective in improving or stabilizing VA and reduction of exudation in eyes with occult CNV secondary to AMD with minimal side effects.


New

AMD-TTT65 Transpupillary Thermotherapy (TTT) of Classic and Occult Choroidal Neovascularization in Patients with Age Related Macular Degeneration; Results at 29 Months
Newsom RSB, McAlister JC, Saeed M, El-Ghonemy K, McHugh JDA. Poster 25. Meeting of the Club Jules Gonin. Montreux, Switzerland. Aug 31 - Sept 4, 2002

MIP

To report on the outcome of patients treated with TTT for classic and occult CNV secondary to AMD, a retrospective, non-comparative case series of 36 eyes of 33 patients was performed. Angiographically defined CNV, 11 predominantly classic and 25 predominantly occult were treated with TTT using an 810 nm OcuLight large spot diode laser. TTT exposure was 1 minute, the endpoint being no or minimal visible change. Outcome was assessed with best-corrected Snellen VA, clinical examination and FA. Patients were followed-up for a mean of 28.7 months (range 18-40 months). The mean change in Snellen VA for predominantly classic membranes was -0.77 (SD 1.9) and 3/11 (27%) had visual loss of 3 lines or more. Predominantly classic membranes were closed in 9/11 patients eyes, stabilized in 2/11 with 0/11 recurrence. The mean change in Snellen VA for predominantly occult membranes was -0.68 (SD 2.6) and 4/25 (16%) patients had visual loss of 3 lines or more. Predominantly occult CNV were stabilized in 25/25 cases, reoccurrence developed in 2/25; one of these developed classic CNV. Conclusions: The medium term results for patients treated with TTT for both occult and classic CNV show good stability, with little visual loss and few recurrences. This data confirms the authors original findings (see AMD-TTT11, pg 19).

New

OCU-TTT66 Transpupillary Thermotherapy (TTT) of Choroidal Neovascularization in Age-Related Macular Degeneration
 Gelisken O, Güler K, Yücel A, Avci R.
 Poster 31. Meeting of the Club Jules Gonin. Montreux, Switzerland, Aug 21 – Sept 4, 2002

Twenty eyes of 20 patients with visual deterioration due to neovascular AMD were treated with TTT using the 810 nm diode laser. CNV membranes were occult in 10, occult and classic mixed in 7 and classic in 3 patients. Outcome was assessed with Snellen VA, ophthalmoscopic and fluorescein angiographic examination at 2 weeks, 1, 3, and 6 months.

Treatment Parameters

Power: 250 - 800 mW

Spot size: 1 – 3.5 mm

Duration: 60 seconds

Clinical endpoint: no visible change or a slight graying of the retina.

Retreatment: 7 patients (35%). A second treatment session was performed after 2 weeks if no clinical and angiographical improvement was noted.

At 3 months post-treatment, VA improved (2 or more Snellen lines) in 6/20 (30%), was stabilized in 12/20 (60%) patients. At 6 months, VA improved in 5/20 (25%) and remained unchanged in 11/20 (55%) patients. The main treatment outcome was significant reduction of exudative components of AMD and shrinkage of the lesion complex in 16 patients (80%), occurring within 1 to 3 months. Clinical improvement was associated with disappearance or a reduction of leakage on FA mainly in eyes with occult CNV, whereas this was not a consistent finding in eyes showing classic CNV. Neovascular outgrowth was observed in 2 patients within 1 and 3 months. Subretinal hemorrhage developed in 2 eyes, one being negligible not interfering central vision and resorbing in 2 weeks, and the other being associated with neovascular outgrowth and reduced VA. Conclusions: TTT application appears to be a feasible methodology in neovascular AMD. This treatment modality is able to reduce the clinical signs of exudative process, resulting in visual improvement and stabilization in the majority of the patients. Findings in this pilot study warrant further prospective and randomized clinical trials to compare this intervention with the natural course and other treatment approaches.

New

OCU-TTT67 Deep Retinal Vascular Anomalous Complex in Age Related Macular Degeneration: Transpupillary Thermotherapy
 Midena E, Pilotto E, de Belvis V, Zaltron S, Piermarocchi S.
 Poster 32. Meeting of the Club Jules Gonin. Montreux, Switzerland, Aug 21 – Sept 4, 2002

In a prospective, open trial, 25 eyes of 25 patients with deep retinal vascular anomalous complex in AMD were treated with TTT. A new, two consecutive spots (3 and 1.2 mm) subthreshold TTT technique - based on thermotolerance mechanisms of tissue hyperthermia - was used. Outcome was assessed with VA (ETDRS charts), and dynamic ICGA and FA. Eyes were examined 1 and 4 weeks, and every 3 months after TTT. Results: Minimum follow up was 6 months. Mean follow up was 18 months (range 6-36 months). Twenty of 25 eyes (80%) showed significant and persistent decrease of dye leakage (and exudation). No eye was retreated. Baseline VA remained stable (no change or 1 line improvement) in all successfully treated eyes. VA deteriorated (equal to 1 line worsening or greater) in 5 eyes, which showed disciform scarring. Conclusions: Two spots, subthreshold TTT may represent a potential treatment for deep retinal vascular anomalous complex, a neovascular form of AMD poorly responsive to laser photocoagulation and/or photodynamic therapy.



<p>OCU-TTT68 Transpupillary thermotherapy for Subfoveal Choroidal Neovascularization: A Twelve Months Follow-up of 60 Patients Fuisting B, Feucht M, Richard G. Poster 34. Meeting of the Club Jules Gonin. Montreux, Switzerland, Aug 21 – Sept 4, 2002</p> <p><i>For 12-Month Follow-up, see AMD-TTT23, pg. 25</i></p>	<p>A consecutive series of 60 patients with uni- or bilateral predominantly occult CNV were included in this study. A complete ophthalmic examination including VA, slit lamp biomicroscopy, funduscopy and FA was performed prior to and 3, 6, 9 and 12 months after the treatment.</p> <p><u>Treatment Parameters</u> Power/Spot size: 509 mW/2000 μm; 800 mW/3000 μm Duration: 60 seconds</p> <p>At 12 months, VA stabilized or improved in 65% of patients: improved ≥ 2 lines (7%); stabilized ± 1 line in (58%); and worsened ≥ 2 lines in 35% of patients. Retinal leakage, assessed by FA, stabilized in 60% of the treated eyes. In 31 (52%) eyes with persistent or increasing membrane size or leakage, additional treatment became necessary. Some patients with further visual loss after TTT showed significant relief of metamorphopsia. Conclusion: The present data show stabilization of VA in 65% of eyes after TTT. Compared to the natural course of occult and mixed subfoveal CNV, these data give some evidence for patient benefit after TTT. In March 2001, a multicenter trial has started to further evaluate TTT.</p>
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AGE-RELATED MACULAR DEGENERATION

<i>Laser Treatments in Non-Exudative AMD</i>	
<p>AMD-DRY1 Improvement of Visual Acuity Following Direct Perifoveal Photocoagulation of Soft Drusen Maculopathy Ruiz-Moreno JM, Alio JL. Alicante, Spain Scientific Session. AAO Chicago, IL November, 1993</p>	<p>Thirty-two cases of soft drusen maculopathy (SDM) were treated with direct perifoveal photocoagulation (DPP). The authors studied visual acuity, fluorescein angiography and visual field pre- and post- (2 months) treatment. Visual acuity improved from 20/100 to 20/50 ($p < 0.001$, student test), without detectable alterations in visual field. In 2 cases, (6 and 8 months after DPP), choroidal neovascularization appeared (both have choroidal neovascularization in the other eye). Results suggest that DPP may be important for treating SDM.</p>
<p>AMD-DRY2 Laser Photocoagulation to Treat Macular Soft Drusen in Age-Related Macular Degeneration Figueroa M, Regueras A, Bertrand J. Retina 14:391-396, 1994</p>	<p>A prospective pilot study of 20 patients with confluent soft drusen involving the fovea was conducted. One spot of argon green laser was applied to each soft druse in the temporal macula. Treated and untreated drusen disappeared in all patients after mean times of 2 months and 10 months, respectively. The treated temporal drusen disappeared first, followed by the subfoveal and then the nasal drusen. Superonasal drusen persisted longer. Visual acuity improved by one line or more in 6 patients, remained unchanged in 13 (65%), and worsened in 1 (.5%) patient. No treatment-related complications were observed after an 18 month follow-up period. Treatment with laser photocoagulation caused resolution not only of treated soft drusen, but also of untreated soft drusen located far from the laser scars in the nasal macula.</p>
<p>AMD-DRY3 Bilateral Macular Drusen in Age-Related Macular Degeneration. Prognosis and Risk Factors Holz FG, Wolfensberger TJ, Pique B, Gross-Jendroska M, Wells JA, Minassian DC, Chisholm IH, Bird AC. Ophthalmology 101:1522-1528, 1994</p>	<p>In a prospective study, 126 patients with bilateral drusen were reviewed annually for up to 3 years. Serial fundus photographs and fluorescein angiograms were analyzed independently by two readers in a masked fashion using a standardized grading scheme, including size, number, density, and fluorescence angiographic behavior of drusen. Results showed that new lesions occurred in one or both eyes of 17 (13.5%) of the 126 patients. The cumulative incidence of exudative or nonexudative lesions was 8.55% at 1 year, 16.37% at 2 years, and 23.52% at 3 years for patients older than 65 years of age. Significant risk factors included the degree of confluence of drusen within 1600 μm of the center of the fovea ($p = 0.023$), focal hyperpigmentation ($p = 0.004$), slow choroidal filling ($p = 0.023$), and focal extra-foveal areas of atrophy of the retinal pigment epithelium ($p = 0.042$). These results give an estimate of the incidence of complicating lesions in patients with bilateral drusen and identify those features indicating higher than average risk of visual loss.</p>
<p>AMD-DRY4 Evidence for a Remote Effect of Photocoagulation in Promoting Resolution of Drusen Maguire M, Fine S, Alexander J, Phillips D. Scientific Program. The Macula Society. Palm Beach Gardens, FL February 22-25, 1995</p>	<p>The authors compared the eyes of 60 Macular Photocoagulation Study patients with bilateral drusen and CNV in one eye whose CNV was treated with confluent laser burns. Over time, approximately 25% of untreated eyes had fewer drusen compared to more than 50% of the treated eyes. However, the clinical significance of reduction in the extent of drusen remains unknown. Conclusion: Laser photocoagulation has a remote effect in reducing the extent of drusen which exceeds the reduction that may occur over time without any treatment. The hypothesis that this remote effect of laser photocoagulation may reduce the rate of development of CNV in high risk eyes is being evaluated in several multicenter clinical trials.</p>

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<p>AMD-DRY5 Laser to Drusen Trial: An Assessment of Short Term Safety within a Randomized, Prospective, Controlled Clinical Trial Bressler SB, Vitale S, Hawkins BS, Alexander J, Orr PR, Schachat AP, Finkelstein D, Haller JA, Bressler NM. Department of Ophthalmology, Johns Hopkins Univ. School of Medicine; Baltimore, MD. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S225. Abstract nr 1028, 1995</p>	<p>This abstract summarizes the first phase of a prospective, randomized clinical trial to explore macular scatter laser treatment as a means of retarding development of neovascular age-related macular degeneration (AMD) in eyes with non-neovascular disease. Twenty-five patients had evidence of neovascular AMD in the non-study eye and non-neovascular AMD with large drusen, focal areas of hyperpigmentation, and visual acuity $\geq 20/50$ in the study eye. Study eyes were assigned randomly to laser treatment (dye yellow laser at 50 μm spot or infrared diode laser at 75 μm spot) or observation. Three (n=25) and 6 (n=13) months following randomization, no differences were observed between laser treated eyes and untreated eyes with respect to change from baseline level of visual acuity, contrast sensitivity, or reading speed. Choroidal neovascularization did not develop in any study eye by the third month visit. Scatter laser treatment in the macula was not associated with any significant adverse effects in the early post-treatment period.</p>
<p>AMD-DRY6 Prophylactic Perifoveal Laser Treatment of Soft Drusen Sarks SH, Arnold JJ, Sarks JP, Gillies MC, Walter CJ. Australian and New Zealand J Ophthalmol 24(1):15-26, 1996</p>	<p>In an uncontrolled series, laser was applied to 30 eyes of 28 patients, 18 patients with bilateral drusen and 10 with exudative disease in the fellow eye. Comparison was made between treated and untreated eyes in 14 patients with bilateral drusen. Treatment was performed using the argon green laser, with burns applied in a perifoveal ring (diameter 1 DD or 1500 μm). A template corresponding to the size of the optic disc was centered over the fovea on a recent 30 or 35 degree fundus photograph and was projected as a guide to treatment. A ring of 40 to 50 laser burns, spaced one burn width apart, was placed outside this circle, but in some of the early cases a double ring was applied at this first session. Spot size was 100 μm, duration 0.05 to 0.07 seconds, and power just sufficient to cause a barely discernible whitening of the RPE, generally 100 mW (range, 100 to 140 mW). Where larger drusen ($\geq 125 \mu\text{m}$) or a drusenoid PED lay on the perifoveal ring, direct treatment to the drusen was avoided and laser was applied only to the edge away from the fovea, even if this was more than 1000 μm from the foveal center. Mean follow-up was 16.8 months (range, 3 to 42 months). Soft drusen resorbed in all treated eyes in the vicinity of laser and within the fovea. Large soft confluent drusen (>500 μm) responded most rapidly. Visual acuity improved one or more lines in 12 (40%) treated eyes, was unchanged in 16 (53%) and deteriorated in two (7%). In 14 patients with bilateral drusen in whom only one eye was treated, VA remained unchanged in 10 eyes and improved in 4 treated eyes, while none of the untreated eyes improved ($p = 0.03, X^2$), and decreased in 4 eyes. Atrophic expansion of laser burns was minimal. CNV developed in 2 of 30 eyes (7%). Conclusion: Perifoveal laser treatment appears to expedite the regression of soft drusen within the fovea. The risk of complications may be reduced by treating eyes early, before pigment changes develop, and by applying a minimum number of burns at a distance greater than 750 μm from the foveal center.</p>

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<p>AMD-DRY7 Laser Photocoagulation for Macular Soft Drusen. Update Results Figueroa MS, Regueras A, Bertrand J, Aparicio MJ, Manrique MG. <i>Retina</i> 17:378-384, 1997</p>	<p>A total of 46 patients with confluent soft drusen and pigmentary changes were studied prospectively. Group 1 was composed of 30 patients with bilateral drusen; the authors randomly assigned one eye of each patient for treatment and the fellow eye for the control. Group 2 was composed of 16 patients with a choroidal neovascular membrane present in one eye, and treatment was applied to the fellow eye. Treatment included the direct application of argon green laser to the soft drusen located temporal to an imaginary vertical line crossing the fovea. The laser beam was applied a minimum of 500 microns from the center of the foveal avascular zone to avoid the well-known problem of laser scar extension. If all the drusen were beneath the fovea, two crescent-shaped vertical rows of laser spots in the temporal macula were applied at least 500 microns from the fovea, and the drusen were not treated. The treatment parameters consisted of 0.1 seconds with a spot size of 100 microns. The energy was set at the minimum level to obtain a light gray-white reaction, which made the laser spots difficult to identify immediately after treatment. All treated drusen disappeared in a mean of 3.5 months after treatment, and untreated drusen disappeared in all but three patients in an average of 8.5 months. After an average period of 3 years, only one control eye and none of the treated eyes in group 1 developed a choroidal neovascular membrane ($p = 0.500$). In group 2, neovascularization occurred in 18% of the patients an average of 12.2 months after treatment. The initial improvement in Snellen acuity after subfoveal drusen disappearance diminished as a consequence of cataract progression. Although no definitive conclusions should be made because of the small number of patients studied, results seem to show that this treatment does not reduce the risk of choroidal neovascularization in the treated eye of patients with a history of exudative disease in the fellow eye. It may be effective in patients with high-risk bilateral soft drusen, that is, in less advanced stages of the disease.</p>
<p>AMD-DRY8 A Pilot Randomized Controlled Study on the Effect of Laser Photocoagulation of Confluent Soft Macular Drusen Little HL, Showman JM, Brown BW. <i>Ophthalmology</i> 104:623-631, 1997</p> <p><i>See Follow-up Letter to the Editor, AMD-DRY18, pg. 58</i></p>	<p>The authors determined the effect of photocoagulation of drusen on visual acuity and progression to subretinal neovascular membranes (SRNV). One of paired eyes was randomized to photocoagulation with other eye to control in 27 patients having symmetrical maculopathy and visual acuities, aged 46 to 81 years (mean, 69.7 years). Selection criteria included: 1) symmetrical drusen in both eyes, 2) minimum drusen size of 100 μm in diameter, 3) 20 or more drusen, or 10 drusen measuring 500 μm or greater in diameter, 4) drusen concentrated within 1500 μm of the foveola with at least part of one druse within 150 μm of the foveola, 5) minimal correctable visual acuity of 20/60 or better for each eye, with macular degenerative changes accounting for the visual impairment. A focal, directed treatment of each drusen rather than a random or grid treatment was used. Laser photocoagulation was performed with 577 to 620 nm wavelengths, 100 or 200 μm diameter setting with 100 to 200 mW of power at .05 to 0.1 second exposures. The treatment endpoint was a slightly visible lightening of the retinal pigment epithelium or outer retina overlying the drusen. No heavy white burns were applied. No burns were applied within 300 μm and rarely within 500 μm of the center of the fovea. Over large drusen, lesions were placed one lesion diameter apart. No confluent laser burns were applied. The total number</p>

	<p>of photocoagulation lesions ranged from 23 to 516, with a mean of 132 lesions per eye. One session of treatment was performed in 17 patients, 2 sessions in 7 patients, 3 sessions in 2 patients, and 4 sessions in 1 patient. More than one treatment session was performed in patients with persistence of drusen after 6 months following initial treatment or in whom new drusen developed during the course of the study. When SRNV developed in control or treated eyes, conventional laser photocoagulation was administered. Follow-up was 1 to 6 years (mean, 3.2 years).</p> <p>Visual Results of Treated vs. Control Eyes (27 patients)*</p> <table border="1"> <thead> <tr> <th></th> <th>Treated</th> <th>Control</th> </tr> </thead> <tbody> <tr> <td>Better \geq 2 lines</td> <td>6 (22%)</td> <td>0 (0%)</td> </tr> <tr> <td>Same</td> <td>16</td> <td>17</td> </tr> <tr> <td>Worse \leq 2 lines</td> <td>5</td> <td>10</td> </tr> </tbody> </table> <p>*p = 0.018 (disregarding the pairing of eyes)</p> <p>Progression to SRNV was less with treatment. The results of this small randomized paired-eye control study showed that visual acuity in treated eyes fared better than controls without increased complications of subretinal neovascularization or foveal atrophy. However, a larger study with longer follow-up is needed to determine whether laser photocoagulation of soft drusen causes a statistically significant reduction in development of exudative maculopathy.</p>		Treated	Control	Better \geq 2 lines	6 (22%)	0 (0%)	Same	16	17	Worse \leq 2 lines	5	10
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<p>AMD-DRY9 Laser Treatment in Subjects with High-risk Clinical Features of Age-Related Macular Degeneration Guymer RH, Gross-Jendroska M, Owens SL, Bird AC, Fitzke FW. Arch Ophthalmol 115:595-603, 1997</p>	<p>In this pilot study, 12 patients considered to be a high risk for sight-threatening complications from age-related macular degeneration were treated with an argon green laser. They received 12 lesions of 0.2 seconds duration and 200 μm spot size at the lowest possible intensity to achieve faint blanching of the RPE (80 – 300 mW). The lesions were placed between drusen in a ring 750 to 1000 μm from the fovea. In 5 patients in whom there appeared to be no change in the drusen after 3 to 14 months, photocoagulation was repeated, ranging from 5 to 16 more lesions. Follow-up was 12 to 24 months. Choroidal neovascularization developed in 1 patient 8 months after treatment, with consequent loss of central vision. In 9 of the remaining 11 patients, high-risk characteristics of drusen were reduced. Four patients had retinal pigment epithelium depigmentation, and all maintained 20/40 visual acuity at 12 months. One patient lost 3 lines of vision due to geographic atrophy after 12 months. Conclusions: A few laser lesions in the posterior pole lead to resolution of drusen. There does not appear to be an increased risk for choroidal neovascularization. Retinal threshold measurements show no indication of geographic atrophy at 1 year, but cannot be excluded as a late outcome. Laser treatment may reduce the risk for profound sight-threatening lesions in age-related macular degeneration.</p>												

<p>AMD-DRY10 A Random Pilot Study Comparing Subthreshold vs Threshold Diode Laser Photocoagulation (PC) in the Reduction of Drusen Associated With Age-Related Macular Degeneration</p> <p>MIP</p> <p>Olk RJ,¹ Friberg TR,² Stickney KL,¹ Akduman L,¹ Wong KL,³ Chen M,³ Morse L,⁴ Garcia C,⁵ Musch DC.⁶</p> <p>¹Washington Univ. School of Medicine. St. Louis, MO; ²Univ. of Pittsburgh, Pittsburgh, PA; ³Sarasota Retina Institute, Sarasota, FL; ⁴UC Davis, Sacramento, CA; ⁵Univ. of Houston, Houston, TX; ⁶Univ. of Michigan. Ann Arbor, MI [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): 518. Abstract nr 79, 1997</p>	<p>One hundred forty-six patients (217 eyes) with dry AMD were enrolled in a multicenter pilot study. Each eligible eye had at least 5 large soft drusen and VA of $\geq 20/63$. Bilateral eligible eyes (71 patients) were randomly assigned to receive diode laser (IRIS OcuLight SLx) photocoagulation in one eye and observation in the other. Unilateral eligible eyes (75 patients) were randomized to either treatment or observation. Treatment eyes were further randomized to threshold or subthreshold PC. Both treated groups showed a reduction in drusen during the course of the follow-up period. None of the observed eyes had a reduction in drusen. Disappearance of drusen was faster initially in the threshold treatment subgroup (43% (23/53) vs 18% (9/49) at 3 months), but gradually equalized in both threshold and sub-threshold subgroups during the follow-up period: 80% vs 36% at 6 months; 88% vs 75% at 12-18 months. Three cases of acute choroidal neovascular membranes (CNVM) were induced by visible laser burns early in the study. No cases of geographic atrophy occurred in any treated eyes. Conclusions: Subthreshold diode laser photocoagulation decreases the amount of drusen present in dry AMD eyes with minimal side effects. These results are helpful in the design of a larger multicenter randomized study to determine whether reduction of drusen may reduce the incidence of CNVM formation in eyes with dry AMD.</p>
<p>AMD-DRY11 Laser Treatment of High-Risk Nonexudative Age-Related Macular Degeneration (AMD)</p> <p>Boscia F, Ferrari TM, Lorusso G, Durante G, Cardia L.</p> <p>Istituto di Clinica Oculistica – Università di Bari – Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38 (4): 593. Abstract nr 455, 1997</p> <p><i>For related Letter to the Editor, see AMD-DRY18, pg. 58</i></p>	<p>In a prospective, controlled study, 12 patients with bilateral soft drusen, large drusen, confluent drusen and pigment clumping were treated with argon green laser photocoagulation in the eye more severely affected. Mild laser burns (100 micron, 0.1-0.2 seconds) were placed on the drusen and scattered over areas where no drusen were present. The better eye was followed up as a control. At study entry as well as after 3 and 6 months after treatment, visual acuities, fundus color photographs, fluorescein angiographies and 10° central visual fields were obtained. The number and extension of the drusen on the angiograms and fundus color photographs in the treated eyes decreased significantly compared to the untreated eyes. No significant changes in VA or in the macular threshold occurred in either of the two groups. No treatment-related complications were observed after a 6 month follow-up period. This study suggests that early laser treatment to the posterior pole leads to resolution of drusen. There is no increased risk of new choroidal vessels, and VA and macular threshold measurements show no evidence of atrophy at 6 months. Laser photocoagulation may play a role in the treatment of high-risk non-exudative AMD.</p>
<p>AMD-DRY12 Ultrastructural Change of Age-Related Debris in Bruch's Membrane Analyzed in Laser Scars of Human Retina</p> <p>Ulbig MW,¹ Ruskovic D,¹ Bengisu M,¹ McHugh DA,² Marshall J.³</p> <p>¹University Eye Hospital Munich, Germany; ²King's College Hospital, London, UK; ³St. Thomas' Hospital, London, UK [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): 594. Abstract nr 461, 1997</p> <p><i>Also listed as DME-CW11, pg. 68</i></p>	<p>The authors wanted to elucidate the mechanism of action of laser treatment for diffuse retinal edema or drusen, especially the mechanism of action of lasers using a near infrared wavelength. It has been shown that diabetic macular edema and drusen respond to such laser treatment. As a hypothesis, there may be interference with accumulated lipid deposits at the level of RPE and Bruch's membrane, which block active fluid transport from the sensory retina to the choroid. It has been shown previously by means of light microscopy that lipid components in Bruch's membrane are reduced by laser treatment. (<i>See HIST9, pg. 190</i>)</p> <p>Prior to enucleation, four eyes with a malignant choroidal melanoma were lasered using an 810 nm diode laser. Eight diabetic donor eyes with laser scars were also included (2 eyes with 9-month old pigmented laser scars, 6 eyes with already</p>

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	<p>depigmented lesions). Sections of lasered areas were stained with Oil-red-O for light microscopy or were processed for electron microscopy. In all laser scars the staining intensity for Oil red-O was reduced, whereas the immediate laser burns revealed persistence of lipid debris. Ultrastructurally, there was thinning of the inner collagenous layer with a reduced amount of age-related debris. This effect was more pronounced in 9-month-old pigmented lesions in the area with overlying phagocytic RPE cells. At the margins of the scars, the decrease of debris was gradual and patchy, whereas the center of the lesion and areas adjacent to phagocytic RPE cells were almost completely denuded. Laser induced reduction of lipid components was evident in all examined laser scars, independently from the laser source or the age of the lesion.</p>
<p>AMD-DRY13 A Pilot Study Comparing Sub-threshold vs. Threshold Diode Laser Photocoagulation in the Prophylactic Treatment of Macular Degeneration: One Year Follow-Up MIP Friberg TR,¹ Olk RJ,² Wong KL,³ Chen M,³ Garcia CA⁴, Morse L,⁵ Stickney KL,² Musch DC.⁶ ¹University of Pittsburgh; ²Washington University School of Medicine; ³Sarasota Retinal Institute; ⁴University of Houston; ⁵U.C. Davis; ⁶University of Michigan. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S243. Abstract nr 1108, 1998</p>	<p>The authors followed 155 patients with dry AMD with more than 5 large drusen and good vision in the eligible eye(s). Seventy-three patients had both eyes eligible and 82 had one eye eligible with a disciform scar in the fellow eye. Treatment consisted of sub-threshold or threshold diode laser (810 nm, IRIS Medical OcuLight SLx) photocoagulation administered in a grid pattern, sparing the fovea. Bilateral patients had one eye randomized to treatment using the fellow eye as a control. Unilateral patients had their eligible eye randomized to treatment or no treatment. Treatment was further randomized to either threshold (visible laser lesions) or subthreshold (invisible laser lesions). Patients were followed for disappearance of drusen, development of CNV, and for changes in vision. At 12 months, disappearance of drusen occurred in 56% of visibly treated, 45% of subthreshold treated, and 7% of control eyes. The difference between treated and untreated eyes regarding drusen disappearance was statistically significant ($P < 0.05$). Choroidal neovascularization developed in 11% of eligible eyes. While there was no statistically significant difference in the incidence of CNV between groups, there were more than twice as many neovascular events in threshold treated versus subthreshold treated eyes. Conclusion: Subthreshold laser photocoagulation promotes disappearance of drusen.</p>
<p>AMD-DRY14 Prophylactic Laser Treatment in Early Age-Related Maculopathy Reduced the Incidence of Exudative Complications Frennesson C, Nilsson SEG. Br J Ophthalmol 82:1169-1174, 1998</p>	<p>The authors investigated the effect of prophylactic laser treatment on drusen area and incidence of exudative lesions in patients with soft drusen maculopathy. In a prospective study, 38 patients with early age-related maculopathy and good visual acuity were randomized to laser treatment or to a control group. Treatment consisted of perifoveal argon-green laser photocoagulation, approximately 100 mild laser burns (200 μm), on and between the drusen in a horseshoe-shaped area temporal to the fovea. Each group consisted of two subgroups: a fellow eye group and a bilateral drusen group. At study entry, there were no significant ($p > 0.5-0.9$) differences in drusen area between the groups. At 3 years, 36 of 38 patients remained in the study. In the treatment group, mean drusen area decreased significantly in fundus photographs and angiograms ($p < 0.001$). Visual acuity and color contrast sensitivity (CCS) did not change significantly. All these results are also valid for the subgroups. In the control group, however, mean drusen area increased significantly ($p < 0.001$), mean visual acuity decreased significantly ($p < 0.01$), as did the color contrast sensitivity along the tritan axis ($p = 0.02$). For the fellow eye control group ($n = 7$), the increase in drusen area in fundus photographs and the decrease in CCS along the</p>

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	<p>tritan axis were not statistically significant ($p=0.57$ and $p=0.37$, respectively). Furthermore, at 3 years, five patients in the control group showed exudative lesions (1/7 in the fellow eye group and 4/12 in the bilateral drusen group), whereas no such complications occurred in the treatment group. One patient developed a small atrophy. Thus, there is now a significant difference ($p=0.047$), however with a large 95% confidence interval, 0.06-0.46, regarding exudative complications between the treated group and the control group. Conclusion: Perifoveal mild laser treatment causes a reduction in drusen area in patients with soft drusen maculopathy and may lower the incidence of exudative lesions.</p>
<p>AMD-DRY15 A Model of the Incidence and Consequences of Choroidal Neovascularization Secondary to Age-Related Macular Degeneration. Comparative Effects of Current Treatment and Potential Prophylaxis on Visual Outcomes in High-Risk Patients Lanchoney DM, Maguire MG, Fine SL. Arch Ophthalmol 116:1045-1052, 1998</p>	<p>The objective of this study was to describe the comparative impact of current and preventative treatments on incidence of CNV and severe vision loss in patients with bilateral soft drusen (BSD). The model was designed to assess the morphologic and functional outcomes of eyes in a cohort of white patients in the United States 43 years or older with BSD. Interventions included application of prophylaxis of 10% to 50% efficacy to 1 or both eyes of patients with BSD, application of laser photocoagulation to eligible CNV lesions, or both. Conclusions: Patients with BSD face a 12.40% risk of developing CNV within 10 years. The addition of even a modest (10% effective) bilateral preventive treatment to the current regimen for CNV would more than double the prevention of legal blindness in the BSD population relative to current laser treatment; a preventative treatment of 33% efficacy more than halves the rate of legal blindness caused by CNV. Preventative treatment given to the fellow eye only after the first develops CNV has substantially less impact.</p>
<p>AMD-DRY16 Laser Treatment in Eyes with Large Drusen. Short-Term Effects Seen in a Pilot Randomized Clinical Trial The Choroidal Neovascularization Prevention Trial Research Group Ophthalmology 105:11-23, 1998</p>	<p>The CNVPT consisted of two studies operating under a common protocol with regard to treatment and evaluation of outcomes. The Bilateral Drusen Study consisted of 156 patients without exudative age-related macular degeneration and with more than 10 large ($>63 \mu\text{m}$) drusen in each eye. The Fellow Eye Study consisted of 120 patients with exudative age-related macular degeneration in 1 eye and more than 10 large drusen in the other eye. The treatment protocol for more (85%) of the eyes consisted of 20 laser burns, 100 μm in diameter, in a pattern of 3 rows placed between the 12- and 6-o'clock positions beyond the temporal perimeter of the foveal avascular zone. The desired intensity of the burns was a gray-white lesion. Whenever the area of drusen had not been reduced by 50% or more at 6 months of enrollment, a second laser treatment protocol was adopted that specified 24 laser burns, 100 μm in diameter, in a circular pattern of 2 rows surrounding the macular drusen. Results: In the Bilateral Drusen Study, CNV developed in 4 of 156 treated eyes and in 2 of 156 observed eyes ($p = 0.62$); in the Fellow Eye Study, the proportions are 10/59 treated eyes and 2/61 observed eyes ($p = 0.02$). Changes in visual acuity are similar in treated and observed eyes in the Bilateral Drusen Study through 18 months. However, by 18 months, observed eyes in the Fellow Eye Study have lost more visual acuity than treated eyes ($p = 0.02$). Changes in contrast threshold are similar in treated and observed eyes in each study. Conclusions: Laser treatment to high-risk fellow eyes may increase the short-term incidence of CNV. Long-term effects in fellow eyes and effects in patients with bilateral drusen require additional observation.</p>

<p>AMD-DRY17 Prophylactic Laser Treatment to Fellow Eyes of Unilateral Retinal Pigment Epithelial Tears Gross-Jendroska M, Owens SL, Flaxel CJ, Guymer RH, Bird AC. Am J Ophthalmol 126:77-81, 1998</p>	<p>In a prospective study, 12 patients with a RPE tear in one eye caused by AMD and drusen in the fellow eye received prophylactic laser treatment of the retina in their fellow eyes and were followed for 2 years or more. In the first year, a reduction in BCVA to 20/80 or worse occurred in 1 (8%) of 12 eyes and in the second year occurred in 2 (18%) of the remaining 11 eyes. The cumulative risk of visual loss in the treated fellow eye was 25% in 2 years. In historical control, subjects in a natural history study of patients with RPE tear in one eye, central visual loss occurred in 16 (37%) of 43 eyes in the first year for a cumulative loss of 59% in the first 2 years. Compared with these historical control subjects, findings of this study suggest that visual loss in the fellow eyes of patients with a retinal pigment epithelial tear in the first year is reduced by prophylactic low intensity laser photocoagulation of the macula.</p>
<p>AMD-DRY18 Laser Photocoagulation of Confluent Soft Macular Drusen Boscia F, Ferrari TM, Durante G, Cardia L. Letters to the Editor. Ophthalmology 105:760-761, 1998</p> <p><i>Letter to the Editor in response to Little, et al. article. See AMD-DRY8, pg.53</i></p> <p><i>*Invest Ophthalmol Vis Sci 1997; 38 (Suppl):455. See AMD-DRY11, pg. 55</i></p>	<p>The authors congratulate Little, et al on their study design and highlight that having the symmetrically involved contralateral eye as a control, given the high correlation between eyes, offers more power to their study and greater validity to their results. The authors share their similar prospective study* on 12 patients in which they found the same effects on drusen resolution and on VA as reported by Little et al. However, in contrast to Little, no significant atrophy following the treatment-related resolution of drusen was observed. This might be due to the different photocoagulation modalities of the two studies. The authors' treatment was lighter in intensity than Little's, used only 100 µm, and did not apply more than one laser burn per drusen. Patients were not re-treated because it was difficult to determine an endpoint in case of drusen not absorbing. The authors believe not retreating might have spared the degenerated RPE; and believe if laser-induced resolution of drusen is also the result of enhanced permeability of Bruch's membrane after photo-coagulation, a more indirect treatment should be equally effective.</p>
<p>AMD-DRY19 Therapeutic Benefits of Infrared Diode Laser (810 nm) Photocoagulation in Prophylactic Treatment of Nonexudative Age-Related Macular Degeneration – 2 Year Results of a Randomized Pilot Study</p> <p>MIP</p> <p>Olk RJ, Friberg TR, Stickney KL, Akduman L, Wong KL, Chen MC, Levy MH, Garcia CA, Morse LS. Ophthalmology 106:2082-2090, 1999</p> <p><i>See AMD-DRY22 for 4 Year Results, pg. 60</i></p>	<p>Of 229 eyes (152 patients), 75 eyes (75 patients) were enrolled in a unilateral group, and 154 eyes (77 patients) in a bilateral group. Eyes received 810 nm photocoagulation using either visible endpoint burns or invisible (subthreshold) lesions and compared to eyes receiving no treatment. Main outcome measures were reduction of drusen, change in VA, and rate of CNVM formation. At 12 months post-treatment, 62% of eyes treated with visible burns had a clinically significant reduction in drusen, whereas this proportion (65%) was reached in 18 months for eyes treated with subthreshold lesions. At 24 months, treated eyes had a significant reduction in drusen compared to observation eyes (P < 0.001). VA was significantly improved in treated eyes at 12, 18, and 24 months compared to observation eyes (P < 0.001). Review of pre-treatment and post-treatment photographs of all treated eyes with 2 or more lines of VA improvement at 24 months showed resolution of central, soft confluent drusen in 11 (91.6%) of 12 eyes. CNV formation was similar in treated and observation eyes through 24 months follow-up. Complications with visible burn treatment included CNV associated with 6 eyes and a juxtafoveal laser scar in 1 eye. Conclusions: Infrared diode laser macular grid photocoagulation in patients with nonexudative AMD significantly reduces drusen levels and significantly improves VA when either visible endpoint burns or subthreshold endpoint lesions are used. Longer follow-up is needed to determine the efficacy of treatment in reducing the rate of CNV formation. Data from this pilot study have</p>

	<p>been used to design the Prophylactic Treatment of AMD (PTAMD) Clinical Trial, a multicenter, randomized, prospective trial currently in progress comparing subthreshold (invisible) treatment to observation in eyes with nonexudative AMD.</p>																																																	
<p>AMD-DRY20 Effects of Laser Photocoagulation on Macular Soft, Hard and Diffuse Drusen Lau LI, Lee FL, Cheng CY, Liu JH, Hsu WM. Dept of Ophthalmology, Taipei Veterans General Hospital, National Yang-Ming University, Taipei, Taiwan [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S178. Abstract nr 927, 2000</p>	<p>To investigate the effects of laser photocoagulation on VA, drusen number and area in patients with soft, hard and diffuse drusen maculopathy, 53 eyes with drusen maculopathy were enrolled under the criteria of corrected VA $\geq 6/30$ without other maculopathy or subretinal neovascularization. The drusen were classified into soft, hard and diffuse types. Grid, focal and c-shape green argon laser photocoagulation were applied to the three groups respectively. VA, drusen number and area were evaluated both before and 6 months, 1 year and 2 years after laser treatment. At 35 months (mean) follow-up, partial or complete regression of macular drusen was observed in 51% (N = 27), 24.5% (N=13), 24.5% (N= 13) of eyes with soft, hard, and diffuse drusen respectively. Diffuse drusen group showed the best result and the difference in regression among the three groups just reached statistical significance (P = 0.05). Changes in VA were as follows:</p> <table border="1"> <thead> <tr> <th colspan="2"></th> <th colspan="3">Drusen Type</th> </tr> <tr> <th colspan="2"></th> <th>Soft</th> <th>Hard</th> <th>Diffuse</th> </tr> </thead> <tbody> <tr> <td rowspan="3">6 mos</td> <td>Increase ≥ 2 lines</td> <td>8.0%</td> <td>15.4%</td> <td>44.4%</td> </tr> <tr> <td>No Change</td> <td>48.0%</td> <td>61.5%</td> <td>33.3%</td> </tr> <tr> <td>Decrease ≥ 2 lines</td> <td>44.0%</td> <td>23.1%</td> <td>22.2%</td> </tr> <tr> <td rowspan="3">1 yr</td> <td>Increase ≥ 2 lines</td> <td>9.5%</td> <td>20.0%</td> <td>30.8%</td> </tr> <tr> <td>No Change</td> <td>57.1%</td> <td>60.0%</td> <td>38.5%</td> </tr> <tr> <td>Decrease ≥ 2 lines</td> <td>33.3%</td> <td>40.0%</td> <td>30.8%</td> </tr> <tr> <td rowspan="3">2 yrs</td> <td>Increase ≥ 2 lines</td> <td>21.4%</td> <td>60.0%</td> <td>14.3%</td> </tr> <tr> <td>No Change</td> <td>50.0%</td> <td>20.0%</td> <td>42.9%</td> </tr> <tr> <td>Decrease ≥ 2 lines</td> <td>28.6%</td> <td>20.0%</td> <td>42.9%</td> </tr> </tbody> </table> <p>Most of the soft drusen group showed either no change or decrease in VA throughout the follow-up period. Hard drusen group showed more improvement in the latter period, whereas most of the diffuse drusen group had improved VA in the beginning, but the result did not sustain throughout the follow-up period. Conclusions: Laser treatment induces drusen regression, especially in the diffuse type, but has no significant benefit in improving VA.</p>			Drusen Type					Soft	Hard	Diffuse	6 mos	Increase ≥ 2 lines	8.0%	15.4%	44.4%	No Change	48.0%	61.5%	33.3%	Decrease ≥ 2 lines	44.0%	23.1%	22.2%	1 yr	Increase ≥ 2 lines	9.5%	20.0%	30.8%	No Change	57.1%	60.0%	38.5%	Decrease ≥ 2 lines	33.3%	40.0%	30.8%	2 yrs	Increase ≥ 2 lines	21.4%	60.0%	14.3%	No Change	50.0%	20.0%	42.9%	Decrease ≥ 2 lines	28.6%	20.0%	42.9%
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<p>AMD-DRY21 Laser Photocoagulation to Eyes with Drusen: What happens to the Fellow Eye? Friberg TR,¹ Pelekoydas D,² Ballas C.² ¹University of Pittsburgh, Pittsburgh, PA; ²F.O.R.T.H., Crete, Greece [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S178. Abstract nr 929, 2000</p>	<p>Ten patients with multiple large drusen in both eyes were photocoagulated with 810 nm subthreshold laser in one eye selected at random as per the PTAMD protocol. At baseline and 1 year after treatment, the total area of drusen present within a circle of 2 DD in size, centered at the foveola, was quantitated using drusen analyzer software (IRIS Medical and A.R.T.T.) after digitizing the fundus images. This software has an area measurement precision of 85 to 90%. The analysis was performed in a masked manner without knowledge of which of the 10 pairs of eyes had been photocoagulated. As subthreshold laser is used, photocoagulation marks are not seen in the fundus photographs. The photographs were scanned using off-the-shelf hardware and software at 675 dpi, and absolute measurements were made assuming a standard diameter of the optic nerve in each image. Results: The percent area reduction for treated eyes averaged $26.1 \pm 21.1\%$ at 1 year while the area reduction in untreated eyes measured $2 \pm 19\%$. There was a statistically significant difference at P = 0.01 indicating the effectiveness of subthreshold laser in</p>																																																	

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	<p>promoting drusen disappearance. Drusen in the fellow eye did not consistently decrease in area, with some eyes showing a reduction of 40% of original drusen area while others showed an increase in area of 25%. Treated eyes all showed an area reduction, which ranged from 5 to 65%. Conclusions: While subthreshold photocoagulation promotes the disappearance of drusen, there is little evidence that such photocoagulation using subthreshold laser levels has any specific effect in the contralateral eye.</p>
<p>AMD-DRY22 Therapeutic Benefits of Diode Laser Grid Photocoagulation in Prophylactic Treatment of Age-Related Macular Degeneration (AMD) Long-Term (4-5 Years) Results of A Randomized Pilot Study</p> <p>MIP</p> <p>Olk RJ,¹ Friberg TR,² Olk HR,¹ Akduman L,¹ Wong KL,³ Chen MC,³ Levy MH,³ Garcia CA,⁴ Morse LS.⁵ ¹The Retina Center, St. Louis, MO; ²University of Pittsburgh Eye and Ear, Pittsburgh, PA; ³Sarasota Retina Institute, Sarasota, FL; ⁴Herman Eye Center, Houston, TX; ⁵UC Davis, Sacramento, CA. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S319. Abstract nr 1685, 2000</p> <p><i>See AMD-DRY19 for 2 Year Study Results, pg. 58</i></p>	<p>To determine the effectiveness and safety of 810 nm diode laser grid photocoagulation in dry AMD, 229 eyes of 152 patients were enrolled in a randomized pilot study. 75 eyes (75 patients) were enrolled in the unilateral arm; 154 eyes (77 patients) were enrolled in the bilateral arm. In the unilateral arm, 32 eyes were randomized to the observation group, 27 eyes were treated with visible burns, and 16 eyes with subthreshold lesions. In the bilateral arm, 77 eyes were in the observation group, 36 eyes were treated with visible burns, and 41 eyes with subthreshold lesions. Reduction of drusen, change in VA, and rate of CNV formation were compared among the groups. At 4-5 years follow-up, 70% of treated eyes had a significant reduction in drusen compared to observation eyes (p<0.0001). VA was significantly improved in treated eyes at 36 and 48 months compared to observation eyes (p<0.001). CNV formation was decreased in treated vs. observation eyes through 4-5 years follow-up. Conclusions: Diode laser grid photocoagulation in patients with dry AMD significantly reduces drusen levels and significantly improves VA when either visible or subthreshold burns are used in the long-term. The efficacy of treatment in reducing the rate of CNV formation demonstrated a decreased rate in treated eyes vs. observation eyes at 4-5 years follow-up.</p>
<p>AMD-DRY23 Predictors of Drusen Reduction After Subthreshold Infrared (810-nm) Diode Laser Macular Grid Photocoagulation in Prophylactic Treatment for Nonexudative Age-Related Macular Degeneration</p> <p>MIP</p> <p>Rodanant N,¹ Aurora A,¹ Friberg TR,² Cheng L,¹ Toyoguchi M,¹ Corbin P,² Freeman WR.¹ ¹Department of Ophthalmology, Shiley Eye Center, UCSD, La Jolla, CA 92093-0946; ²University of Pittsburgh, Pittsburgh, PA. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 42(4): S127. Abstract nr 677, 2001</p>	<p>An analysis of two centers' data from a prospective, randomized, controlled, clinical trial was conducted on a total of 78 eyes of 39 patients with AMD. One eye of each patient was randomized to the observation group; the other eye was treated with subthreshold (invisible endpoint) lesions. Eyes were treated with 48 spots of 810 nm diode laser macular grid photocoagulation using subthreshold (half of the power needed to induce a threshold laser burn) lesions and compared to eyes which received no treatment. The number of laser uptake lesions and area of laser induced RPE changes on FA at 3 months post-treatment were studied as predictors for reduction of drusen 50% or greater from baseline (major reduction) at 1 year by using computer-assisted analysis. At 12 months follow-up, 41% of eyes treated with subthreshold burns had major reduction in drusen compared to 2.6% of observation eyes (p<0.0001). In treated eyes with major reduction of drusen, the mean number of laser uptake lesions on FA at 3 months post-treatment was 34.1 compared to 14.7 in non-major drusen reduction group (p<0.0001). Mean area of RPE change on FA at 3 months post-treatment in major drusen reduction group was 0.96 square mm compared to 0.39 square mm in non-major drusen reduction group (p=0.0003). Conclusions: Subthreshold 810-nm diode laser macular grid photocoagulation in patients with nonexudative AMD significantly reduces drusen level at 1 year (p<0.0001). The surface area of RPE disturbance as measured at 3 months post-treatment appears to be a good predictor for major reduction of drusen level at 1 year (p=0.0003).</p>

New

AMD-DRY24 Prophylactic Treatment of Age-Related Macular Degeneration (PTAMD): Update on the Clinical Trial

MIP

Friberg TR,¹ Musch D,² PTAMD Study Group. ¹Ophthalmology/Eye & Ear Institute, University of Pittsburgh, Pittsburgh, PA; ²University of Michigan School of Medicine, Ann Arbor, MI.
2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2904, 2002

The PTAMD trial was organized to determine whether a single treatment placing a grid of 48 spots of 810 nm subthreshold laser is effective in decreasing the rate of CNV and/or visual loss in patients whose eyes harbor multiple large drusen (more than 5 drusen >63 microns in diameter). Patients with good VA (20/63 or better) and multiple drusen in both eyes (bilateral group), or with good VA and multiple drusen in one eye and advanced AMD in the fellow eye (unilateral group) were randomized to treatment (bilateral group: right or left eye treated; unilateral group: eligible eye randomized to treatment or observation). Patients were followed at multiple intervals after entry into the study with FA and BCVA (ETDRS). Results: 242 patients in the unilateral arm and over 600 patients in the bilateral arm were enrolled and followed for up to 5 years thus far. Enrollment in the unilateral arm closed on 4/1/00, based on a difference between treated and observed eyes; as of the most recent follow-up (8/01), 21.0% (26 of 124) of treated eyes and 14.4% (17 of 118) of observed eyes developed CNV (P<0.02, Wilcoxon test). Early post-randomization visual acuities also differed, with treated eyes showing higher rates of moderate loss (≥ 3 lines) at 6 months (11.4%) than observed eyes (4.0%). Follow-up of the unilateral group continues. Enrollment in the bilateral arm was closed as of 12/1/01, based on advice from the monitoring committee that the enrollment was sufficient to evaluate clinically important differences in outcomes with further follow-up. Conclusion: Prophylactic diode laser treatment of an eye of a patient whose fellow eye already had an AMD event shows no beneficial effect in preventing CNV, and may promote CNV events and visual loss at least in the short term. Patients who only have bilateral drusen and no CNV may or may not benefit from prophylactic subthreshold laser treatment; follow-up in the bilateral study arm is also ongoing and no safety issues have been raised.

New

AMD-DRY25 Predictors of Choroidal Neovascularization in Eyes Treated With Subthreshold Diode Grid Laser Therapy to Prevent Choroidal Neovascularization; Results From the Unilateral Arm of the PTAMD Study

MIP

Rodanant N,¹ Freeman WR,¹ Musch DC,² Friberg TR,³ Cheng L,¹ Toyoguchi M,¹ Bartsch DUG,¹ PTAMD Study Group.
¹Ophthalmology, Shiley Eye Center, UCSD, La Jolla, CA; ²Kellogg Eye Center, Ann Arbor, MI; ³Ophthalmology, University of Pittsburgh, Pittsburgh, PA.
2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 1211, 2002

To determine the predictors of CNV in unilateral arm eyes treated with subthreshold diode laser photocoagulation in the Prophylactic Treatment of Age-Related Macular Degeneration (PTAMD) study. There were 242 patients enrolled in the unilateral arm of the PTAMD study: 118 eyes were randomized to the observation group, and 124 eyes were treated with subthreshold diode laser photocoagulation using the 810 nm OcuLight SLx photocoagulator. During follow-up as of 8/31/01, 26 eyes of the treated group developed CNV, versus 17 CNV events in observed eyes (P=0.02, Wilcoxon test of Kaplan-Meier curves). Preoperative stereo fundus photographs and 3 month post treatment angiograms were analyzed in a masked manner for a sample of the treated eyes that developed CNV and of the treated eyes that did not develop CNV. By using computer-assisted analysis, the surface area of drusen was determined at baseline and the 3-month post treatment angiograms were analyzed for number of laser uptake spots. Results: The mean surface area of drusen in treated eyes that subsequently developed CNV was 7.18 ± 4.27 mm² versus 3.83 ± 1.92 mm² in eyes that did not develop CNV (P=0.016). There was no association between the number of laser uptake lesions detectable on FA and the development of CNV (Mean number of laser spots was 27 ± 4 spots in the CNV group versus 30 ± 9 spots in the non CNV group (P=0.56)). Conclusion: This case-



New

AMD-DRY26

Subthreshold Diode Laser Grid Photocoagulation for Treatment of Adult Vitelliform Macular Degeneration

MIP

Grignolo FM, Piccolino FC, Eandi CM, Ventre L.
Poster 51. Meeting of the Club Jules Gonin. Montreux, Switzerland, Aug 21 – Sept 4, 2002

control sub-analysis indicates that CNV incidence after prophylactic laser photocoagulation is more likely in eyes with a greater area of drusen preoperatively. The amount of laser-induced RPE changes does not predict CNV although the authors' prior work showed that it can predict drusen reduction in bilateral arm patients.

Adult vitelliform macular degeneration is characterized by a deep central yellowish lesion which results in a gradual atrophic maculopathy with central visual decrease. The purpose of this study is to determine whether subthreshold diode laser macular grid photocoagulation may be clinically effective in the treatment of this disease.

Methods: Four eyes of 4 patients with adult vitelliform macular degeneration were treated after obtaining informed consent. Patients complained of progressive visual blurring due to subfoveal yellowish material in both eyes. In each patient the eye with larger vitelliform lesion was chosen for treatment. Lesion size of the treated eyes varied between one-third and 1 disc diameter. VA of treated eyes ranged between 20/50 and 20/100. Eyes were treated with subthreshold diode laser (810 nm) macular grid photocoagulation (48 spots). Changes of macular lesion and VA were evaluated in a follow-up period of at least 6 months.

Results: Complete resolution of the yellowish lesion was observed in all 4 eyes 3 or 4 months after the treatment. At the end of the follow-up, irregular pigmentation without geographic atrophy of the RPE was seen in the area previously covered by the abnormal material. At 6 months VA was unchanged in 3 eyes and improved 2 lines in one eye. During the follow-up, minimal changes of the macular lesion were observed in the fellow eye of 3 patients. An atrophic maculopathy developed in the fourth fellow eye.

Conclusions: Subthreshold diode laser macular grid photocoagulation seems to induce elimination of the subretinal material and preservation of VA in adult vitelliform macular degeneration. Further studies are required to confirm the benefit of treatment with respect to the natural history of the disease.

AGE-RELATED MACULAR DEGENERATION

<i>Other</i>	
<p>AMD-O1 Indocyanine Green Dye-Enhanced Diode Laser Photocoagulation of Poorly Defined Subfoveal Choroidal Neovascularization Reichel E, Puliafito C, Duker J, Guyer D. Ophthalmic Surg 25:195-201, 1994</p>	<p>Ten patients with poorly defined subfoveal choroidal neovascular membranes (CNVM) were treated with ICG dye-enhanced diode infrared laser photocoagulation and followed for an average of 15 months. Subfoveal chorioretinal scar formation was noted postoperatively in all 10 patients. At last follow-up, 6 to 18 months, (mean, 15 months), 9 of the 10 patients had no more than a two-line increase or decrease in visual acuity. These preliminary results suggest that poorly defined subfoveal CNVM can be successfully treated by ICG dye-enhanced diode laser photocoagulation with minimal adverse affect on visual acuity in most cases.</p>
<p>AMD-O2 Enhanced Diode Laser Treatment in Exudative Age-Related Macular Degeneration Cuzzani O, Young P, van Westembrugge J. Scientific Poster P77. XXVIIth ICO. Toronto, Canada, 1994</p>	<p>In a prospective study, 40 consecutive patients were treated with infrared diode laser after 10 minutes of intravenous injection of 50 mg of indocyanine green. Six months after laser treatment, the vision was unchanged ($p>0.05$). Cases with occult subretinal membranes showed a significant visual decrease at 2 and 4 weeks that improved at 2 and 3 months after surgery. In general, patients tended to keep the pre-operative visual acuity. Infrared diode laser treatment seems to preserve visual acuity in the immediate postoperative period better than do other laser treatments.</p>
<p>AMD-O3 Preliminary Results of ICG Dye-Enhanced Micro-Pulsed Laser Photocoagulation of Subfoveal Choroidal Neovascular Membranes in Age-Related Macular Degeneration Angioletti L. The New York Eye & Ear Infirmary. Abstract. American Society for Laser Medicine and Surgery. San Diego, CA April, 1995</p>	<p>Twenty-one eyes with choroidal neovascular (CNV) membranes directly beneath the foveal center were treated in this study. Following digital fluorescein angiography (FA), the patients received an intravenous injection of 25 mg of ICG dye. Diode infrared laser photocoagulation was initiated after ICG injection using starting parameters of 500 mW power, 500 ms duration and a 300 μm spot. A confluent pattern of direct laser burns was delivered over the entire CNV. Outside the center of the FAZ, moderate whitish diode laser burns were delivered by titrating the laser endpoint; but within the center of the FAZ, subvisible threshold diode applications were applied using micropulsed parameters of 25 ms on/25 ms off. Follow-up ranged from 1 to 4 months. In all eyes, complete obliteration of the CNV was confirmed by visual observation and by FA. Visual appearance of the macula was dramatically improved as noted by clearing of the subretinal blood and flattening of the sensory retinal elevation. None of the treated eyes had any immediate loss of vision. The preliminary results of this pilot study suggest that ICG dye-enhanced micropulsed-diode laser photocoagulation may successfully treat subfoveal CNV without loss of vision.</p>

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<p>AMD-O4</p> <p>Dye Enhanced Diode Laser Photocoagulation Under Continuous Infusion of Indocyanine Green Obana A,¹ Goto Y,¹ Matsumoto M,¹ Miki T,¹ Nishi S,² Asada A.² ¹Department of Ophthalmology; Osaka City University, Japan. ²Department of Anesthesiology and Intensive Care Medicine; Osaka City University, Japan [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S244. Abstract nr 1109, 1995</p>	<p>Five ml of 5 mg/ml indocyanine green (ICG) solution was injected intravenously as a bolus, then followed by continuous infusion of ICG (10 mg/min) for 5 minutes using an infusion pump in 17 ARMD cases. ICG concentration in the blood was measured using a finger tip probe connected to an ICG clearance meter and an 810 nm diode laser was irradiated under the steady state of ICG concentration. Occlusion of the CNV was confirmed ICG angiographically in 15 of 17 (88%) cases. A mean follow-up time was 3.8 months (1~12 months). Only one patient complained of pain. Despite the limitations of a small number of patients and short follow-up time, these preliminary results support the feasibility of this continuous infusion method for the treatment of CNV.</p>
<p>AMD-05</p> <p>Makula-Lifting and Indocyanine Green-Enhanced Endolaser Coagulation of Occult Subfoveal Neovascularization in Age-Related Macular Degeneration Nasemann JE, Frieling E, Andrassi Abstract. Deutsche Ophthalmologische Gesellschaft. Berlin, September, 2000</p>	<p>Twenty-four patients with mean preoperative visual acuities between 20/200 and 60/200 and who suffered from occult CNV with rapid visual deterioration, received a new treatment method that avoids thermal damage to sensory retina but allows for safe occlusion of CNV. The method: After a standard three port vitrectomy, a retinotomy is created temporal to the macula. A small amount of viscoelastic substance is injected under the fovea lifting up the entire macular area. After IV injection of 50 mg ICG, 810 nm endophotocoagulation is performed transretinally covering the area of leakage detected on a preoperative FA. The viscoelastic is removed in part at the end of the operation. Results: Due to the macular detachment, no whitening or burn of sensory retina was observed intraoperatively. No or mild edema was visible at the level of the RPE depending on the laser power. Postoperative angiograms showed a complete occlusion of choriocapillaris and occult neovascularization even with low laser energy (300 mW for 2 seconds). Postoperatively, VA ranged between 10/200 and 20/200. The macula was flat and dry within 2 weeks postoperatively in 11 of 24 patients. Makulalifting and ICG-enhanced infrared endolaser coagulation is a new method to treat occult CNV in AMD. The method allows for a complete occlusion of new vessels without visible damage to the sensory retina.</p>

DIABETIC RETINOPATHY - MACULAR EDEMA

<i>Continuous-Wave Photocoagulation</i>	
<p>DME-CW1 Macular Grid Photocoagulation. An Experimental Study on the Primate Retina Wilson D, Finkelstein D, Quigley H, Green R. Arch Ophthalmol 106:100-105, 1988</p>	<p>The authors studied the effect of macular grid photocoagulation on the retinal vessels, retina, retinal pigment epithelium, and choroid of normal cynomolgus monkeys. Argon blue-green laser photocoagulation, similar to that employed for treating macular edema due to branch retinal vein occlusion, resulted in a decreased retinal capillary area at both 1 and 5 months after treatment. The photoreceptors and retinal pigment epithelium between laser lesions were altered at 3 days after treatment, but their appearance returned to normal by 5 months. Delayed narrowing and occlusion of the retinal capillaries may, at least in part, explain the resolution of macular edema that occurs following this treatment in branch vein occlusion. These delayed changes in the retinal capillaries do not appear to be due to direct thermal or mechanical damage, since the capillaries appear, histologically and ultrastructurally, to be undamaged at 3 days.</p>
<p>DME-CW2 Argon Green (514 nm) Versus Krypton Red (647 nm) Modified Grid Laser Photocoagulation for Diffuse Diabetic Macular Edema Olk R Joseph. Ophthalmology 97:1101-1113, 1990</p>	<p>Between 1984 and 1988, 335 eyes of 132 patients were entered in a prospective, randomized clinical trial to determine if any significant differences exist between treatment with argon green and krypton red modified grid laser photocoagulation for patients with diffuse diabetic maculopathy with or without cystoid macular edema. At the 12 and 24 month follow-up visits, no statistically significant difference was found between the two groups with respect to all of the following: reduction or elimination of macular edema, improvement in visual acuity, worsening of visual acuity, number of treatments per eye, and effect on the visual field.</p>
<p>DME-CW3 Comparison of Krypton Grid Laser Photocoagulation versus Argon Focal Laser Photocoagulation in Treatment of Diabetic Macular Edema Sipperley JO. Southwest Retina, Phoenix, AZ [ARVO Abstract]. Invest Ophthalmol Vis Sci. 334(4): 880. Abstract nr 942, 1992</p>	<p>This study was conducted to determine the usefulness of krypton grid laser photocoagulation in the treatment of diabetic macular edema. Eighty-four eyes of patients with insulin dependent diabetes and clinically significant macular edema were treated with either krypton grid laser photocoagulation or argon green focal laser photocoagulation. Results show that there appears to be no clinically significant difference in the response of patients to argon focal or krypton grid laser photocoagulation in the treatment of diabetic macular edema.</p>
<p> DME-CW4 Diode Laser Treatment of Diabetic Retinopathy Chong L. Los Angeles, CA Scientific Poster 251. AAO. Chicago, IL. November, 1993 <i>Also listed as PDR-CW5, pg. 82</i></p>	<p>Thirty-seven eyes were treated with grid diode laser photocoagulation for diabetic macular edema. Of these eyes, 81.1% had complete resolution of the retinal thickening. Twenty-three eyes were treated with diode laser panretinal photocoagulation for proliferative diabetic retinopathy. Of these eyes, 39.1% had total regression, 43.5% had partial regression and 17.4% showed no regression. Conclusion: Diode laser was effective in treating diabetic retinopathy.</p>
<p> DME-CW5 Diode Laser Photocoagulation for Macular Edema Pallan L, Friberg T. Univ. of Pittsburgh and Medical Center, Pittsburgh, PA. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1396. Abstract nr 657, 1994</p>	<p>Eleven patients with clinically significant macular edema were treated in one session with diode laser photocoagulation in a grid pattern. The IRIS Medical OcuLight photocoagulator was used to treat five patients with diabetic macular edema, five patients with macular edema after branch retinal vein occlusion, and one patient with a central retinal vein occlusion. Laser power was adjusted to produce a very light gray lesion and spot</p>

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	<p>sizes varied from 75 to 150 μ. Follow-up fundusoscopic examination revealed resolution of macular thickening in 9 of the 11 patients (82%). Conclusion: This small series suggests that 810 nm diode laser photocoagulation may be effective in reducing retinal thickening and improving macular edema secondary to diabetes or retinal vascular occlusion.</p>
<p>DME-CW6 Diode Laser Photocoagulation for Diabetic Macular Oedema Ulbig M, McHugh D, Hamilton P. Br J Ophthalmol 79:318-321, 1995</p>	<p>Thirty-three eyes with clinically significant diabetic macular edema were treated with an 810 nm diode laser. Fundus evaluation before and after treatment included visual acuity, stereoscopic biomicroscopy, color photographs, and fluorescein angiography. Treatment variables were spot size 100 μm, exposure duration 400 ms, and powers between 200 and 1000 mW (mean 560 mW). The desired endpoint was to produce a threshold burn, with mild blanching of the retinal pigment epithelium, either focally deep to the leaking microaneurysm, or in a grid pattern in thickened retina within a circinate ring of hard exudate. Although there was no evidence of any acute laser induced effect on the microvascular lesions in the sensory retina, closure was observed to occur over a time course of 3 months, with attendant reduction in retinal edema and the density of hard exudates. At a mean period of review of 6 months (range 3-15 months), macular edema had completely or partially resolved in 27 (81%) eyes; visual acuity improved in 3, deteriorated in 1, and was unchanged (\pm 1 Snellen line) in 2 eyes. As a consequence of the near infrared treatment beam, no patient noticed any bright flashes during therapy. Also, no pain was noticed during macular treatments. In no case was it necessary to abandon therapy, or to perform retrobulbar or peribulbar anaesthesia. The absence of discomfort ensured that the patient remained perfectly still during therapy and this enhanced the precision of retinal targeting. The penetration of infrared diode laser light through macular edema was excellent. Preliminary data suggest that diode laser therapy induces closure of leaking retinal microaneurysms and is effective in the treatment of diabetic macular edema. It therefore seems that much of the beneficial effect of photocoagulation in retinal vascular disease derives from processes dependent on energy deposition in the retinal pigment epithelium rather than in retinal vessels themselves. In conclusion, photocoagulation with near infrared wavelength may have a number of biophysical advantages over treatment with laser radiation of shorter wavelengths. There is better transmission through media opacities, for example, nuclear sclerotic cataracts, and during treatment the patient is not irritated by bright flashes. In macular treatment there is no extra pain compared with the argon laser.</p>
<p>DME-CW7 Macular Photocoagulation with a Diode Laser Friberg TR. Department of Ophthalmology; Univ. of Pittsburgh, PA [ARVO Abstract]. Invest Ophthalmol Vis Sci.36(4): S440. Abstract nr 2016, 1995</p>	<p>Fifty patients with clinically significant macular edema, defined as retinal thickening on biomicroscopy and leakage on fluorescein angiography, were treated in one session with an 810 nm diode laser in a grid pattern at the slit lamp. The end-point was a light grey visible lesion. Patients were reevaluated 3 months later with respect to edema status and visual acuity. Of 35 eyes with diabetic retinopathy, 85% had clinical resolution of macular thickening at follow-up, while 80% of the 15 eyes with retinal vein occlusion had resolution. While there was no significant change in measured visual acuity pre- and post-laser treatment, the majority of patients experienced either subjective improvement or no change with only eight reporting a deterioration of</p>

Infrared Diode Laser Applications

	<p>vision. There were no observed immediate complications of diode laser treatment and no patient developed choroidal neovascularization during the follow-up period. This series suggests that grid laser treatment using the 810 nm wavelength is an effective strategy in the management of macular edema.</p>																		
<p>DME-CW8 Diode Laser (810 nm) versus Argon Green (514 nm) Modified Grid Photocoagulation for Diffuse Diabetic Macular Edema Akduman L, Olk R.J. Ophthalmology 104:1433-1441, 1997</p>	<p>The authors conducted a randomized, prospective clinical trial comparing treatment of diffuse diabetic macular edema (DDME) with either argon green (514 nm) or diode laser (810 nm) modified grid laser photocoagulation. One hundred seventy-one eyes of 91 patients were treated and follow-up was conducted for a minimum of 12 months (16.55 ± 3.52 months).</p> <p>Treatment Parameters - Two or three rows of laser spots were applied in the parafoveal region up to and including the edge of the foveal avascular zone. The treatment goal was to keep the burns as light as possible, obtaining burns just barely visible at the level of the outer retina or retinal pigment epithelium.</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 35%; text-align: center;"><u>Argon</u></th> <th style="width: 35%; text-align: center;"><u>Diode</u></th> </tr> </thead> <tbody> <tr> <td>Power</td> <td style="text-align: center;">100 - 300 mW</td> <td style="text-align: center;">200 - 700 mW</td> </tr> <tr> <td>Duration</td> <td style="text-align: center;">100 ms</td> <td style="text-align: center;">200 ms</td> </tr> <tr> <td>Endpoint</td> <td colspan="2" style="text-align: center;">Light as possible, just barely visible at the level of the outer retina or RPE.</td> </tr> <tr> <td>Number of Spots</td> <td style="text-align: center;">153.1 ± 74.2</td> <td style="text-align: center;">131.4 ± 50.7</td> </tr> <tr> <td>Spot Size in the parafoveal area</td> <td style="text-align: center;">100 µm</td> <td style="text-align: center;">125 µm</td> </tr> </tbody> </table> <p>Retreatment was performed for residual edema involving the foveal avascular zone. Results show there is no statistically significant difference between eyes with DDME treated with either argon green or diode laser modified grid laser photocoagulation in terms of improvement in visual acuity at 12 and 24 months, worsening of visual acuity at 12 and 24 months, and number of treatments per eye. When treating eyes with DDME close to the foveal avascular zone, longer wavelength lasers, like the 810 nm diode laser, may have a theoretic advantage since the burns will affect deeper layers with relative sparing of the inner neurosensory retina, which in turn, may reduce the degree of perifoveal scotomas usually experienced by patients undergoing laser photocoagulation for DDME.</p>		<u>Argon</u>	<u>Diode</u>	Power	100 - 300 mW	200 - 700 mW	Duration	100 ms	200 ms	Endpoint	Light as possible, just barely visible at the level of the outer retina or RPE.		Number of Spots	153.1 ± 74.2	131.4 ± 50.7	Spot Size in the parafoveal area	100 µm	125 µm
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<p>DME-CW9 Is a Near Infrared Diode Laser Effective in Inducing the Closure of Retinal Macroaneurysms? Lanzetta P, Virgili G, Menchini U. Department of Ophthalmology, Univ. of Udine, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S86. Abstract nr 420, 1997</p>	<p>The authors evaluated the efficacy of near infrared diode laser (805 nm) in occluding retinal macroaneurysms. Eleven eyes of 11 patients affected with idiopathic retinal macroaneurysms or associated to vein occlusion were recruited. All eyes underwent green light and color photographs and fluorescein angiogram before and 7, 30, 90, 180, 360 days after treatment in order to evaluate the closure of the lesion and the resorption of the exudates when present. The treatment of the macroaneurysms was conducted around the margins of the lesion. In no case was a direct treatment performed. The follow-up time ranged from 3 to 18 months. Treatment parameters were a 160-200 µm spot with a power of 400-800 mW; exposure time varied from .5 to 1 second. All lesions were successfully photocoagulated and most exudates reabsorbed.</p>																		

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<p>DME-CW10 Laser Photocoagulation of Diabetic Macular Edema Akдуман L, Olk RJ. Ophthalmic Surg Lasers 28(5):387-408, 1997</p>	<p>The authors review the definitions, diagnosis, indications for surgery, preoperative evaluation, and the intraoperative and postoperative complications of diabetic macular edema (DME), including diffuse diabetic macular edema (DDME) and clinically significant diabetic macular edema (CSDME). The treatment techniques and parameters that are covered include focal, grid, and modified grid laser photocoagulation using argon green (514 nm), krypton red (647 nm), or diode (810 nm) lasers.</p> <p>Modified grid laser treatment has been effective in treating DME regardless of whether argon, krypton, or diode laser has been used. When treating eyes with DDME close to the foveal avascular zone, longer wavelength lasers such as the diode laser may have a theoretical advantage because the burns will affect deeper layers with relative sparing of the inner neurosensory retina. This, in turn, may reduce the degree of parafoveal scotomas usually experienced by patients undergoing laser photocoagulation for DDME. To date, clinical studies have not confirmed a significant advantage of longer wavelength lasers over argon green.</p> <p>The authors also summarize the Early Treatment Diabetic Retinopathy Study (ETDRS). The ETDRS has shown that laser photocoagulation decreases visual loss from DME by more than 50%. Modified grid laser photocoagulation, regardless of the laser wavelength used, at least stabilized vision in approximately 80% of the eyes over 2 years. Finally, special cases of cataract and DME, and proliferative diabetic retinopathy and DME, are reviewed as well as five case studies. Many photographs and figures are included.</p>
<p>DME-CW11 Ultrastructural Change of Age-Related Debris in Bruch's Membrane Analyzed in Laser Scars of Human Retina Ulbig MW,¹ Ruskovic D,¹ Bengisu M,¹ McHugh DA,² Marshall J.³ ¹University Eye Hospital Munich, Germany; ²King's College Hospital, London, UK; ³St. Thomas' Hospital, London, UK [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S94. Abstract nr 461, 1997</p> <p><i>Also listed as AMD-DRY12, pg. 55</i></p>	<p>The authors wanted to elucidate the mechanism of action of laser treatment for diffuse retinal edema or drusen, especially the mechanism of action of lasers using a near infrared wavelength. It has been shown that diabetic macular edema and drusen respond to such laser treatment. As a hypothesis, there may be interference with accumulated lipid deposits at the level of RPE and Bruch's membrane, which block active fluid transport from the sensory retina to the choroid. It has been shown previously by means of light microscopy that lipid components in Bruch's membrane are reduced by laser treatment. (<i>See HIST9, pg. 190</i>). Prior to enucleation, four eyes with a malignant choroidal melanoma were lasered using an 810 nm diode laser. Eight diabetic donor eyes with laser scars were also included (2 eyes with 9-month old pigmented laser scars, 6 eyes with already depigmented lesions). Sections of lasered areas were stained with Oil-red-O for light microscopy or were processed for electron microscopy. In all laser scars the staining intensity for Oil red-O was reduced, whereas the immediate laser burns revealed persistence of lipid debris. Ultrastructurally, there was thinning of the inner collagenous layer with a reduced amount of age-related debris. This effect was more pronounced in 9-month-old pigmented lesions in the area with overlying phagocytic RPE cells. At the margins of the scars, the decrease of debris was gradual and patchy, whereas the center of the lesion and areas adjacent to phagocytic RPE cells were almost completely denuded. Laser induced reduction of lipid components was evident in all examined laser scars, independently from the laser source or the age of the lesion. This may explain why laser treatment for macular edema or drusen is sufficient with different types of lasers and wavelengths.</p>

<p>DME-CW12 Subthreshold (Invisible) Modified Grid Diode Laser Photocoagulation in Diffuse Diabetic Macular Edema (DDME) Akduman L, Olk RJ. Ophthalmic Surg Lasers 30:706-714, 1999</p> <p style="border: 1px solid black; padding: 2px; display: inline-block;">MIP</p>	<p>In a prospective pilot clinical trial, 50 eyes of 29 patients with diffuse diabetic macular edema (DDME) were treated with subthreshold (invisible) 810 nm diode laser modified grid laser photocoagulation using the OcuLight SLx laser and Slit Lamp Adapter. Follow-up was conducted for a minimum of 6 months (average 14.11 ± 6.15 months). Visual improvement, visual loss, visual field, reduction/elimination of macular edema, and the number of treatments per eye were studied. Results: Reduction/elimination of DDME was observed in 39% of eyes after 1 to 3 treatments in 6 to 12 months and in 74% of eyes after 1 to 5 treatments in 15 to 24 months follow-up. Forty-four of 50 eyes (88%) had stabilization of post-treatment VA. Four eyes (8%) improved and 2 patients (4%) deteriorated at least 3 lines from the baseline. Two out of 10 visual field tests showed a decrease in paracentral scotomas; no post-treatment subjective complaints of increased paracentral scotomas were encountered. Conclusion: Subthreshold (invisible) 810 nm diode laser modified grid photocoagulation is effective in terms of reduction/elimination of DDME, stabilization or improvement in VA, reduction of post-treatment objective paracentral scotomas, elimination of subjective complaints of scotomas post-treatment, and reduction of post-treatment atrophic scarring. Its effectiveness in reducing/eliminating DDME may be slightly prolonged; however, this method may be advantageous compared to conventional continuous-wave photocoagulation in that it appears to reduce the objective and subjective effect on the paracentral visual field.</p> <p><u>Treatment Parameters:</u> Power: Test laser burn was applied to the nasal retina using 200 ms duration and power was increased until a barely visible laser burn was obtained. The power was left at the same level, but the duration was halved to 100 ms and treatment was carried out. Two or 3 rows of laser spots were applied in the parafoveal region up to, and including, the edge of the FAZ. Laser applications were not evident for the vast majority of treatment lesions applied. In the case that the application could be seen due to pigment changes, the power was adjusted downward accordingly.</p> <p>Spot Size: 125 μ in the parafoveal area. Spots were placed one spot size apart from each other. Then, 200 μ spots were applied 200 μ apart from each other throughout all remaining areas of retinal thickening and in all areas of capillary non-perfusion. In areas of obvious focal leakage, additional spots were applied focally. For primary treatment, an average of 127 ± 65 spots were applied with power ranging between 200 to 600 mW at 100 ms duration.</p>
<p>DME-CW13 Minimal Intensity Diode Laser (810 nanometer) Photocoagulation (MIP) for Diffuse Diabetic Macular Edema (DDME) Olk JR, Akduman L. Semin Ophthalmol 16(1):25-30, 2001</p> <p style="border: 1px solid black; padding: 2px; display: inline-block;">MIP</p>	<p>To determine the effectiveness of 810 nm diode laser minimal intensity photocoagulation (MIP) for diffuse diabetic macular edema (DDME). Patients demonstrating DDME were treated with minimal intensity diode 810 laser photocoagulation or modified grid photocoagulation consecutively. Selected patients were tested with Goldmann visual field, pre and post-treatment. Visual improvement, visual loss, visual field, reduction/elimination of macular edema, and a number of treatments were studied.</p>

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	<p><u>Treatment Parameters</u></p> <p>Test spots are generally applied nasal to the optic nerve using on average 200 to 700 mW of power for 0.2 seconds and increasing the power until a barely visible burn at the level of the outer retina or RPE is achieved. The duration is then reduced to 0.1 seconds and a grid treatment of 2 or 3 rows of laser spots are applied to areas of retinal thickening and capillary nonperfusion in the posterior pole outside the parafoveal area. A 100 micron or 125 micron spot size is used in the parafoveal area. Spots are placed one spot size apart from each other. Then, 200 micron spots placed 200 microns apart from each other are applied throughout all remaining areas of retinal thickening and in all areas of capillary nonperfusion. In areas of obvious focal leakage, additional spots are applied focally; however, minimal attention to areas of focal leakage are required and it is unusual that focal treatment is required in most cases.</p> <p>It is not unusual to have to adjust the power downward as one carries out the treatment, especially in areas where there is less macular edema and less retinal thickening. No visible treatment burns should be visible at the end of treatment. Patients are seen and re-evaluated at regular follow-up visits every 3 to 4 months and retreated if residual DDME was still present. If there is residual retinal thickening involving the FAZ, then supplemental treatment is applied to those areas where residual edema or nonperfusion is present. For any supplemental treatment, duration, power, and spot size parameters are similar to those used for the primary treatment.</p> <p>Results: With 24 months follow-up, reduction/elimination of DDME was observed in approximately 74% of eyes. The number of treatments per eye ranged from 1 to 5. The presence of cystoid macular edema, initial poor VA, the presence of coexisting macular ischemia, or a history of systemic hypertension did not effect the outcome. At the last follow-up, 88% of patients had at least stable VA. No post-treatment subjective complaints of increased pericentral scotomas were encountered in this group of patients and post-treatment atrophic scarring was substantially reduced, by using minimal intensity diode laser 810 photocoagulation, compared to eyes previously treated with shorter wavelengths and more visible burns.</p> <p>Conclusion: Minimal intensity diode laser 810 nm modified grid laser photocoagulation for DDME is effective in reducing/eliminating DDME, although resolution of edema may be slightly prolonged and may require 1 or 2 additional treatments compared to eyes previously treated with shorter wavelengths and more visible burns. However, this method appears to be advantageous in that it appears to reduce the objective and subjective effect on the pericentral visual field, as well as substantially reducing the post-treatment atrophic scarring seen in patients treated with shorter wavelength lasers and more visible burns.</p>
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DIABETIC RETINOPATHY - MACULAR EDEMA

<i>MicroPulse™ Photocoagulation</i>	
<p>DME-MP1 Selective RPE Damage by MicroPulse Diode Laser Photocoagulation</p> <p>MIP</p> <p>Chong LP,¹ Kohen L,¹ Kelsoe W,² Donovan M,² Buzawa D.² ¹University of Southern CA, ²IRIS Medical Instruments, Inc. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): S722. Abstract nr 150, 1992</p>	<p>Limitation of collateral damage to adjacent normal retinal tissue is the goal of retinal laser surgery, and has motivated the development of green argon, dye and krypton lasers. However, the chromophore-specific damage has not been attained using conventional lasers with pulse durations exceeding 1 millisecond. The authors used an 800 nm diode laser to deliver a burst of pulses of microsecond duration delivered within an overall envelope of millisecond duration. In this fashion they were able to achieve damage at the level of the retinal pigment epithelium (RPE) in pigmented rabbits without causing apparent damage to the photoreceptors or choroid, as studied by light microscopy. These photocoagulation burns were not visible by slit lamp biomicroscopy. The power energy required to achieve this endpoint was judged to be approximately 10% of the power energy required to produce visible blue-green argon laser burns (3 mJ.). The MicroPulse diode laser and its RPE-selective damage capability may be valuable in the study of the RPE and of its role in the mechanism of action of photocoagulation therapy. This laser may provide a more specific therapy for the treatment of those retinal diseases in which the RPE plays an important pathogenic or therapeutic role.</p>
<p>DME-MP2 Selective RPE Damage by Micro-Pulse Diode Laser Photocoagulation</p> <p>MIP</p> <p>Chong LP, Ryan SJ. Los Angeles, CA. Abstract. The Retina Society Meeting. September 29 - October 2, 1993</p>	<p>To produce laser damage in the retina confined only to the RPE, an 800 nm diode laser was modified to deliver a burst of pulses of microsecond duration delivered within an overall envelope of millisecond duration. The retina of pigmented rabbits was photocoagulated through a slit lamp delivery system. Fundus photography, fluorescein angiography, light microscopy and electron microscopy were performed. The RPE was damaged sparing the adjacent photoreceptors and choroid. These photocoagulation burns were not visible by slit lamp biomicroscopy and did not show hyperfluorescence. The power energy required to achieve this endpoint was approximately 10% of the power required to produce visible blue-green argon laser burns (3mJ). Conclusion: This RPE selective laser may provide insight into RPE function and mechanisms of laser action. This laser may be a more specific therapy for the treatment of retinal macular disease and may allow treatment of the fovea.</p>
<p>DME-MP3 Localized Retinal Pigment Epithelial (RPE) Lesions Generated by Pulsed Diode Laser</p> <p>MIP</p> <p>Wagner DG, Glaser SR, Ward T, Allen F. Abstract. The Vitreous Society Meeting. London, England. August 14, 1995</p>	<p>A short pulsed infrared diode laser was used to generate RPE lesions in a pigmented rabbit model. Pulse duration was 100 to 200 microseconds, and total laser power was 2 Watts. Lesions were created in 2 weeks, 1 week, and 1 day before fundus photography and tissue fixation. Light and Electron Microscopy demonstrated RPE specific lesions and very localized outer segment changes. Conclusion: Short pulsed diode laser may offer inner retina sparing photocoagulation, which may find utility in the treatment of diabetic macular edema or choroidal neovascularization.</p>

<p>DME-MP4 The Selective Effect of Micropulse Diode Laser Upon the Retina</p> <p>MIP</p> <p>Kim SY¹, Sanislo SR¹, Dalal R¹, Kelsoe WE², Blumenkranz MS¹ ¹Department of Ophthalmology, Stanford University Medical Center, Stanford, CA; ²IRIS Medical, Mountain View, CA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S779. Abstract nr 3584, 1996</p>	<p>Ten eyes of Dutch belted rabbits were treated with the IRIS Medical OcuLight SLx diode laser. Once the required settings needed to create visible threshold burns in individual eyes using both continuous and micropulse settings were determined, four different subthreshold levels of power were administered to each of these eyes. Subthreshold powers were arbitrarily set at 10, 25, 50, and 75% of the amount needed for threshold burns using MicroPulse control. Immediately after treatment, eyes were enucleated and processed for both light and electron microscopy. The authors found that the power required to create a 200 micron full-thickness visible threshold burn ranged from 1.30 to 1.55 W at 5% duty cycle (0.1 ms on/1.9 ms off; duration = 200 msec.). However, although threshold power varied from eye to eye, subthreshold levels between 10-25% of this level consistently limited damage to the RPE layer and spared the choriocapillaris and overlying neurosensory retina. Conclusion: This study demonstrates that a micropulse diode laser system may be used to selectively photocoagulate the RPE and that appropriate invisible subthreshold laser parameters could be derived from visible endpoints. Clinical applicability of this laser modality for treating retinal diseases involving the RPE is yet to be determined.</p>																											
<p>DME-MP5 The Treatment of Macular Disease Using a Micropulsed and Continuous Wave 810-nm Diode Laser</p> <p>MIP</p> <p>Friberg TR, Karatzas EC. Ophthalmology 104:2030-2038, 1997</p> <p><i>Also listed as AMD-CW13, pg. 4</i></p>	<p>Two studies are presented: The objective of the first study was to determine whether the OcuLight 810 nm diode laser using continuous-wave (CW) exposures is clinically effective in the treatment of CNV from AMD. Fifty-three patients were treated in 1 eye for CNV (77% subfoveally) and were followed for 6 mos.</p> <p>Treatment Parameters:</p> <table border="0"> <thead> <tr> <th>Power (mW)</th> <th>Exposure</th> <th>Spot Size</th> <th>Endpoint</th> </tr> </thead> <tbody> <tr> <td>200 - 1200</td> <td>0.3 - 0.5 sec</td> <td>75 μ in foveal area;</td> <td>Intense yellow-white lesions</td> </tr> <tr> <td></td> <td></td> <td>125 - 500 μ outside fovea</td> <td></td> </tr> </tbody> </table> <p>Results: Sixty percent (60%) of eyes treated had no persistence or recurrence at 6 months, and 74% achieved visual stabilization. Results are similar to conventional photocoagulation, except a longer duration was used (0.3-0.5 sec). Endpoint was ablative.</p> <p>The second study was to determine if using a MicroPulse pulsed exposure with the OcuLight SLx 810 nm photocoagulator is clinically effective in the treatment of macular edema secondary to branch vein occlusion (BVO) (14 patients treated), or to diabetic retinopathy (59 patients treated, 40 of which were treated for the first time).</p> <p>Treatment Parameters:</p> <table border="0"> <thead> <tr> <th>Power (mW)</th> <th>Exposure</th> <th>Duty Cycle</th> <th>Spot Size</th> <th>Endpoint</th> </tr> </thead> <tbody> <tr> <td>150 - 1200</td> <td>0.2 - 0.4 sec</td> <td>66%</td> <td>75 μ in foveal area;</td> <td>Very light lesions/</td> </tr> <tr> <td></td> <td></td> <td></td> <td>125 - 200 μ outside fovea</td> <td>minimum visibility</td> </tr> </tbody> </table> <p>Results: <u>Macular edema secondary to BVO</u>: 92% of eyes treated showed clinical resolution by 6 months, and 77% had stabilization of visual acuity. <u>Macular edema secondary to diabetic retinopathy</u>: 76% of newly treated patients and 67% of previously treated patients had clinical resolution. Vision was</p>	Power (mW)	Exposure	Spot Size	Endpoint	200 - 1200	0.3 - 0.5 sec	75 μ in foveal area;	Intense yellow-white lesions			125 - 500 μ outside fovea		Power (mW)	Exposure	Duty Cycle	Spot Size	Endpoint	150 - 1200	0.2 - 0.4 sec	66%	75 μ in foveal area;	Very light lesions/				125 - 200 μ outside fovea	minimum visibility
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	<p>improved or stabilized in 91% of newly treated patients and 73% of retreated patients at 6 months. Despite the fact that microaneurysms were not specifically targeted, grid photocoagulation promoted the resolution of macular edema. From the authors' perspective, it appears that lesions and alterations in the retinal pigment epithelium, rather than closure of microaneurysms, play a salient role in edema fluid absorption. Although occasionally patients felt minimal discomfort during the administration of some of the laser lesions, none of them complained of pain during treatment. Conclusions: MicroPulsing in the macula is safe. Minimal threshold endpoint lesion results in resolution of edema.</p>
<p>DME-MP6 Therapeutical Bandwidth of Selective RPE-Photocoagulation Treatment by Repetitive Laser Pulses (527 nm) First Clinical Results</p> <p>MIP</p> <p>Roider J¹, Brinkmann R,² Laqua H,¹ Birngruber R.²</p> <p>¹Department of Ophthalmology, ²Medical Laser Center, University of Lubeck, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S83. Abstract nr 404, 1997</p>	<p>The authors used a Nd:YLF laser (527 nm) to treat central serous retinopathy, diabetic macular edema, early PDR and drusen. Exposure parameters were as follows: pulse duration 1-2 μs, repetition rate: 500 Hz, number of pulses applied: 500, spot size: 158 μm. Energy was judged after performing test exposures and evaluation of an immediate postoperative FA. After the test exposures the true therapeutical selective RPE treatment was performed. Results: In humans, more energy is necessary than in animals (a factor of 5-10 difference). Similar to the animal experiments with 200 ns pulses even with energies, which lead to blanching of the retina, no disruptive effects could be observed. Energies, which lead to a selective RPE effect, show a different fluorescein pattern than conventional CW-mild retinal photocoagulation. While CW photocoagulation effects show a destruction of the choriocapillaris resulting in early non perfusion in FA, no such effects are detected after selective RPE photocoagulation. Selective RPE photocoagulation effects are only detectable in the late stage of the FA. In contrast to conventional very mild CW photocoagulation effects, the selective RPE photocoagulation effects could not be detected by infrared imaging. Microperimetry underlines the selectivity of the effects. Conclusions: Selective RPE photocoagulation with repetitive 1-2 μs laser pulses is possible and safe in humans. No acute adverse effects were detected up to now.</p>
<p> DME-MP7 Clinical Applications of the MicroPulse Diode Laser</p> <p>MIP</p> <p>Moorman CM, Hamilton AMP. Eye 13:145-150, 1999</p> <p><i>Also listed as PDR-MP1, pg. 87</i></p>	<p>The purpose of this study was to evaluate the efficacy of the OcuLight MicroPluse 810 nm diode laser in the treatment of 1. macular edema secondary to either branch retinal vein occlusion (BRVO) or diabetic maculopathy and 2. proliferative diabetic retinopathy (PDR). Fifty-two eyes of 33 consecutive patients were treated over a 6 month period. Panretinal and grid pattern photocoagulation were performed using the micropulse mode with the laser on for 100 – 300 μs and off for between 1900 and 1700 μs repeatedly in a pulse envelope of 0.1 – 0.3 s duration. The spot size used was between 200 and 500 μm. Patients were assessed clinically and angiographically at 3 and 6 months. Overall, 22 eyes (57%) showed resolution of macular edema at 6 months; and 10 eyes (77%) with proliferative disease showed some regression of new vessels at 6 months. Visual acuity was maintained in 27 eyes (69%) and improved in 11 eyes (28%).</p> <p>1. Macular Edema. Thirty-nine eyes of 33 patients were treated with standard grid pattern photocoagulation to areas of retinal thickening; microaneurysms were not specifically targeted. Twenty-two eyes (57%) demonstrated resolution of macular edema on angiography at 6 months. Fifteen eyes remained unchanged on angiography at 6 months follow-up and 2 eyes</p>

Reference Catalog: Summaries of Studies

	<p>(1 patient) were worse. Vision improved by 1 or more Snellen lines in 11 patients and was maintained in 27 (69%) patients. There was no difference between patients with BRVO and DME. Over half (54%) the eyes treated for macular edema required more than one treatment episode.</p> <p>2. Proliferative Diabetic Retinopathy. Thirteen eyes of 9 patients were treated with standard PRP: 1500 burns initially, followed by a further 1500 burns at 6 week intervals depending on the clinical response. At 6 months, 8 eyes (62%) of 5 patients showed complete regression of new vessels. A further 2 eyes (2 patients) showed partial regression. Three eyes (2 patients) showed minimal or no response to laser treatment over 6 months.</p> <p>Treatment with the diode laser on micropulse mode was extremely well tolerated by all patients. None recorded any sensation during laser treatment. Since there was no light flash, fixation was good and most patients co-operated well during treatment of the macular region. Diode laser in micropulse mode is effective in the management of diabetic and occlusive macular edema and proliferative diabetic disease.</p>
<p>DME-MP8 Micropulse Laser in the Treatment of Diabetic Macular Edema Stanga PE, Reck AC, Hamilton AMP. Seminars in Ophthalmology 14:210-213, 1999</p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-top: 10px;">MIP</div>	<p>This article reviews the current use and technique of MicroPulse photocoagulation using the OcuLight SLx diode laser. Results from a previous study (See DME-MP7) have been published and confirm the efficacy of treatment for diabetic macular edema. Another study is underway that compares argon vs micropulse diode laser for the treatment of DME. The preliminary results of early analysis show no difference in between the two groups; however, final analysis of the follow-up of patients has to be performed. The clinical appearance of the diode burn, because of the greater penetration into the choroid, is not comparable with an argon burn. The appearance of the burn is grayer as opposed to white with the argon laser. MicroPulse treatment produces similar results in both the authors' preliminary data and trial patients. This indicates that placing a burn that is confined to the RPE is effective in reducing macular edema. This result shows that changing some of the characteristics of the RPE may be all that is required of laser treatment, and burns that spread into the retina and choroid are not required. Therefore, this treatment is effective, the application of the laser is invisible to the patient, there is no accompanying photophobia, and the damage is confined to the RPE with no or minimal thermal spread. The major difficulty of this treatment is that burns are invisible and care is required in the placement of the burns, trying not to overlap previous burns. If retreatment is required, then FA is essential to avoid previous burns. As the laser reaction on the RPE has little or no collateral damage, then treatment can be performed immediately adjacent to the macula without any risk of macular damage as a result of enlargement of the burn creeping into the foveal area. Conclusion: Micropulse diode laser is an effective way of treating DME and its effectiveness is helpful in indicating the tissue to be targeted. The results of the full analysis of the comparative study of argon vs. micropulse diode are awaited. A pilot study is underway for the treatment of proliferative retinopathy by PRP by using the micropulse laser. Animal studies need to be pursued to establish the exact power settings, pulse duration, and envelope size to produce the most effective result.</p>

<p>DME-MP9 Selective RPE Laser Treatment in Macular Diseases: Clinical Results</p> <p>MIP</p> <p>Roider J,¹ Brinkmann R,³ Framme C,¹ Schüle G,³ Joachimeyer E,² Wirbelauer C,² Kracht D,³Laqua H,² Birngruber R.³ ¹University of Regensburg, 93051 Regensburg, ²University of Lübeck, 23538 Lübeck, ³Medical Laser Center Lübeck, 23538 Lübeck, Germany [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S695. Abstract nr 3741, 2001</p>	<p>Seventy patients with various macular diseases were treated by a train of short laser pulses (527 nm/532 nm; 30-500 pulses, 160 mm, 70-200 mJ, pulse durations: 700 ns/1,7 ms, rep. rate: 100/500 Hz; total exposure time: 100 - 500 ms). Indications for treatment were as follows: DME (38 patients), large drusen in AMD (18 patients) and long-standing central serous retinopathy (CSR) (15 patients). FA was performed 1 hr after treatment in all patients and ICG angiography additionally in a subgroup. To monitor the laser effects during irradiation, the green treatment beam was used in selected patients for exciting lipofuscin within the RPE thus enabling evaluation of the changes within the RPE during laser irradiation. None of the laser lesions were clinically visible during treatment. Follow-up was between 6 months and 3 years. Hard exudates or edema were less in 21 out of 38 diabetic maculopathy (DMP) patients. In CSR, exudation disappeared in 9 out of 14 patients within 4 weeks and drusen were significantly less in 5 out of 15, mostly in bilateral drusen. RPE effects 1 hour after treatment could be visualized by FA in all patients with drusen and CSR. In DME, ICG proved to be advantageous. During irradiation a decay in autofluorescence intensity was found, however the decay rate was almost independent of the laser energy used. Conclusion: RPE laser treatment can lead to therapeutic effects in macular diseases. Visualization of RPE effects immediately after treatment can be achieved by FA in drusen and CSR and by ICG angiography in DME. The change of AF intensity during treatment was not significant to monitor RPE laser effects on-line.</p>
<p>DME-MP10 Autofluorescence Imaging After Selective RPE Laser Treatment in Macular Diseases: A Pilot Study</p> <p>MIP</p> <p>Framme C,¹ Schuele G,² Birngruber R,² Brinkmann R,² Roider J.¹ ¹University Eye Clinic Regensburg, Franz-Josef-Strauss-Allee 11, 93042 Regensburg, Germany, ²Medical Laser Center Luebeck, Peter-Monnik-Weg 4, 23562 Luebeck, Germany [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S703. Abstract nr 3785, 2001</p>	<p>Selective RPE laser treatment is a new technique, which selectively damages the RPE and avoids adverse effects to the neural retina. A problem is the non-visibility of the laser lesions. The aim of the study was to investigate whether fundus-autofluorescence (AF) is changed due to the RPE damage, and thus may be used for treatment control. Twenty-nine patients with macular diseases: diabetic maculopathy (DMP), soft drusen maculopathy (AMD) and central serous retinopathy (CSR) were treated and followed for at least 6 months. Treatment was performed with a train of repetitive short laser pulses (800 ns) of a green Nd:YAG laser (parameters: 532 nm, 100 and 500 pulses at 500 Hz, retinal spot diameter 200 micrometers, pulse energies 70 - 200 microJoule). AF was excited by 488 nm and detected by a barrier filter at 500nm (HRA, Heidelberg engineering). Patients were examined by ophthalmoscopy, FA and AF measurements 10 minutes; 1 hour; 1, 6 weeks; and 3, 6, 12 months times after treatment. FA showed leakage of the irradiated areas for about 1 week. None of the laser lesions was ophthalmoscopically visible during treatment. Identification of the lesions was possible by AF imaging showing an intensity decay in the irradiated area in 24/29 patients, predominantly in patients with CSR and AMD. Lesions could be identified 10 minutes after treatment as hypofluorescent spots, which were more pronounced 1 hour later. During follow-up, the laser spots became hyperautofluorescent. In patients with DMP some AF images were less helpful due to diffuse edema and larger retinal thickness. Conclusions: Imaging of non-visible selective RPE laser effects can be achieved by AF measurements predominantly in patients without retinal edema. Therefore AF may replace invasive FA in most cases to verify therapeutic laser success.</p>

New

DME-MP11

Infrared Micropulsed Laser Treatment for Diabetic Macular Edema - Subthreshold versus Threshold Lesions

MIP

Friberg TR.
Semin Ophthalmol 16(1):19-24, 2001

To assess the effectiveness of subthreshold (invisible after placement) and threshold (barely visible after placement) 810 nm laser photocoagulation in the treatment of clinically significant diabetic macular edema, a grid of subthreshold laser spots was delivered using the 810 nm OcuLight SLx diode laser to treat patients with diabetic macular edema.

Treatment Parameters

The MicroPulse mode was used for all lesions, with the laser on for 100 microseconds and off for 50 microseconds with a pulse envelope of 300 ms (a duty cycle of 67%). Typical threshold laser power intensities ranged from 300 to 1000 mW, depending on RPE pigmentation, with more lightly pigmented fundi requiring more energy.

First, a visible test lesion was produced in the edematous area, away from the foveola, by increasing the laser power gradually until a lesion could just be detected a few seconds after placement. Then, the laser power was reduced by 50% and in the region of macular edema, the entire grid of lesions 125 microns in diameter was placed with the edges of the laser spots located no closer than 125 – 200 microns (1 to 1-1/2 laser spot diameters) from each other. In the event that the spots became visible during the treatment of the edematous area, the peak power level was adjusted downward until visible spots were no longer produced. These adjustments were sometimes necessary as a more central, more pigmented macula was approached. Smaller spots of 75 microns in diameter were used if treatment was required within 1/2 disc diameter from the foveola. Microaneurysms were not targeted and were specifically avoided.

Retrospectively, the results of subthreshold treatment of 20 eyes of 20 patients were compared to the results of treatment of 120 eyes of 120 patients using a grid of threshold laser lesions. At 6 months follow-up, 60% of subthreshold treated eyes and 75% of threshold treated eyes showed anatomic resolution of macular edema. Improvement or stabilization of VA was achieved in 85% of threshold or subthreshold treated eyes. Conclusion: Gentle grid treatment of regions of diabetic macular edema was effective in ameliorating the edema and limiting visual loss. Subthreshold laser was less effective in promoting resolution of edema compared to threshold lesions, though the difference was not significant in this instance.

New

DME-MP12

Micropulsed Diode Laser for Diabetic Macular Edema

MIP

McHugh JA,¹ Tandon A,² el-Ghonemy K.²
¹Ophthalmology, Kings College Hospital, London, UK; ²Ophthalmology, Kings College Hospital, Denmark Hill, London, London, UK
2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 562, 2002

To evaluate effectiveness of micropulsed diode laser in DME, a prospective, non-randomized study was performed in 25 eyes of 18 patients with diffuse and focal macular edema. Pre- and post-laser assessment included VA, biomicroscopy, FFA and macular perimetry. At 6 months follow-up, resolution of macular edema with stabilization of vision occurred in 24 of 25 eyes (96%). Retreatment for persistent edema was needed in only 1 out of 25 eyes (4%). Conclusion: Micropulsed laser may be an effective technique for DME. The photocoagulation burns are confined only to RPE, thus avoiding the non-therapeutic side effects of full thickness burns with conventional lasers. A randomized trial is underway to confirm these findings.



DME-MP13 Diode Subthreshold Laser for DME
 Bhagat N, Zarbin MA
 Review of Ophthalmology 9(9):83-86, 2002

Diabetic macular edema is by far the most common cause of visual loss in patients with diabetes mellitus. DME is more common in patients with adult-onset (Type 2) as compared to juvenile (Type 1) diabetes mellitus, but in both forms of the disorder, the prevalence of DME correlated directly with the duration of the disease. The incidence of DME has been estimated to be 0% at 5 years and 20% at 20 years if the disorder is diagnosed before the age of 30, vs. 3% at 5 years and 28% at 20 years if the disorder is diagnosed after the age of 30. Forty-two percent of patients with Type 1 diabetes will develop macular edema during their lifetime. Approximately 75,000 new cases of DME are diagnosed annually in the United States.

The ETDRS showed that argon laser photocoagulation reduces the risk of moderate visual loss in patients with CSME by approximately 50 percent. However, retinal laser photocoagulation is not without risks. Well-recognized complications that can occur following laser-induced thermal damage to the retina and/or choroid include the development of symptomatic paracentral scotomata and the formation of CNV. In this respect, micropulse diode laser therapy may have significant advantages over conventional retinal laser photocoagulation since it is theoretically less likely to produce unwanted retinal or choroidal thermal damage, and because published retrospective case series indicate that the micropulse 810 nm diode laser is effective in the treatment of DME.

The diameter of a RPE cell is ~10 μm. A pulse duration of 0.1 ms (termed micropulse) corresponds to a thermal diffusion distance of 10 μm in ocular tissue. Thus, a pulse duration of less than 0.1 ms should have no thermal effect on structures 10 μm or more from the RPE cell (e.g., photoreceptors and choroidal melanin granules) and may be associated with a lower incidence of complications such as symptomatic scotomata and CNV formation.

At New Jersey Medical School's Institute of Ophthalmology and Visual Sciences, the authors are conducting a prospective, randomized study to compare conventional laser photocoagulation and subthreshold micropulse diode laser photocoagulation (SMDLP). The study is a pilot trial that seeks to answer the following questions:

- Does SMDLP induce resolution of CSME in diabetic patients?
- If SMDLP induces resolution of CSME, is it more, less, or equally effective as conventional laser photocoagulation?
- Do SMDLP and conventional laser photocoagulation have the same incidence of complications, such as demonstrable paracentral scotomata, CNV, subretinal fibrosis, foveal distortion, accidental foveal burns, blood vessel perforation, chorioretinal anastomosis and other complications?

Theoretical considerations and early clinical results indicate that micropulse laser may offer an effective and safer treatment option for patients with this very common cause of visual disability.

Additional Education Material Available on:

Diabetic Retinopathy - Macular Edema

DME-A Applications Note: Diode Laser Treatment of Diabetic Macular Edema

This Applications Note provides a history of clinical studies on the treatment of diffuse and focal diabetic macular edema. It also details recommendations and guidelines to treat macular edema using the 810 nm wavelength. Benefits of the 810 nm are also highlighted.

DIABETIC RETINOPATHY - PROLIFERATIVE

<i>Endophotocoagulation</i>	
 <p>PDR-E1 Diode Endolaser Photocoagulation Smiddy W. Arch Ophthalmol 110:1172-1174, 1992 <i>Also listed as RTD-E1, pg. 183</i></p>	<p>Endolaser photocoagulation was applied using an 810 nm diode laser in 25 patients. Indications were for treatment of complications of proliferative diabetic retinopathy, proliferative vitreoretinopathy, complex retinal detachments, and a retinal break. Predictable clinical results and no adverse effects have been observed.</p>
<p>PDR-E2 La Endofotocoagulación con Laser de Diodo Colin A, Corcóstegui B, Mateo C, Fernandes E. Arch Soc Esp Oftalmol 62:231-236, 1992 Abstract - English/Spanish Article - Spanish</p>	<p>A study was carried out in 40 patients who received 810 nm diode laser endophotocoagulation throughout different vitreo-retinal pathologies surgery. The diode laser proved to be an efficient endophotocoagulation system in vitreoretinal surgery due to its technical characteristics and its clinical advantages.</p>
<p>PDR-E3 Retinal Diode Laser Photocoagulation Smiddy W. Bascom Palmer Eye Institute, Miami, FL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1310. Abstract nr 3089, 1992 <i>Also listed as RTD-E2, pg. 183</i></p>	<p>Diode (805 nm) endolaser photocoagulation was applied in 50 patients with proliferative diabetic retinopathy, proliferative vitreoretinopathy, complicated retinal detachments, and posterior tears. Treatment was found to be effective using an average of 505 spots, 0.5s duration, and 800 mW. The clinical effects of diode laser photocoagulation were similar to that achieved with argon.</p>
<p>PDR-E4 An Endolaser Probe with Aspiration Capability Peyman G, D'Amico D, Alturki W. Arch Ophthalmol 110:718, 1992</p>	<p>This article describes a new probe that can be used as a flute needle for drainage of subretinal fluid and for endolaser treatment of a retinotomy site after vitrectomy. This instrument allows removal of vitreous and subretinal fluid during air-fluid exchange and immediate endolaser photocoagulation without exchange of instruments.</p>
 <p>PDR-E5 Diode Laser Endophotocoagulation Sasho M, Smiddy W. Retina 15:388-393, 1995 <i>Also listed as RTD-E3, pg. 183</i></p>	<p>Two hundred twenty-six consecutive eyes underwent 810 nm endolaser photocoagulation during vitrectomy for proliferative diabetic retinopathy (134 eyes), proliferative vitreoretinopathy (27 eyes), complicated retinal detachment (50 eyes), and miscellaneous indications (15 eyes). A retrospective comparison group of 67 consecutive eyes undergoing vitrectomy with argon endolaser photocoagulation was also studied. Visual acuity was improved in 159 eyes (71%) and was 5/200 or better in 157 eyes (70%) with diode endophotocoagulation. In comparison, final visual acuity was improved in 48 eyes (73%) and was 5/200 or better in 45 eyes (68%) for argon endophotocoagulation. No statistically significant difference was found between the two groups regarding rate of visual improvement or final visual results. The desired intraoperative effect was obtained in 99.6% of the cases without complication. Diode laser is a safe, reliable, and effective mode of endophotocoagulation.</p>

Reference Catalog: Summaries of Studies

DIABETIC RETINOPATHY - PROLIFERATIVE

<i>Continuous-Wave Photocoagulation</i>	
<p>PDR-CW1 Initial Clinical Experience Using a Diode Laser in the Treatment of Retinal Vascular Disease McHugh JDA, Marshall J, fytche T, Hamilton P, Raven A, Keeler CR. Eye 3:516-527, 1989</p>	<p>A pilot study was carried out to investigate the clinical use of an 810 nm, infrared diode laser in the treatment of a number of retinal vascular conditions. Thirty-three eyes in 30 patients were treated for conditions such as proliferative diabetic retinopathy, exudative retinopathy, and branch and central retinal vein thrombosis. Regression of neovascularization was observed in 13 of 16 eyes with proliferative diabetic retinopathy and in 6 of 8 eyes with branch retinal vein occlusion. Four eyes were successfully treated for established or incipient rubeosis iridis following central vein thrombosis. Focal point photocoagulation applied to five eyes for diabetic exudative maculopathy resulted in partial resorption of the exudates.</p>
<p>PDR-CW2 Semiconductor Diode Laser Photocoagulation in Retinal Vascular Disease Balles M, Puliafito C, D'Amico D, Jacobson J, Birngruber R. Ophthalmology 97:1553-1561, 1990</p>	<p>The authors successfully performed clinical transpupillary retinal photocoagulation in 30 eyes of 26 patients with retinal vascular disease using a diode laser emitting at 805 nm. Retinal photocoagulation was performed at treatment powers of 300 to 1300 mW and exposure durations of 0.2 to 0.5 seconds with a 200 µm diameter treatment spot. Patients treated with both diode and argon green lasers required 4.5 ±1.8 times greater mean laser energy with diode compared with argon to create ophthalmoscopically similar lesions.</p>
<p>PDR-CW3 Argon and Diode Laser Photocoagulation in Proliferative Diabetic Retinopathy. A Preliminary Report Brancato R, Bandello F, Trabucchi G, Leoni G, Lattanzio R. Laser Light Ophthalmol 3:233- 237, 1990</p>	<p>Twenty-six eyes of 24 diabetic patients affected by PDR were randomly treated with 810 nm diode lasers (13 eyes) and 514 nm argon-green lasers (13 eyes). In the diode laser group, partial or total regression of neovascularizations was observed in nine eyes (69.2%) while four (30.8%) remained unchanged. In the argon-green group seven eyes (53.8%) showed partial or total regression, five (38.2%) unchanged and one (7.6%) worsened.</p>
<p>PDR-CW4 Comparison of Semiconductor Diode Versus Argon-Green Laser in Panretinal Photocoagulation of Diabetic Retinopathy Ulbig MW, Hamilton AMP. Ophthalmologie 90:457-462, 1993</p> <p>Abstract - English Article - German</p>	<p>In a prospective study, 10 diabetics (3 type I and 7 type II) ranging in age from 26 to 72 years, with bilateral PDR or severe nonproliferative diabetic retinopathy and visual acuity better than 6/18 in both eyes, underwent panretinal photocoagulation. One eye was treated with the 810 nm, infrared diode laser; the fellow eye was treated with 514 nm, argon green. Follow-up was documented by best-corrected visual acuity, fundus photography and fluorescein angiography. Mean duration of follow-up was 12 months. In neither group was there a significant difference in the response of retinopathy and neovascularization to the treatment, or in the course of visual acuity. Fluorescein angiography revealed the more profound effects of the diode laser in the choroid. Compared to argon laser treatment, patients found diode laser treatment more painful, but appreciated the absence of bright flashes during therapy. Photocoagulation for diabetic retinopathy using the diode laser was as effective as using the argon system in this initial pilot study.</p>

Reference Catalog: Summaries of Studies



PDR-CW5 Diode Laser Treatment of Diabetic Retinopathy

Chong L.
Los Angeles, CA
Scientific Poster 251. AAO. Chicago, IL
November, 1993

Also listed as DME-CW4, pg. 65

Thirty-seven eyes were treated with grid diode laser photocoagulation for diabetic macular edema. Of these eyes, 81.1% had complete resolution of the retinal thickening. Twenty-three eyes were treated with diode laser panretinal photocoagulation for PDR. Of these eyes, 39.1% had total regression, 43.5% had partial regression and 17.4% showed no regression. Diode laser was effective in treating PDR.



PDR-CW6 Patient Discomfort During Laser Treatment. A Comparison Between Diode and Argon Laser

Goebel W, Pfeiffer N, Grehn F.
Department of Ophthalmology,
University of Mainz, Germany
[ARVO Abstract]. Invest Ophthalmol
Vis Sci. 35(4): 1372. Abstract nr 553,
1994

Patients undergoing panretinal photocoagulation were randomly treated with either the IRIS Medical 810 nm diode laser, (n=24) or the Coherent 514 nm argon laser (n=28) and immediately asked to grade the intensity of glare, number of painful laser burns, and degree of pain on a visual analog scale (ranging from 0 to 100). The laser power was set to produce a light grey burn in the diode laser group and a grayish white burn in the argon laser group, so that the resulting scar would turn out similar. No significant difference between the diode and argon group could be found for pain. Conclusion: Equal laser scarring can be produced by argon and diode laser with a similar degree of pain, provided that the energy level is carefully adapted. Due to less glare during diode laser treatment, eye motility is reduced.

PDR-CW7 Color Contrast Sensitivity and Pattern Electoretinographic Findings After Diode and Argon Laser Photocoagulation in Diabetic Retinopathy

Ulbig M, Arden G, Hamilton P.
Am J Ophthalmol 117:583-588, 1994

Fourteen patients with diabetic retinopathy requiring bilateral panretinal photocoagulation were treated with the 810 nm diode laser on the right eye and the argon laser on the left eye. Before and after treatment, visual acuity and central and peripheral retinograms were recorded. No difference was noted in the clinical response or visual acuity outcome, but a tendency was observed for less decline in color contrast sensitivity and pattern electroretinogram recordings after diode laser photocoagulation. A tendency for less decline in visual function in this study suggests that diode laser photocoagulation is a possibly more gentle mode of treatment that warrants a more extended study.

PDR-CW8 The Effect of Argon vs. Diode Laser Photocoagulation on Oxygenation of Avascular Retina

Funatsu H,¹ Berkowitz BH,^{1,2}
Wilson CA.¹
Depts. of ¹Ophthalmology and ²Radiology,
Univ. of Texas Southwestern
Medical Center; Dallas, TX
[ARVO Abstract]. Invest Ophthalmol
Vis Sci 36(4): S117. Abstract nr 570,
1995

Photocoagulation was applied to avascular rabbit retina to produce grade I to II lesions. On the day of oxygen measurement, a droplet of perfluorotributylamine was placed into the preretinal vitreous space and the steady-state PO₂ was measured using ¹⁹F magnetic resonance spectroscopy [NMR in Biomed 4:157-159; 1991]. To determine the PO₂ directly over laser lesions, small (5 μl) droplets were placed over large (~ 4 mm x 5 mm), confluent areas of treatment. To determine the PO₂ in between laser lesions, a larger (10 μl) droplet was placed over a field of scatter photocoagulation (burn area ~ 32% of the total retinal surface area). Thus, the area of retina sampled by the droplet was weighed strongly towards retina in between lesions. Results: Untreated eyes had a preretinal PO₂ of 22.4±9.4 mm Hg (mean ±S.D., n=15 eyes). The preretinal PO₂ was significantly higher over confluent, 12 day-old argon laser photocoagulation (ALP) or diode laser photocoagulation (DLP) lesions (51.3±13.2 mm Hg, n=8 eyes; p<.01). However, DLP lesions had significantly higher PO₂ values (60±12.7 mm

Infrared Diode Laser Applications

	<p>Hg, n=4 eyes) than did ALP lesions (42.4±6.0 mm Hg, n=5 eyes; p=.01). These results support the use of DLP as an alternative to ALP for the treatment of retinal vascular diseases in which hypoxia is suspected to play a role.</p>
<p>PDR-CW9 Patient Compliance During Argon and Diode Lasercoagulation Partsch MC,¹ Türrner KH,¹ Kreissig I,¹ Wohlrab TM.² ¹Ophthalmology III, ²Ophthalmology I: Univ. Eye Hospital; Tübingen, Germany. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S1001. Abstract nr 4636, 1995</p>	<p>Two-hundred-eleven consecutive patients with hitherto untreated pre- or proliferative diabetic retinopathy were coagulated with both argon and diode lasers. Immediately after treatment, the patients were asked to comment on pain and discomfort experienced during treatment. Only topical anesthesia was used. All treatments were carried out by one experienced retinal surgeon. On the average, 235 laser spots were applied during one session, with spot sizes ranging between 200 and 500 microns (energy-level from 100 to 350 mW (argon) and 300 to 900 mW (diode), exposure time 400 msec). Results: 83.9% had little or no pain or discomfort, 13.8% considerable, and 2.3% unbearable pain; their treatment with the diode laser could not be continued. When asked which laser they preferred, 75.8% chose diode, 13.8% could not make up their mind, and 10.4% preferred not to receive diode treatment again. All patients found the missing glare during treatment with the diode laser positive. Treatment with both types of lasers seems to cause similar amounts of pain and discomfort and is widely accepted by the patients.</p>
<p>PDR-CW10 Diode Laser in Treatment of Proliferative Diabetic Retinopathy Carlos de M. Goncalves J. Arq. Bras. Oftal. 58(2), 127-129, 1995</p> <p>Abstract - English/Portuguese Article - Portuguese</p>	<p>Retinal photocoagulation was applied to 45 patients presenting with proliferative diabetic retinopathy. Patients with severe lens opacification, vitreal hemorrhages, and retinal detachment, or those that presented with previous photocoagulation were excluded. Treatment parameters - power: 300 – 900 mW depending on degree of retinal edema present; spot size: 75, 200, and 300 µm (75, 125 µm in posterior pole; 200 – 300 spots in the equator and periphery); number of spots: 150 – 1000; duration: 300 – 400 ms. Each application was separated by the same spot size of the endpoint. Average follow-up was 11 months. A minimal to moderate level of discomfort using peribulbar anesthesia was experienced in 95.4% of patients. Only 2 patients experienced intense pain and required peribulbar anesthesia to complete treatment. One of the 2 patients had already been treated on one eye with argon laser photocoagulation and required peribulbar anesthesia. Regression of neovascularization was observed in 95.5% of the cases.</p>
<p>PDR-CW11 Indirect Diode Laser Photocoagulation through Nonresolving Total Diabetic Vitreous Hemorrhage: An Alternative to Vitrectomy Mansour AM, Salti HI, Uwaydat SM. Dept of Ophthalmology, American University of Beirut, Beirut, Lebanon. [ARVO Abstract]. Invest Ophthalmol Vis Sci 41(4): S657. Abstract nr 3493, 2000</p>	<p>Nineteen consecutive patients with non-resolving total vitreous hemorrhage (NRTVH) underwent indirect diode laser photocoagulation (IDL) (median values 1,207 shots: power 800 mW and duration 600 msec) with a median follow-up of 6 months. Nearly half of the patients were unioctular, referred for vitrectomy, had cataract, and a high morbidity. Results: Vitreous hemorrhage decreased markedly in 15 patients eliminating the need for vitrectomy. Median Snellen visual acuities improved from finger counting 30 cm to 6/60. Peripheral hyaloid face separation was observed in the area of IDLP. Conclusions: Diode laser can penetrate media opacities. IDLP can eliminate the need for vitrectomy in selected subjects with NRTVH (unioctular sick patients who cannot or refuse to undergo surgery). When the vitreous hemorrhage does not clear, IDLP helps in quieting APDR making subsequent vitrectomy less complicated.</p>



Reference Catalog: Summaries of Studies

DIABETIC RETINOPATHY - PROLIFERATIVE

Contact Transscleral Panretinal Photocoagulation

PDR-TS1 Contact Transscleral Diode Laser Panretinal Photocoagulation in the Management of Proliferative Diabetic Retinopathy in Eyes with Cataract
 Dowler J, Hamilton AMP.
 Lasers Light Ophthalmol 7:216, 1996

Cataract extraction in eyes with active proliferative retinopathy is associated with a high risk of progression of retinopathy, iris neovascularization, macular edema, severe uveitis, and poor postoperative visual acuity. Although the prognosis may be improved by preoperative panretinal photocoagulation, cataract may prevent this. Two cases are reported in which transscleral diode laser panretinal photocoagulation (TSDPRP) induced a regression of neovascularization in eyes in which cataract precluded transpupillary laser. Subsequent cataract surgery was uncomplicated and final visual acuities were 6/9 and 6/12. TSDPRP may induce regression on neovascularization in eyes in which cataract prevents preoperative transpupillary laser, reducing the morbidity and improving the visual outcome of subsequent cataract surgery.

Reference Catalog: Summaries of Studies

DIABETIC RETINOPATHY - PROLIFERATIVE

MicroPulse™ Photocoagulation

PDR-MP1 Clinical Applications of the MicroPulse Diode Laser

MIP

Moorman CM, Hamilton AMP. Eye 13:145-150, 1999

Also listed as DME-MP7, pg. 73

The purpose of this study was to evaluate the efficacy of the OcuLight SLx MicroPluse 810 nm diode laser in the treatment of 1. macular edema secondary to either branch retinal vein occlusion (BRVO) or diabetic maculopathy and 2. proliferative diabetic retinopathy (PDR). Fifty-two eyes of 33 consecutive patients were treated over a 6 month period. Panretinal and grid pattern photocoagulation were performed using the MicroPulse mode with the laser on for 100 – 300 μs and off for between 1900 and 1700 μs repeatedly in a pulse envelope of 100 - 200 ms duration. The spot size used was between 200 and 500 μm. Patients were assessed clinically and angiographically at 3 and 6 months. Overall, 22 eyes (57%) showed resolution of macular edema at 6 months; and 10 eyes (77%) with proliferative disease showed some regression of new vessels at 6 months. Visual acuity was maintained in 27 eyes (69%) and improved in 11 eyes (28%).

1. Macular Edema. Thirty-nine eyes of 33 patients were treated with standard grid pattern photocoagulation to areas of retinal thickening; microaneurysms were not specifically targeted. Twenty-two eyes (57%) demonstrated resolution of macular edema on angiography at 6 months. Fifteen eyes remained unchanged on angiography at 6 months follow-up and 2 eyes (1 patient) were worse. Vision improved by 1 or more Snellen lines in 11 patients and was maintained in 27 (69%) patients. There was no difference between patients with BRVO and diabetic macular edema. Over half (54%) the eyes treated for macular edema required more than one treatment episode.

2. Proliferative Diabetic Retinopathy. Thirteen eyes of 9 patients were treated with standard panretinal photocoagulation: 1500 burns initially, followed by a further 1500 burns at 6 week intervals depending on the clinical response. At 6 months, 8 eyes (62%) of 5 patients showed complete regression of new vessels. A further 2 eyes (2 patients) showed partial regression. Three eyes (2 patients) showed minimal or no response to laser treatment over the 6 month study period.

Treatment with the diode laser on MicroPulse mode was extremely well tolerated by all patients. None recorded any sensation during laser treatment. Since there was no light flash, fixation was good and most patients co-operated well during treatment of the macular region. Diode laser in MicroPulse mode is effective in the management of diabetic and occlusive macular edema and proliferative diabetic disease.

Additional Education Material Available on:

Diabetic Retinopathy - Proliferative

PDR-A Applications Note: Diode Laser Treatment of Proliferative Diabetic Retinopathy

This Applications Note provides a history of the clinical studies for the treatment of proliferative diabetic retinopathy (PRP). Also included are 810 nm diode laser treatment recommendations detailing the power, the duration, and the spot size to produce a clinically effective diode laser lesion with minimum patient discomfort. Clinical advantages of 810 nm diode lasers for PRP are also addressed.

GLAUCOMA

<i>Laser Trabeculoplasty</i>	
<p>G-LT1 Diode Laser Trabeculoplasty (DLT) for Primary Open-Angle Glaucoma and Ocular Hypertension McHugh D, Marshall J, ffytche T, Hamilton P, Raven A. Br J Ophthalmol 74:743-747, 1990</p>	<p>This pilot study examined the efficacy of 810 nm diode laser trabeculoplasty in the treatment of primary open-angle glaucoma and ocular hypertension. It concluded that diode laser trabeculoplasty is an effective mode of treatment for eyes with open-angle glaucoma or with ocular hypertension.</p>
<p>G-LT2 Diode Laser Compared With Argon Laser for Trabeculoplasty Brancato R, Carassa R, Trabucchi G. Am J Ophthalmol 112:50-55, 1991</p>	<p>A randomized prospective study on two groups of 10 patients compared the efficacy of diode laser and argon laser trabeculoplasty. Differences between the two groups were not significant at 2 hours, 6 months, and 1 year, concluding that laser trabeculoplasty may be effective with a diode laser.</p>
<p>G-LT3 A Controlled Clinical Trial of Diode versus Argon Laser Trabeculoplasty Schuman J, Puliafito C, Jacobs D, Lamkin J, Rand Allingham R, Weiss H, Jacobson J. Massachusetts Eye & Ear Infirmary; Boston, MA. Abstract. 3rd International Congress on Laser Tech. San Francisco, CA May, 1991</p>	<p>The authors initiated a prospective, randomized clinical trial comparing laser trabeculoplasty with argon blue-green (488-514 nm, ALT) versus semiconductor diode laser (805 nm, DLT). They treated eyes with 50 applications over 180° using sufficient power to produce blanching. There were no significant differences for mean pre-treatment IOPs.</p>
<p>G-LT4 Ultrastructural Changes of Human Trabecular Meshwork After Photocoagulation with a Diode Laser McHugh D, Marshall J, ffytche T, Hamilton P, Raven A. Invest Ophthalmol Vis Sci. 33:2664-2671, 1992</p>	<p>A diode laser, emitting infrared radiation at a wavelength of 810 nm, was used to perform trabecular photocoagulation in a human eye prior to enucleation for malignant melanoma. For comparison, burns were applied with an argon blue-green laser (488-514.5 nm). These findings confirm that trabecular photocoagulation is not a process that depends upon the wavelength of the incident energy at the two spectral extremes of 488 nm and 810 nm.</p>
<p> G-LT5 Comparison of the Anterior Chamber Inflammatory Response to Diode and Argon Laser Trabeculoplasty Using a Laser Flare Meter Moriarty A, McHugh D, Spalton D, ffytche T, Shah S, Marshall J. Ophthalmology 100:1263-1267, 1993</p>	<p>Of 25 patients with uncontrolled IOP, 21 eyes underwent ALT and 17 DLT (810 nm). Flare values were measured at 1, 3, 24, 48, 72, 96, and 168 hours using a laser flare and cell meter. IOPs were measured at similar intervals and at 8 weeks. Both forms of treatment induced a similar hypotensive effect with a significant reduction in IOP at 8 weeks compared with initial IOP. However, there was a significantly greater disruption of the blood-aqueous barrier with ALT when compared with DLT at 1, 3, and 24 hours and at 48, 72, and 96 hours. By 1 week, there was no significant difference in flare values between the two groups. Post laser pain occurred in seven eyes treated with ALT but in no eyes treated with DLT. In addition, peripheral anterior synechiae occurred in four eyes after ALT by 8 weeks, but none occurred in the DLT group. Conclusion: ALT produces a greater disruption of the blood-aqueous barrier than DLT, which may be associated with the development of complications in the anterior segment.</p>

Reference Catalog: Summaries of Studies

<p>G-LT6 Long-Term Follow-Up of Diode Laser Trabeculoplasty for Primary Open-Angle Glaucoma and Ocular Hypertension Moriarty A, McHugh D, ffytche T, Marshall J, Hamilton P. Ophthalmology 100:1614-1618, 1993</p>	<p>Twenty-five eyes of 16 patients were treated with DLT (810 nm) for the control of primary open-angle glaucoma and ocular hypertension. Treatment consisted of applying 50 burns to 180° of the trabecular meshwork. The laser spot size was 100 μm, and pulse duration was 0.2 seconds. The target area was the pigmented portion of the meshwork. Although a mild pricking sensation was noticed during treatment in some eyes, no patient complained of postoperative pain or discomfort, and no patients required topical steroids. In no eyes was an acute rise in IOP noted. Patients were evaluated at 2 and 6 weeks, and at 3, 6, 12, 18, and 24 months. This study is the longest reported follow-up period for eyes treated with DLT. Control of IOP was well maintained in the majority of patients. Quantitative measurements of anterior chamber flare after treatment have shown that DLT is associated with significantly less disruption of the blood-aqueous barrier and anterior uveitis. This study has confirmed the ocular hypotensive effect of DLT to be of equivalent efficacy to ALT with an absence of its associated inflammatory complications. In addition, the portability and reliability of diode lasers may allow access to laser therapy for glaucoma patients in developing countries.</p>																																							
<p>G-LT7 Laser Flare Meter Comparison of Ocular Inflammation Following Argon Laser and Diode Laser Trabeculoplasty Garcia-Sanchez J, Arias-Puente A, Puy P. Scientific Paper SP580. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>The authors studied anterior segment inflammation with a laser flare meter following argon laser and diode laser trabeculoplasty in 60 eyes with primary open-angle glaucoma. They analyzed the intraocular pressure results and characteristics of both techniques. The aqueous humor protein concentration following argon laser trabeculoplasty was significantly higher than after diode laser trabeculoplasty (p=0.05). In the diode laser group, the treated zone was identified in only 9% of cases, but the intraocular pressure results were similar in both groups.</p>																																							
<p>G-LT8 Diode Laser Trabeculoplasty (DLT) versus Argon Laser Trabeculoplasty (ALT) in Primary Open-Angle Glaucoma Moriarty A, McHugh J, ffytche T, Marshall J, Spalton D, Moriarty B. Scientific Poster #52. AAO. San Francisco, CA. October, 1994</p>	<p>Forty patients with primary open-angle glaucoma were enrolled in a prospective randomized trial of diode laser trabeculoplasty versus argon laser trabeculoplasty. No significant difference in hypotensive effect was found over a 2 year period. Post laser pain (seven patients) and peripheral anterior synechiae (four patients) were complications of ALT, but were not a feature of DLT.</p> <table border="1"> <thead> <tr> <th></th> <th>DLT</th> <th>ALT</th> </tr> </thead> <tbody> <tr> <td>Eyes Treated</td> <td>20</td> <td>20</td> </tr> <tr> <td>Mean age (years)</td> <td>66</td> <td>68</td> </tr> <tr> <td>Mean Pre-Op IOP</td> <td>26.5</td> <td>25.5</td> </tr> <tr> <td>Mean IOP at 2 years</td> <td>20.0</td> <td>19.5</td> </tr> <tr> <td>Mean Fall in IOP</td> <td>6.5</td> <td>6.0</td> </tr> <tr> <td>Eyes Controlled (2 yrs) (<22 mm Hg)</td> <td>18 (90%)</td> <td>16 (80%)</td> </tr> <tr> <td>Post-Op Pain</td> <td>0</td> <td>7</td> </tr> <tr> <td>PAS</td> <td>0</td> <td>4</td> </tr> <tr> <td>Flare</td> <td></td> <td></td> </tr> <tr> <td> 1 hour</td> <td>22</td> <td>50</td> </tr> <tr> <td> 24 hours</td> <td>18</td> <td>28</td> </tr> <tr> <td> 168 hours</td> <td>15</td> <td>22</td> </tr> </tbody> </table>		DLT	ALT	Eyes Treated	20	20	Mean age (years)	66	68	Mean Pre-Op IOP	26.5	25.5	Mean IOP at 2 years	20.0	19.5	Mean Fall in IOP	6.5	6.0	Eyes Controlled (2 yrs) (<22 mm Hg)	18 (90%)	16 (80%)	Post-Op Pain	0	7	PAS	0	4	Flare			1 hour	22	50	24 hours	18	28	168 hours	15	22
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<p>G-LT9 Five Year Results of a Randomized, Prospective Clinical Trial of Diode versus Argon Laser Trabeculoplasty Chung P, Lloyd-Muhammad R, Netland P, Schuman J. Free Paper. AAO. Chicago, IL. October, 1996</p>	<p>The authors initiated a prospective, randomized clinical trial comparing laser trabeculoplasty with argon blue-green (488-514 nm, ALT) versus semiconductor diode laser (805 nm, DLT). Fifty eyes of 46 patients were treated with 50 applications over 180° using sufficient power to produce blanching (530-850 mW DLT, 400 - 1100 mW ALT). DLT was performed using a 100 micron spot size (smallest available), 0.5 seconds exposure, and a</p>																																							

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	<p>Ritch lens. ALT was performed with a 50 micron spot, 0.1 seconds and a Goldmann lens. There were no significant differences in the mean pretreatment IOPs [21.2 (DLT, n=22) and 21.5 (ALT, n=28), p=0.81] or mean final IOPs (15.7 DLT and 17.1 ALT, p=0.19). Time to surgical failure showed no significant differences with 50% of the DLT patients and 58% of the ALT patients surviving at 5 years, p=0.60. The mean follow-up times for those that had more than 1 year of follow-up were 49.4 months DLT (n=17) and 45.8 months ALT (n=21). When those with less than 1 year of follow-up were excluded, the survival curve remained essentially the same. Diode and argon laser trabeculoplasties are equally efficacious in lowering intraocular pressure over a 5 year period.</p>																								
<p>G-LT10 Argon versus Diode Laser Trabeculoplasty Englert JA, Cox TA, Allingham RR, Shields MB. Duke University Eye Center, Durham, NC, Department of Ophthalmology. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S168. Abstract nr 833, 1997</p>	<p>Fellow eyes of 11 patients, requiring laser trabeculoplasty to lower intraocular pressure (IOP), were randomized to diode laser trabeculoplasty (DLT) in one eye and argon laser trabeculoplasty (ALT) in the other eye. The differences from baseline IOP were statistically significant ($p < 0.01$) at all time periods for the ALT group, but were not statistically significant at any of the follow-up periods in the DLT.</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;"></th> <th style="width: 35%; text-align: center;">DLT</th> <th style="width: 35%; text-align: center;">ALT</th> <th style="width: 15%;"></th> </tr> </thead> <tbody> <tr> <td>Ave. Baseline</td> <td style="text-align: center;">21.6+2.0 mm Hg</td> <td style="text-align: center;">24.4+3.3 mm Hg</td> <td></td> </tr> <tr> <td><u>Follow-up</u></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1 month</td> <td style="text-align: center;">19.6+2.1 mm Hg</td> <td style="text-align: center;">17.6+1.7 mm Hg</td> <td style="text-align: right;">$p < 0.01$</td> </tr> <tr> <td>2 months</td> <td style="text-align: center;">19.3+2.6 mm Hg</td> <td style="text-align: center;">16.8+2.5 mm Hg</td> <td style="text-align: right;">$p < 0.01$</td> </tr> <tr> <td>3 months</td> <td style="text-align: center;">19.0+3.3 mm Hg</td> <td style="text-align: center;">15.5+1.2 mm Hg</td> <td style="text-align: right;">$p < 0.05$</td> </tr> </tbody> </table> <p>IOPs were higher 1 hour postoperatively with ALT than with DLT, but these values were not statistically significant. ALT appears to be more effective than DLT in lowering IOP during the first 3 months following treatment. Subjectively, patients noted less discomfort with the diode laser.</p>		DLT	ALT		Ave. Baseline	21.6+2.0 mm Hg	24.4+3.3 mm Hg		<u>Follow-up</u>				1 month	19.6+2.1 mm Hg	17.6+1.7 mm Hg	$p < 0.01$	2 months	19.3+2.6 mm Hg	16.8+2.5 mm Hg	$p < 0.01$	3 months	19.0+3.3 mm Hg	15.5+1.2 mm Hg	$p < 0.05$
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<p>G-LT11 Low Energy Laser Irradiation of Perfused Trabecular Meshwork Cell Monolayers: Results of a Pilot Series using a Diode Laser Rivera BK,^{1,2} Roberts CJ,^{1,2} Weber P,¹ Herderick EE.² ¹Department of Ophthalmology, ²Biomedical Engineering Center, The Ohio State University, Columbus, OH [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S138. Abstract nr 732, 2001</p>	<p>The purpose of this pilot experimental series was to determine if perfused trabecular meshwork (TM) cell monolayers treated in a low energy irradiation regime exhibit different hydraulic conductivity (Lp) characteristics when compared to pre-irradiation baseline values. Using a specialized perfusion apparatus reported upon previously, 10 low energy pilot experiments were attempted. TM monolayers grown on filter supports consisting of 2nd-4th passage cells from three donors were used. Upon reaching a steady-state perfusion condition, the entire cell monolayer was irradiated for 1.0, 1.5, or 2.0 seconds using a diode laser ($\lambda=810$ nm) at power settings of 1.0, 1.1, or 1.2 W. Perfusion and data collection continued for 45 minutes post-treatment. For 6 of the pilot experiments, cell monolayers were then tested to determine cellular viability using Molecular Probes Live/Dead Assay (#L3224). Calculated Lp values were imported into SAS®, normalized to pre-treatment baseline, and then analyzed for post treatment response in 5-minute increments. Of the 10 experiments attempted, 3 were excluded due to complications with the apparatus. Four monolayers exhibited an increase in Lp post-treatment. For 3 of these, the cells proved to be patent and viable. Numerous dead cells were observed to be present in</p>																								

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	<p>the remaining 3 cellular viability tests. SAS® analysis using Dunnett's method at $\alpha=0.05$ for all 7 successful experiments revealed no statistically significant change in hydraulic conductivity post-treatment when compared to baseline. When post-treatment cellular viability was taken into account (6 of the 7 experiments), there were statistically significant increases in Lp from 10 minutes onward, post-treatment for the viable group; and statistically significant decreases in Lp from 20 minutes onward, post-treatment for the non-viable group. Conclusions: Low energy diode laser irradiation increases Lp in a viable, perfused TM cell monolayer model when compared to baseline values in this pilot series of experiments.</p>

GLAUCOMA

<i>Transscleral Cyclophotocoagulation (TSCPC)</i>	
<p>G-TS1 Experimental Investigations on the Light Scattering Properties of the Human Sclera Rol P, Niederer P, Dürr U, Henchoz P, Fankhauser F. Lasers Light Ophthalmol 3:201-212, 1990</p>	<p>This study was undertaken in order to quantify the scattering and the transmission characteristics of laser light by the sclera and to compare argon, dye, diode, and Nd:YAG lasers with respect to their ability to induce transscleral coagulation either of the ciliary body or of the retina/choroid. All experiments were performed in vitro with human scleras obtained from autopsy eyes. Conclusion: Transscleral photocoagulation of the ciliary body and retina/choroid can be performed with the diode laser operating at 840 nm just as favorably as with the Nd:YAG laser.</p>
<p>G-TS2 Transscleral Application of a Semiconductor Diode Laser Peyman G, Naguib K, Gaasterland D. Lasers Surg Med 10:569-575, 1990</p>	<p>An 810 nm diode laser with an output of 1 Watt through a fiberoptic light pipe was used to deliver laser energy through the sclera of pigmented rabbits. Ciliary body destruction occurred with energy levels of 300-400 mW and exposure time of 0.5 sec. Retinal photocoagulation was achieved with energy levels of 200-500 mW in 0.5 sec. Chorioretinal scar formation was observed clinically and histologically within 2 to 3 weeks. Conclusion: Diode TSCPC may be used for destruction of the ciliary body processes or peripheral retinal coagulation in pigmented eyes.</p>
<p>G-TS3 Optical Properties of Human Sclera, and their Consequences for Transscleral Laser Applications Vogel A, Dlugos C, Nuffer R, Birngruber R. Lasers Surg Med 11:331-340, 1991</p>	<p>The spectral dependence of the optical properties of human sclera adjacent to the limbus was investigated and related to the potentials of transscleral photocoagulation. The total transmission, absorption, and reflection, as well as the angular distribution of the transmitted and reflected light, were measured at five laser wavelengths both for non-contact and contact applications. Fifteen in vitro scleral specimens were used for non-contact measurements, and seven specimens for contact measurements. Five lasers with different wavelengths were used: helium-cadmium (442 nm), argon ion (514 nm), helium-neon (633 nm), diode (804 nm), and Nd:YAG (1,064 nm). The results support the use of a contact delivery system for transscleral laser applications at wavelengths in the near-infrared region, like those of the diode or the ND:YAG laser.</p>
<p>G-TS4 A Modified Probe for Semiconductor Diode Laser Contact Transscleral Cyclophotocoagulation in Rabbits Pollack I, Paris D, Abrams D. Sinai Hospital of Baltimore, MD [ARVO Abstract]. Invest Ophthalmol Vis Sci. 32(4): 747. Abstract nr 406, 1991</p>	<p>The authors investigated the in vivo effects of a specialized contact probe (G-Probe) used with an 810 nm semiconductor diode laser in creating ciliary body lesions in eight eyes from four Dutch-belted rabbits. The G-Probe was designed to reproducibly create evenly spaced burns of equal diameter centered within the ciliary body in humans. Gross examination of the ciliary body revealed evenly spaced burns and blanching of the ciliary processes. Higher energy levels caused hemorrhage and full thickness scleral fistulization. Light microscopy revealed thermal destruction of the ciliary processes. Areas of hemorrhage were noted in eyes treated with higher energies. The G-Probe effectively delivers localized diode laser energy to the ciliary body in a controlled fashion by reducing contact probe placement variability.</p>

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<p>G-TS5 Transscleral Cyclophotocoagulation in Human Autopsy Eyes: Contact Diode Compared with Noncontact Nd:YAG Lasers Monsour M, Kane H, Gaasterland D. Worthen Center for Eye Care Research, Georgetown Univ., Washington, D.C. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1018. Abstract nr 1642, 1992</p>	<p>Three pairs of fresh autopsy eyes were used to compare tissue effects of TSCPC done with contact diode laser (810 nm) versus non-contact Nd:YAG laser. One eye of each pair received 11 contact diode applications and the other received 11 non-contact free-running Nd:YAG applications. Results show that long duration, low power contact diode laser causes more predictable and consistent TSCPC than equienergetic non-contact, free-running Nd:YAG laser.</p>
<p>G-TS6 A Multicenter Study of Contact Diode Laser Transscleral Cyclophotocoagulation in Glaucoma Patients Gaasterland D, Abrams D, Belcher C, Liebmann J, Pollack I, Ritch R, Schuman J, Shields B, Wise J, Baird M, Boutacoff T. Worthen Center for Eye Care Research, Georgetown Univ., Washington D.C. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1019. Abstract nr 1644, 1992</p>	<p>Thirty eyes of 30 patients, each with severe, medically uncontrolled, high surgical risk glaucoma, were treated with 810 nm diode laser TSCPC. Treatment was conducted with the IRIS Medical G-Probe following a uniform protocol in six centers. Each eye received 16 to 18 laser applications evenly spaced over 270° centered 1.2 mm behind the surgical limbus. Results show a mean reduction of IOP from a baseline of 36 mm Hg to 21 at 6 weeks with no hypotony or phthisis. Treatment causes mild inflammations that clear quickly with minimal discomfort. Six month follow-up results suggest treatment with the G-Probe is comparatively safe and effective.</p>
<p>G-TS7 Contact Transscleral Cyclophotocoagulation (CTCP) with Diode Laser. A Pilot Clinical Study Carassa R, Trabucchi G, Bettin P, Fiori M, Brancato R. Department of Ophthalmology, University of Milano, H S. Raffaele, Italy. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1019. Abstract nr 1646, 1992</p>	<p>The aim of this study was to evaluate the clinical effectiveness of 810 nm diode laser for CTCP. Twelve eyes of 12 patients suffering from uncontrolled glaucoma were treated with a diode laser coupled with a 400 micron optic fiber. All eyes were treated with 16 spots over 360°, 1.5 mm posterior to the limbus, using 2.5 W and 1.5 W setting. Nine out of 12 eyes reached an IOP < 21 mm Hg. No major complications and no conjunctival lesions were found. The procedure was reported as very painful and in all cases a retrobulbar anesthesia was needed. Conclusion: Diode laser seems to grant better results for CTCP than Nd:YAG; however, a longer follow-up is required to confirm this conclusion.</p>
<p>G-TS8 Semiconductor Diode Laser Transscleral Cyclophotocoagulation in Patients with Glaucoma Hennis H, Stewart H. Am J Ophthalmol 113:81-85, 1992</p>	<p>A diode laser was used to perform non-contact TSCPC in 14 patients with glaucoma. Laser settings used for this procedure were 990 ms, 100 µm spot size, and 1,200 mW of power. Applications were placed 1 mm posterior to the surgical corneal limbus and a 1 mm defocused toward the ciliary body. This study was considered successful in relieving pain in three of four patients and controlling intraocular pressure to less than 21 mm Hg with no decrease in visual acuity in 10 patients. These results suggest the use of the semiconductor diode laser to perform TSCPC is reasonably safe, comfortable, and effective.</p>
<p>G-TS9 The Influence of Exposure Duration in Transscleral Nd:YAG Laser Cyclophotocoagulation Prum B, Shields S, Simmons R, Echelman D, Shields B. Am J Ophthalmol 114:560-567, 1992</p>	<p>TSCPC was performed in human autopsy eyes by using three Nd:YAG lasers with different durations of exposure: a pulsed contact (duration of 0.75 ms), pulsed noncontact (20 ms), and a continuous-wave contact laser (700 and 2,000 ms). Both pulsed lasers were noted to cause mild whitening of the pigment epithelium with frequent vaporization and explosive tissue disintegration. The continuous-wave laser produced prominent tissue whitening and puckering. Conclusion: Longer exposure durations (2,000 ms) appear to reduce the likelihood of explosive tissue disintegration.</p>

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<p>G-TS10 Initial Experience with a New Method of Laser Transscleral Cyclophotocoagulation for Ciliary Ablation in Severe Glaucoma Gaasterland D, Pollack I. Trans Am Ophthalmol Soc 90:225-246, 1992</p>	<p>TSCPC with the G-Probe was performed on 21 eyes of 21 patients. Most eyes received 16, 17, or 18 applications. Follow-up ranged from 0.5 - 11 mos. This paper offers specific information on each patient's glaucoma, technique used, problems associated with treatment, and outcome information. In general, the study indicated that fiberoptic contact TSCPC of 3/4 of the ciliary body circumference causes a durable reduction of IOP in about 2/3 of eyes with severe, medically uncontrolled glaucoma.</p>
<p>G-TS11 One-Year Results of Semiconductor Transscleral Cyclophotocoagulation in Patients with Glaucoma Hawkins TA, Stewart WC. Arch Ophthalmol 111(4):488-91, 1993</p>	<p>Thirty consecutive patients with glaucoma were treated with diode TSCPC to determine the results and complications of this procedure. Twelve months after surgery the mean (+/- SD) preoperative IOP of 32.5 +/- 10.9 mm Hg (n = 30) had dropped to 20.8 +/- 15.6 mm Hg (n = 19) (P = .018, paired Student's t test), while the mean number of preoperative medications received decreased from 2.0 to 1.8 (P = .060, Wilcoxon's Signed Rank Test). One year after surgery 3 patients (10%) were unavailable for follow-up, 8 (27%) had required other surgical procedures to control the IOP, 17 (56%) had controllable IOP of 21 mm Hg or below or received pain relief from the diode laser alone, and 2 (7%) patients with controlled IOP had suffered visual loss. Other complications included mild conjunctival hyperemia and uveitis in all patients and mild ocular pain in 6 patients. This study suggests the usefulness of TSCPC in reducing the IOP for up to 1 year.</p>
<p>G-TS12 A 1 Year Follow-up Study of Contact Transscleral Cyclophotocoagulation with Diode Laser Brancato R, Trabucchi G, Bettin P, Fiori M. University of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 737. Abstract nr 175, 1993</p>	<p>Twenty-five eyes of 25 patients affected by refractory glaucoma were treated with a diode laser coupled with a 400 µm optic fiber ending in a 3 mm focusing tip. Fifty-two percent of seeing eyes and 100% of blind eyes were successful in achieving an IOP lower than 21 mm Hg. The study concluded that diode infrared laser can be successfully employed for CTCP in refractory glaucomatous eyes.</p>
<p>G-TS13 A Comparative Histopathological Study of Contact Transscleral Cyclophotocoagulation Performed on the Human Eye with Nd:YAG and Diode Lasers Verdi M, Brancato R, Trabucchi G, Carassa R, Gobbi P. University of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 737. Abstract nr 176, 1993</p>	<p>Treatment was performed on one human eye immediately before enucleation for choroidal melanoma. A 1064 nm Nd:Yag and an 805 nm diode laser operating in continuous-wave were delivered through the same fiber optic system. At lower energy doses, the lasers produced similar, well defined cyclodestructive effect; while at higher energy levels, the diode wavelength produced the largest lesions. No damage of the sclera was detected in both treatments.</p>
<p>G-TS14 Contact-Cyclophotocoagulation: Comparison of Diode and Two Nd:Yag Lasers Pfeiffer N, Benning H, Grehn F. Department of Ophthalmology, Mainz University; Langenbeckstr, Mainz, Germany. American and European Glaucoma Society Meeting, Iceland 1993</p>	<p>The authors used an 810 nm diode laser and G-Probe and two contact CW-Nd:YAG lasers (LASAG-Microruptor-III with bare-fiber and SLT laser with a quartz tip) at 1064 nm to treat 47 freshly enucleated porcine eyes with brown or blue irides. Macroscopically, all laser treatments produced similar effects with blanching of the ciliary epithelium and partial destruction of the ciliary body. Effects were smaller in brown than in blue eyes. Using the G-Probe resulted in relatively large effects extending to retina and/or lens. The "safety-zone" between sufficient treatment and over-treatment was broadest with exposure times of 1.5 to 2 seconds. Conclusion: TSCPC and CW-Nd:YAG treatment produces similar effects. The G-Probe produces posterior effects; SLT produces sclera effects, possibly due to the quartz tip. Longer duration of pulses with lower power may offer more safety, although in perfused human eyes results could be different.</p>



<p>G-TS15 Contact Transscleral Cyclophoto-coagulation with the Diode Laser for Severe Glaucoma Kimura Y, Shimizu M, Noguchi S, Shimizu R. Scientific Poster P75. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>Twenty-seven eyes with uncontrolled glaucoma with or without rubeosis received TSCPC using a diode laser and contact G-Probe. As a standard procedure, a wavelength of 810 nm and power output of 1.5 W applied for 2 seconds was used. Each eye received an average of 15 laser applications 1.2 mm posterior to the limbus spaced over 270°, the superior quadrant being spared. Long-term control of intraocular pressure was attained in 20 eyes (74%), either after a single session (12 eyes) or another session (8 eyes). Complications were negligible and included ocular pain, mild inflammation, and transient rise in intraocular pressure.</p>
<p>G-TS16 Contact Transscleral Diode Cyclophoto-coagulation on Human Autopsy Eyes with Abnormally Thin Sclera Cohen J, Palmer D, Torczynski E, Deutsch T. Rush Medical College, Chicago, IL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2172. Abstract nr 4244, 1994</p>	<p>The purpose of this study was to determine if IRIS Medical diode laser (810 nm) energy adjustments are indicated in patients with pathologically thin sclera. The superior 180° of sclera at the limbus was dissected to the level of barely visible choroid in three human cadaver eyes. These eyes were pressurized at 30 mm Hg and a contact G-Probe was placed 1.5 mm behind the limbus with the following settings: Eye #1 - 1.0J, 1.5J, 2.0J, 2.5J; Eye #2 - 3.0J, 3.5J, 4.0J, 5.0J; and Eye #3 - 6.0J, 7.5J and 9.0J. The opposite 180° of normal sclera served as a control. Four adjacent burns were placed at each laser setting. On microscopic examination of the thin sclera, scleral damage was evident starting at 1.5J, scleral and ciliary body (CB) damage was seen starting at 2.0J, and scleral, CB and CB epithelial (CBE) damage occurred beginning at 3.0J. Conclusion: Energy adjustments are indicated in individuals with abnormally thin sclera who require ciliary ablation with the IRIS Medical diode laser to prevent overtreatment.</p>
<p>G-TS17 Diode Laser Transscleral Cyclophoto-coagulation in Buphthalmic Eyes: Histological and Clinical Results Lehmann OJ, McHughJD, Garner A, McCartney A, Rice NSC, Khaw PT. Moorfields Eye Hospital & Institute of Ophthalmology, London, U.K [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2172. Abstract nr 4245, 1994</p>	<p>Contact transscleral ciliary body coagulation was applied with a diode laser (810 nm) on a blind, painful, buphthalmic eye prior to enucleation. The globe was transilluminated and multiple burns applied at different distances from the limbus, with varying exposures from 2 to 4 J. Examination of this eye revealed that the burns located with the concurrent use of transillumination were the most accurate. The authors then treated five patients with buphthalmic eyes with the contact diode laser after locating the ciliary body with transillumination, using initial power settings of approximately 2 J per burn over 180°. Of the five eyes treated clinically, four eyes had an IOP reduction of 25% or greater up to 6 months. Conclusion: Accurate treatment of the ciliary body in enlarged buphthalmic eyes with transscleral photocoagulation requires knowledge of the distorted anatomy in these eyes, and concurrent preoperative transillumination is recommended.</p>
<p>G-TS18 Diode Contact Transscleral Cyclophotocoagulation to Reduce IOP in Early Glaucoma Carassa RG, Brancato R, Bettin P, Fiori M, Trabucchi G. Dept of Ophthalmology and Visual Sciences, Scientific Institute H.S. Raffaele, University of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2173. Abstract nr 4246, 1994</p>	<p>Aim of this study was to evaluate effectiveness and safety of diode contact transscleral cyclophotocoagulation (CTCP) in seeing eyes affected by early refractory glaucoma with absent to moderate visual field changes. Twenty-one seeing eyes (visual acuity (VA) ranging 20/200 to 20/20) of 21 patients (age 42.7 ±20.8 years) affected by early glaucoma refractory to medical, laser and surgical therapies were treated with a diode laser (EOS3000, Optikon, Italy) coupled with a 400 µm optic fiber ending in a 3-mm focusing tip. All eyes were treated with 16 spots over 360° 1.5 mm posterior to the limbus (center of tip), using 3.9 J (2.6 W x 1.5s). Results: Mean ± SD follow-up was 14.1 ± 5.2 months. The mean ± SD pre- and post-treatment</p>

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	<p>IOPs were 42.7 ± 12.5 and 19.1 ± 6.7 mm Hg respectively. Seventy-six percent reached an IOP below 21 mm Hg. VA showed no significant change: mean \pmSD pre- and post-CTCP VAs were 0.5 ± 0.3 and 0.4 ± 0.3 respectively ($p = .190$). VA remained stable in 18 eyes while it decreased 2 or more lines in 3 eyes, 1 for uncontrolled IOP, and 2 for progression of pre-existing cataract. No major complications were found. Conclusions: Diode laser CTCP is an effective and safe technique for the treatment of seeing eyes affected by early refractory glaucoma.</p>
<p>G-TS19 The Influence of Exposure Duration in Transscleral Diode Laser Cyclophotocoagulation Leoni G, Luppi ML, Penne A. Department of Ophthalmology, S. Antonio Abate Hospital, Gallarate Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2173. Abstract nr 4247, 1994</p>	<p>The aim of this study was to evaluate the influence of clinical results of long and short laser exposure duration in refractory glaucoma patients treated with diode laser contact transscleral cyclophotocoagulation (CTCP). The first group of 23 eyes of 23 patients, was treated with long exposure durations (1 W, 4.5 seconds) with an IRIS Medical OcuLight SL, 810 nm diode laser and a quartz glass fiber optic (G-Probe, IRIS Medical). The second group, 18 eyes of 17 patients, was treated at shorter exposure times (3 W, 1.5 seconds). Mean follow-up period was 14.2 ± 2.6 months for the first group and 11.7 ± 2.3 months for the second group. Results: LONG EXPOSURE GROUP: pre-treatment mean IOP was 41 ± 9.1 mm Hg; post-treatment IOP was 16.2 ± 5.1 mm Hg ($p < .001$). VA remained stable in 69.5% (16/23), decreased more than two lines in 13% (3/23) and from CF to HM in 13% (3/23) of the eyes. SHORT EXPOSURE GROUP: mean pre- and post-treatment IOPs were 43 ± 5.2 mm HG and 15.5 ± 5.9 mm Hg respectively ($p < .001$). VA remained stable in 55.5% (10/18), decreased more than two lines in 33.3% (6/18) and from CF to HG in 11% (2/18) of the eyes. Conclusion: Long exposure laser duration in CTCP results in significant long-term reduction of IOP with slight side effects.</p>
<p> G-TS20 Long-Term Effect of the Diode Laser Using the IRIS G-Probe on Glaucoma Patients Kosoko O*, Pollack IP, Abrams DA, Baird MA, Belcher CD, Boutacoff TA, Gaasterland DE, Liebmann JN, Ritch R, Schuman JS, Shields MB, Wise JB, Enger C. *Sinai Hospital of Baltimore; *The Wilmer Institute, Baltimore, MD [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2173. Abstract nr 4248, 1994</p>	<p>Thirty eyes of 30 patients with uncontrolled severe glaucoma were treated with the IRIS Medical OcuLight SLx, 810 nm diode laser system and the IRIS Medical G-Probe™ to perform TSCPC. Average follow-up was 15 months. Eleven eyes had primary open-angle glaucoma, 12 had secondary glaucoma after cataract surgery, and the rest had various secondary glaucoma diagnosis. Success of treatment was defined as a $\geq 20\%$ reduction in IOP at 6 weeks follow-up or later. Conclusion: At 6 weeks, 23 out of 30 eyes (77%) had at least a 20% decrease in IOP. The cumulative probability of success is 56% (95% confidence interval: 36% -75%) at 24 months.</p>
<p>G-TS21 Does Diode Laser Contact Transscleral Cyclophotocoagulation Cause Short-term Visual Changes in Early Refractory Glaucoma? Bettin P, Brancato R, Carassa RG, Calvauna MR, Fiori M, Berretta L. Dept of Ophthalmology and Visual Sciences, Scientific Institute H S. Raffaele, Univ. of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2173. Abstract nr 4250, 1994</p>	<p>The aim of this study is to assess if diode CTCP causes short-term VA or VF changes in early glaucomatous eyes. Fourteen seeing eyes ($VA \geq 0.3$) of 14 patients affected by early glaucoma refractory to conventional therapies underwent VA and VF (Humphrey Central 30-2 III) testing just before and 10 days after diode laser CTCP (16 - 3.9 J spots over 360°). To avoid artifacts, only patients trained in VF testing and eyes with IOP < 35 mm Hg were included. VA and VF indices were analyzed using paired t-test. VA showed no significant change and clinically, VF was judged stable in all cases. Conclusions: Diode laser CTCP does not produce any significant short-term visual change in seeing eyes affected by early refractory glaucoma.</p>

Reference Catalog: Summaries of Studies

<p>G-TS22 Influence of Exposure Time on Inflammatory Response to Neodymium: YAG Cyclophotocoagulation in Rabbits Echelmann D, Naisse M, Shields B, McGahan C, Fleisher L. Arch Ophthalmol 112:977-981, 1994</p>	<p>A contact, Nd:YAG (1064 nm) continuous-wave laser was used to perform TSCPC on one eye of 48 Dutch belted rabbits. The laser was set at 10 W and 0.2 seconds (2.0 Joules) to treat half of one eye, and 1 W and 2 seconds (2.0 Joules) to treat the other half. Results showed a relative difference in tissue reaction, with the shorter-duration exposure at a higher power level causing a greater degree of tissue disruption. These shorter, more disruptive ciliary body lesions tended to cause more generalized ocular damage, as evidenced by the inflammatory response. The implications from this study are that longer-duration continuous-wave cyclophotocoagulation applications produce milder tissue reaction and less inflammation than shorter applications, at least when the power is adjusted to maintain a constant energy level. Furthermore, the reduction in tissue damage and inflammatory response would presumably lead to fewer postoperative complications.</p>
<p>G-TS23 Contact Diode Laser Cyclophotocoagulation for Refractory Glaucoma. A Pilot Study. Ulbig M, McHugh D, McNaught A, Hamilton P. German J Ophthalmol 3:212-215, 1994</p>	<p>Twelve patients with refractory glaucoma were treated with the IRIS Medical OcuLight 810 nm diode laser and IRIS Medical G-Probe. A mean of 22 pulses with powers of up to 2 Watts and of 2 second duration were applied with the contact G-Probe. The mean intraocular pressure dropped from 42.3 to 13.6 mm Hg over 3 months. The delivery of laser energy via a contact probe seems to improve scleral transmission, although the application of greater total energies also seems to increase the amount of inflammatory response and the development of non-therapeutic side effects.</p>
<p> G-TS24 Transscleral Cyclophotocoagulation Using a Diode Laser Oguri A, Sato Y, Honbe K, Yamamoto T, Jikihara S, Kitazawa Y. Atarashii Ganka (Journal of the Eye). 11:967-970, 1994</p> <p>Abstract - English/Japanese Article - Japanese</p>	<p>Eleven eyes of nine patients with neovascular glaucoma (NG) and five eyes of five patients with secondary glaucoma (SG) received TSCPC with a diode laser. Preoperative intraocular pressure averaged 40.2±11.9 mm Hg (mean ± SD) in NG and 27.4±5.7 mm Hg (mean ± SD) in SG. Eight NG eyes (73%) and four (80%) SG eyes achieved a postoperative IOP of less than 20 mm Hg, although repeated TSCPC was necessary in 2 NG eyes and 3 SG eyes. Complications were minor. The results indicate that TSCPC with diode laser merits further investigation as a treatment modality for refractory glaucoma.</p>
<p>G-TS25 Transscleral Cyclophotocoagulation for Neovascular Glaucoma Oguri A, Sato Y, Suemori H, Yamamoto T, Jikihara S. Japanese Journal of Ophthalmic Surgery. 8:143-147, 1995</p> <p>Abstract - English/Japanese Article - Japanese</p>	<p>The results of TSCPC using a diode laser (10 eyes of 12 patients) and the results of TSCPC using a Nd:YAG laser (nine eyes of nine patients for free-running mode; five eyes of five patients for continuous wave mode without contact probe; six eyes of six patients for continuous-wave mode with contact probe) were compared in patients with neovascular glaucoma. The probability of successful IOP control with diode was 67.3±13.6% (mean ±SE) at 12 months after treatment, significantly better than that with Nd:YAG continuous wave mode with and without contact probe, throughout follow-up periods of up to 12 months. Adverse reactions were minor after diode. The results indicate that TSCPC with diode deserves further investigation as a treatment modality for neovascular glaucoma.</p>

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 <p>G-TS26 Glaucoma Management. A Surgical Way to Reduce Aqueous Production Gaasterland D. Review of Ophthalmology 2:109-110, 1995</p>	<p>In part one of a two part series, Douglas Gaasterland, M.D. reviews indications for ciliary body photocoagulation and discusses diode laser treatment parameters using the IRIS Medical OcuLight laser and G-Probe in the clinic or office setting. The G-Probe's footplate does three things: It orients the fiber nearly parallel to the visual axis; it locates the round-tipped fiberoptic slightly more than 1 mm behind the limbus; and it spaces 16 to 18 applications evenly in three quadrants. The treatment is a relatively straight forward office procedure: starting power of 1.75 Watts and duration of 2 to 2.5 seconds; treat 270°, covering the inferior, nasal, and superior quadrants omitting the temporal quadrant during the first session, and listen for a "popping" sound. The popping sound is an excellent clinical guideline (but not necessary for a good clinical result): If pops aren't heard during the first two laser applications, the power is increased to 2 Watts. If pops are heard during two sequential applications, then the power is decreased by .25 Watts. Peribulbar injections supplemented with retrobulbar anesthetic is suggested prior to treatment, and topical atropine and steroids after treatment.</p>
 <p>G-TS27 Glaucoma Management. A Surgical Way to Reduce Aqueous Production - Part Two Gaasterland D. Review of Ophthalmology 2:134-139, 1995</p>	<p>In part two of this two-part series, Dr. Gaasterland focuses on laser TSCPC treatment parameters with the Nd:YAG laser and then compares results of three clinical studies using either contact Nd:YAG, noncontact Nd:YAG, or diode laser ciliary body photocoagulation. The mean IOP reduction was similar among all three studies, with the diode laser having fewer complications. Dr. Gaasterland further speculates that the physiological effect of ciliary ablation mimics that of beta-blockers, which are often employed as the primary treatment for newly diagnosed glaucoma. In parts of the world where treatment with beta-blockers is not a practical alternative, it is possible that the small size, light weight, efficiency, and low cost of diode laser systems will make ciliary ablation a viable first-line treatment for glaucoma.</p>
 <p>G-TS28 Transscleral Diode Cyclophotocoagulation in the Treatment of Rubeotic Glaucoma Memarzade S, Fanous M, Friberg T. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S483. Abstract nr 2236, 1995</p>	<p>Five patients with rubeotic glaucoma from proliferative diabetic retinopathy or central vein occlusion who could not be managed by medical therapy were treated by transscleral diode photodestruction under retrobulbar anesthesia in the outpatient setting. Four of the five patients had a significant reduction in their intraocular pressure (mean \pmS.D. = 19\pm4 mm Hg) within 1 week of treatment. All patients were comfortable on the first postoperative day in contrast to previous patients treated with YAG cyclodestruction or cryo-cyclodestruction. Conclusion: Cyclophotocoagulation using the diode wavelength may be an excellent alternative to more conventional glaucoma therapies in the treatment of rubeotic glaucoma.</p>
<p>G-TS29 Thermographic Comparison of YAG and Diode Laser Cyclophotocoagulation in Human Autopsy Eyes Parkinson K, Tingey D, Quinn R. Department of Ophthalmology, Univ. of Western Ontario; London, Ontario Canada [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S559. Abstract nr 2595, 1995</p>	<p>The purpose of this study was to compare the thermal effects of transscleral contact YAG and 810 nm diode laser cyclophotocoagulation on the ciliary body. Seven human autopsy eyes were treated with varied power and duration of each laser. Maximum temperature, time to decay to 25 degrees centigrade and area of maximal isotherm were compared. Time to decay at settings of 2 Watts with a duration of 2 seconds were 10.93 seconds for the diode versus 7.11 seconds for the YAG laser. Time to decay at settings of 3 Watts and a duration of 3 seconds were 17.38 seconds for the diode and 13.31 seconds for the YAG. These</p>

	<p>differences were statistically significant. Maximum temperature and maximum area were not statistically different between the two lasers. Conclusion: The different decay times for the YAG and the diode laser may reflect wavelength dependent differences in tissue interaction.</p>
<p>G-TS30 Diode Laser Transscleral Cyclophotocoagulation in Early Refractory Glaucoma Leoni G, Luppi MD, Penne A. Department of Ophthalmology, S. Antonio Abate Hospital; Gallarate, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S559. Abstract nr 2597, 1995</p>	<p>Twenty-three eyes of 23 patients (mean age 58±6.2) with good visual acuity (VA range 20/100 to 20/20) were treated with the IRIS Medical OcuLight SL laser with a quartz glass fiber optic (G-Probe). All eyes were treated with 20 spots over 360° using 4.5 J (3W x 1.5s). Before and during the follow-up period (14.2±2.6 months), patients underwent IOP, VA and VF Humphrey central 30 - 2 testing. Results were analyzed using Mann-Whitney Test. The mean pre- and post-treatment IOPs were 41±9.1 and 16.2±5.1 mm Hg respectively (p<0.001). Seventy-nine percent reached an IOP below 20 mm Hg. VA showed no significant change: mean initial and final VAs were 0.59±0.41 (range 0.3 - 1.0) and 0.58±0.39 (same range) (p=0.15). VA remained stable in 20 eyes while decreasing two or more lines in three eyes: one for uncontrolled IOP, two for cataract evolution. Seventeen eyes reached VF parameters stabilization after treatment; four had progressive glaucomatous VF loss, while in two eyes a diffuse reduction of retinal sensitivity was found. No major complications were observed. Conclusion: This study suggests that 810 nm diode laser CTCP is an effective and safe technique for the treatment of seeing eyes with early refractory glaucoma.</p>
<p>G-TS31 Effectiveness of Diode Transscleral Cyclophotocoagulation (TSCPC) for Neovascular Glaucoma Kurumety UR,¹ Barbour MM,² Gaasterland DE.² ¹Georgetown Univ. Medical Center, ²University Ophthalmic Consultants of Washington [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S560. Abstract nr 2601, 1995</p>	<p>Ten sequential eligible eyes (eight patients) were treated with the IRIS Medical OcuLight SLx diode laser (810 nm) system and G-Probe fiberoptic delivery with 7 to 19 laser applications at 1.5 to 2.25 W and 2.0 to 3.0 second duration. Results: Neovascular glaucoma was secondary to diabetic retinopathy in five, CRVO in two, CRAO in one, and aphakia with uveitis in one. Six had previous PRP. At entry, mean IOP was 58 mm Hg (± 12.6 SD, range 33 to 76), nine eyes were painful, three eyes had vision 20/80 or better and six had CF, HM, or LP. After an average follow-up of 11 months (range 1-20, median 12) one treatment lowered IOP to ≤13 mm Hg in two eyes; a second treatment lowered IOP 59 ≤18 in two more. After one or two treatments, IOP had decreased ≥ 47% in seven eyes, and seven of nine painful eyes became pain-free. Two painful eyes had filtering surgery for persistent IOP elevation. Vision did not worsen in five eyes; two eyes dropped from HM or CF to NLP. One eye developed a postoperative hyphema, which cleared spontaneously within days. None developed atrophial or phthisis bulbi. Conclusion: Contact diode laser TSCPC reduces pain and IOP in a meaningful proportion of eyes with neovascular glaucoma.</p>



<p>G-TS32 Diode Laser Transscleral Cyclophotocoagulation with a Modified G-Probe™ Tip Barbour MM,¹ Gaasterland DE,¹ Pollack IP,² Shields MB,³ Boutacoff TA⁴. ¹University Ophthalmic Consultants of Washington,²Sinai Hospital-Balti, ³Duke Univ.,⁴IRIS Medical Instruments; Mountain View, CA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S560. Abstract nr 2602,1995</p>	<p>Eighteen eyes (18 patients) with medically uncontrolled, severe glaucoma were treated with the IRIS Medical OcuLight SLx diode laser system. Treatment parameters: starting power 1.75 W, range 1.5 to 2.0 W, duration 2.0 seconds, 18 applications (range 16 to 21) to 270° omitting the temporal quadrant. Observations from 6 weeks are compared with results from 30 eyes treated with the flat-tipped fiberoptic G-Probe as reported at 1992 ARVO (See G-TS6, pg. 66).</p> <table border="1"> <thead> <tr> <th></th> <th>Hemispheric-tipped design (30 eyes)</th> <th>Flat-tipped design (18 eyes)</th> </tr> </thead> <tbody> <tr> <td>Race: White</td> <td>14/18 (78%)</td> <td>18/30 (60%)</td> </tr> <tr> <td>Race: Black</td> <td>4/18 (22%)</td> <td>11/30 (37%)</td> </tr> <tr> <td>Number of pops</td> <td>mean 3.2</td> <td>mean 3.6</td> </tr> <tr> <td>Scleral burns</td> <td>3/18 (17%)</td> <td>12/30 (40%)</td> </tr> <tr> <td>Six Week IOP</td> <td>34.4 mm Hg to 20.2 41% less than baseline</td> <td>36.1 mm Hg to 21.1 42 % reduction</td> </tr> <tr> <td>Best corrected VA unchanged (± 1 line) or improved</td> <td>83%</td> <td>87%</td> </tr> </tbody> </table> <p>Both groups had fewer prescribed medications and no phtthisis or atrophy.</p> <p>Conclusion: TSCPC with either a hemispheric or flat-tipped fiberoptic in the G-Probe is equally effective in IOP reduction. The hemispheric probe causes fewer conjunctival surface burns.</p>		Hemispheric-tipped design (30 eyes)	Flat-tipped design (18 eyes)	Race: White	14/18 (78%)	18/30 (60%)	Race: Black	4/18 (22%)	11/30 (37%)	Number of pops	mean 3.2	mean 3.6	Scleral burns	3/18 (17%)	12/30 (40%)	Six Week IOP	34.4 mm Hg to 20.2 41% less than baseline	36.1 mm Hg to 21.1 42 % reduction	Best corrected VA unchanged (± 1 line) or improved	83%	87%
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<p>G-TS33 Does Diode Laser Contact Transscleral Cyclophotocoagulation Produce Scleral Thinning? An Ultrasound Biomicro-scopical In Vivo Study of Human Eyes Verdi M, Carassa RG, Bettin P, Fiori M, Brancato R. Department of Ophthalmology and Visual Sciences, Scientific Institute H S. Raffaele; Univ. of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S565. Abstract nr 2628, 1995</p>	<p>Fifty-four patients were examined preoperatively and 3 months after an 810 nm diode laser contact transscleral cyclophotocoagulation (CTCP) session using an ultrasound biomicroscope (UBM, Humphrey-Zeiss), coupled with a 50 MHz probe. Four images, centered on the treated area, were taken for each eye and the scleral thickness was measured with the built-in caliper. Mean baseline scleral thickness was 0.833±0.072 mm. Mean final scleral thickness was 0.827±0.068 mm (t-test, p=0.17; n.s.). Though macroscopic and slit-lamp examination of some treated eyes revealed the presence of areas of apparent scleral alteration in correspondence with the sites of laser treatment, no focal thinning was detected on UBM examination. Conclusions: Diode laser CTCP does not produce focal scleral thinning. The alterations which sometimes become visible a few months after the laser treatment are not related to localized scleromalacia, but rather to scleral pigmentation.</p>																					
<p>G-TS34 Locating the Ciliary Body in Buphthalmic Eyes: Relevance for Cyclophotocoagulation Pfeiffer N, Münnich S, Lieb W, Grehn F. Universitäts-Augenklinik; Mainz, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S837. Abstract nr 3856, 1995</p>	<p>The authors performed transillumination in 19 buphthalmic eyes of 11 patients. Mean age was 4.8±5.1 years (range from 1 month to 15.9 years). The light source was put as far as possible into the posterior fornix in order to visualize the ciliary body at the opposite side of the globe. In all four quadrants the following distances were measured: the visible limbus to anterior border of ciliary body, the width of the pars plicata, and the visible limbus to ora serrata. The distance of the visible limbus to anterior border of ciliary body was largest in the superior and smallest in the inferior quadrant. Measures correlated weakly with axial length and horizontal corneal diameter. Conclusion: In buphthalmic eyes the location of the ciliary body is very variable, and its anterior border shows a great interindividual variation. In many cases, the limbus seems to be enlarged. Conclusion: When treating such eyes with CPC, transillumination seems very helpful to locate the pars plicata.</p>																					



<p>G-TS35 Control of Intraocular Pressure by Transscleral Diode Laser Ablation of the Ciliary Body in Advanced Refractory Glaucoma Bloom PA, Sharma K, Tsai J, Miller MH, Khaw PT, Rice NS, Hitchings RA. Glaucoma Service, Moorfields Eye Hospital Trust; London, England [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S837. Abstract nr 3857, 1995</p>	<p>One-hundred and twenty eyes of 112 patients aged 3 - 88 years (mean 50 years) were treated by transscleral diode laser cycloablation using a contact probe, then followed-up for between 6 weeks and 30 months (mean 36 weeks). All patients received maximum tolerated medicines before treatment. The causes of glaucoma were: aphakia (24%), silicone oil (14%), neovascularization (12%), congenital (11%), traumatic (7%), chronic angle closure (9%), chronic open angle (9%) and others (14%). In 48% of eyes more than one treatment was given (range two to four), with an overall mean of 1.9 treatments per eye. Mean pre-treatment IOP was 37.2 mm Hg (± 10.4 mm Hg). IOP reduced following treatment in 91% of eyes; mean IOP reduction for all eyes was 19 mm Hg at 1 week, 12 mm Hg at 1 month and 15 mm Hg at 4 months. Mean IOP at last follow-up was 20.6 mm Hg (± 9.4 mm Hg), and mean total medications had reduced from 2.2 to 1.8. Phthisis followed treatment in two eyes (1.7%), but there were no other serious complications. Conclusions: Diode laser cycloablation appears simple, safe and effective at controlling IOP in eyes with advanced refractory glaucoma.</p>
<p>G-TS36 Cyclophotocoagulation in the Treatment of End-Stage Glaucoma Pollack I. Presentation. Age-Related Macular Degeneration Course. Wilmer Ophthalmological Institute at Johns Hopkins; Baltimore, MD January 20-21, 1995</p>	<p>An historical summary of surgical techniques that have been devised to produce ciliary body destruction: from 1956, when photocoagulation of the eye was first introduced by Meyer-Schwickerath, to the introduction of the ruby laser, to the Nd:YAG laser, to the diode laser. Dr. Pollack concludes his presentation highlighting the contact diode laser as being an effective way to treat end-stage glaucoma. It is easier to use, less costly, and more portable than the non-contact Nd:YAG laser and appears to cause less pain, swelling, and discomfort. It is still complicated by postoperative uveitis, occasional cases with hypotony or failure to achieve satisfactory IOP reduction. The laser shows great promise and may end up being the treatment of choice for refractory glaucoma.</p>
<p>G-TS37 Long-term Results of Diode Laser Cyclo Photocoagulation in Secondary Angle Block of Glaucoma Hille K, Waibel C, Weindler J, Palmowski A, Ruprecht K. D.O.G. Meeting. Heidelberg. Mannheim/ Heidelberg September 1995. German J Ophthalmol 1(Suppl):144, 1995</p>	<p>Fifty-four eyes of 51 patients with secondary angle block glaucoma responding inadequately to medical treatment, were treated consecutively with transscleral diode (810 nm) laser cyclophotocoagulation using the IRIS Medical OcuLight laser console and G-Probe. The curvature and dimensions of the G-Probe enabled the physician to deliver 17 applications evenly spaced over 270° centered 1.2 mm behind the surgical limbus. Power was set at 1750 mW with 2 second durations. Intraocular pressure and visual acuity were noted preoperatively, 1 week, 6 weeks, 6 months and more than 1 year postoperatively. Maximal follow-up was 22 months (mean: 6.14). Mean intraocular pressure was 41.5 mm Hg (± 11.2) initially, 21 mm Hg (± 9.4) immediately postoperatively, 20 mm Hg (± 11) after 6 weeks and 18 mm Hg (± 7.5) after 6 months. Mean intraocular pressure at the final visit was 18 mm Hg (± 10.25). In 12 patients (22%) a second cyclophotocoagulation had to be performed after a mean of 7 weeks. Only six patients (11%) did not obtain satisfactory levels of IOP. There were no serious complications, and phthisis bulbi was not induced. Conclusion: TSCPC using the diode laser is a safe and efficient operative procedure leading to long-term reduction of IOP in patients with secondary angle block glaucoma responding inadequately to medical treatment.</p>



<p>G-TS38 Diode Laser versus Contact Transscleral Nd:YAG Cyclophotocoagulation (CPC) for Uncontrolled Glaucoma Klein S, Rockwood EJ, Baerveldt G. Division of Ophthalmology, Cleveland Clinic Foundation, Cleveland, OH [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S261. Abstract nr 1192, 1996</p>	<p>A review and comparison was performed between all transscleral contact Nd:YAG CPC's performed by one surgeon between 1991 and 1994, and diode laser CPC's performed from 1994 to 1995. Analyses included success rates, (IOP \leq 21 mm Hg and no other glaucoma procedure), pre- and postoperative IOP level, number of pre- and postoperative medications and complication rates. Successful control of IOP occurred in 12 of 24 (50%) diode patients and in 11 of 30 (37%) Nd:YAG patients after 1 CPC. With a second treatment, success rates improved to 15 of 24 (63%) in diode and 16 of 30 (53%) in Nd:YAG patients. Mean IOP decrease was 18.6 mm Hg in diode patients and 16.8 mm Hg in Nd:YAG patients. Mean follow-up was 5 months for diode and 12 months for Nd:YAG. VA was maintained in 92% of diode patients and 88% of Nd:YAG patients. Medication to control IOP was reduced from a mean of 2.9 to 1.9 in successful diode patients and from 2.1 to 1.3 in the Nd:YAG group. There was one case of phthisis in the diode group and one (after a second treatment) in the Nd:YAG group. One corneal graft failure occurred in the diode group after a severe fibrinoid anterior segment inflammatory reaction following the laser treatment. Conclusion: Diode laser has slightly higher initial and repeat success rates vs. Nd:YAG laser for CPC.</p>
<p>G-TS39 Contact Transscleral Cyclophotocoagulation (CTCP) with Diode Laser: A Long-Term Follow-Up Study Carassa RG, Brancato R, Bettin P, Fiori M, Durante A. Department of Ophthalmology and Visual Sciences, Scientific Institute H.S. Raffaele, Univ. of Milano, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S261. Abstract nr 1193, 1996</p>	<p>To assess the long-term clinical effectiveness of diode laser CTCP, the authors treated 70 seeing eyes and 20 blind and painful eyes suffering from refractory glaucoma using a diode laser coupled with a fiberoptic probe ending in a focusing tip. All eyes were treated with 16-20 spots over 360°, 1.5 mm posterior to the limbus, using from 2.5 to 3.8 J of energy per spot depending on the laser used. Up to four treatments were performed at 1 month intervals in case of insuccess. In the last 2 years, eyes were examined by ultrasound biomicroscopy before and after CTCP so as to determine the correct treatment site, to point out the effects on the ocular tissues, and to search for ciliary body residuals before retreatments. Mean\pmSD follow-up was 28.3\pm12.9 months (range 8-50). The mean\pmSD pre- and post-treatment IOPs were 35.9\pm10.7 and 18.5\pm7.4 mm Hg in seeing eyes and 49.2\pm12.7 and 23.6\pm14.2 mm Hg in blind eyes, respectively. Pre- and post-CTCP VA were 0.16\pm0.22 and 0.13\pm0.21 respectively. Defining success as the achievement of an IOP $>$2 and \leq21 mm Hg in seeing eyes and the remission of pain in blind eyes, we had 78.6% of success in seeing eyes and 96.5% of success in blind eyes. Complications included one vitreous hemorrhage and two cases of late phthisis. No lesion of conjunctiva, sclera and lens was ever detected by optical and ultrasound biomicroscopy. No signs of sympathetic ophthalmia were seen. According to present study, diode laser CTCP is an effective and safe procedure to treat refractory glaucoma.</p>
<p>G-TS40 Clinical Comparison of Semiconductor Diode versus Neodymium: YAG Non-Contact Cyclo Photocoagulation Ulbig MW, McHugh DA, McNaught AI, Hamilton AM. Br J Ophthalmol 79:569-574, 1995</p>	<p>Forty patients with refractory glaucoma were randomized to receive either 810 nm diode or 1064 nm Nd:YAG therapy. The IOP and inflammatory response to treatment were monitored over 3 months. Results: There was no significant laser related difference in the effect on IOP after one treatment. There was, however, a difference in effect in retreatments with the IOP lowering effect significantly less, but equally sustained in diode retreatment patients. Severe postoperative complications such as hyphema or fibrinous anterior uveitis only occurred in the Nd: YAG group.</p>

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	<p>Conclusion: The degree and duration of the ocular hypotensive response to cyclophotocoagulation appears to be related to the available power output of the system used, and the extent of tissue damage.</p>
<p>G-TS41 Transscleral Contact Diode Laser Cyclophotocoagulation in Refractory Glaucoma Hamard P, Gayraud JM, Kopel J, Valtot F, Hamard H, Haut J. Centre Hospitalier National d'Ophthalmologie des Quinze-Vingts, Paris, France. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S263. Abstract nr 1203, 1996</p>	<p>To examine the effects of transscleral contact cyclophotocoagulation (TSCCP) with diode laser for refractory glaucoma with respect to intraocular pressure (IOP), reduction of medical therapy and complications, the authors used the 810 nm diode laser system (IRIS Medical Instruments, OcuLight SLx) to treat 48 eyes of 45 patients with therapy resistant glaucoma and a poor prognosis with filtering surgery. All eyes had topical glaucoma medication and 36 (80.0%) patients were using carbonic anhydrase inhibitors. Laser energy was delivered to the eye through a quartz glass fiberoptic probe (G-Probe) 13 to 20 spots over 270° using 3.5 J (1.75 W x 2.0 s). A follow-up of 12 months was obtained for all patients. IOP decreased from baseline mean of 32.7±9.2 mm Hg to 19.5±9.3 mm Hg at 12 months (p<0.001) with 1 or 2 cyclophotocoagulations. An IOP below 20 mm Hg was obtained in 33 (68.7%) of the 48 eyes. In 13 patients (36%) carbonic anhydrase inhibitors were discontinued. Four of six painful eyes had a relief of pain. VA decreased in 10 eyes (20.8%): cataract progression (5 eyes), uncontrolled IOP (3 eyes), glaucoma progression despite IOP below 20 mm Hg (1 eye), and corneal dystrophy (one eye). Chronic uveitis occurred in five eyes (10.41%) and hypotony in one eye with neovascular glaucoma. No conjunctival, scleral, or lens damage was detected. Conclusion: TSCCP with diode laser can be successfully used to reduce IOP in therapy resistant glaucoma. The incidence of complications is low with no cyclo-destruction related loss of vision.</p>
<p>G-TS42 Cyclophotocoagulation: A Comparative Study Using Two Different Wavelengths, Nd:YAG (1064 nm) and Diode (810 nm) Campbell K. Grant Laser Center, Columbus, OH. Abstract. American Society for Laser Medicine and Surgery. Lasers Surg Med. 8(suppl):94, 1996</p>	<p>A retrospective study of 20 patients was conducted to compare the cost and patient outcomes of cyclophotocoagulation using the Nd:YAG versus the infrared diode laser. The diode laser results indicate increased patient comfort levels due to decreased inflammation, decreased intraocular pressures for longer time increments, and fewer repeat procedures in comparison to Nd:YAG. There is also a cost reduction with the use of the diode laser.</p>
<p>G-TS43 Combined Transscleral Diode Laser Cyclophotocoagulation and Transscleral Retinal Photocoagulation for Refractory Neovascular Glaucoma Tsai J, Bloom P, Franks W, Khaw P. Retina 16:164-166, 1996</p> <p><i>Also listed as RTD-TS24, pg. 193</i></p>	<p>The authors report their experience with combined transscleral diode laser ablation of the ciliary body and retina for refractory neovascular glaucoma. The OcuLight diode (810 nm) laser (IRIS Medical) was used with different transscleral probes for cyclophotocoagulation (IRIS Medical G-Probe) and for retinal photocoagulation (IRIS Medical DioPexy Probe). Details of two case studies are discussed. Retrobulbar anesthesia was administered using a 1:1 mixture of 0.5% bupivacaine and 2% lidocaine. For each cycloablative treatment, a total of 40 burns were placed over 360° with a power of 1.5 Watts and a duration of 1.5 seconds. Laser settings for retinal photocoagulation were 1.4 to 2.0 Watts power and 1.0 to 1.5 seconds duration. The authors were able to obtain demonstrable regression of iris neovascularization in patients with ocular media opacities, precluding effective transpupillary panretinal photocoagulation. In 25 previous eyes with NVG treated with diode cycloablative laser treatment only, the authors had not observed a marked improvement in rubeosis. Furthermore, combined transscleral diode treatment of the ciliary body and retina seems to induce only minimal inflammation and pain</p>

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	<p>compared with the authors' previous experience using combined transscleral ciliary body and retinal cryotherapy. This would appear to be a major advantage of this new combined treatment. If future surgery requiring minimal conjunctival damage (e.g., trabeculectomy or drainage tube implant surgery) is necessary, a reduction in conjunctival damage may be an advantage. Therefore, combined transscleral diode laser cycloablation and retinal ablation shows promise as a treatment option in patients with refractory neovascular glaucoma with media opacities limiting adequate transpupillary retinal photocoagulation. Long-term prospective studies investigating this combined treatment modality are needed and currently are in progress at Moorfields Eye Hospital, London, England.</p>
<p>G-TS44 Diode Laser Transscleral Cyclophoto-coagulation in Refractory Glaucoma Johnstone M, Wellington D. Abstract 503. ASCRS. Seattle, WA. June 1-5, 1996</p>	<p>The authors evaluated the efficacy of diode laser TSCPC as a treatment modality for refractory glaucoma. A total of 34 consecutively treated eyes (33 patients) between 10/21/94 and 10/2/95 were included in this study. All eyes had severe advanced glaucoma uncontrolled medically with visual acuity in the 20/200 to LP range. TSCPC was administered with the IRIS Medical OcuLight SL diode (810 nm) laser system and delivery was accomplished with the contact fiberoptic IRIS Medical G-Probe. All eyes were treated with 17 applications over 360° using 2 Watts for a duration of 2 seconds. The mean pretreatment IOP was 39.9 ± 13.3 (range 19 to 78) mm Hg. Two eyes required further treatment (trabeculectomy and repeat TSCPC) prior to the third month of follow-up interval. The mean post-treatment pressures were 23.5 ± 14.5 mm Hg at 1 month and 21.0 ± 11.0 (3 - 50) mm Hg at 3 months. The mean IOP reduction for the 32 eyes included in the study at 3 months was 19.5 mm Hg. Sixteen eyes (50%) had IOP's below 20 mm Hg. Three of the 32 eyes went on to have repeat TSCPC subsequent to the 3 month follow-up interval. No phthisis was encountered during the study interval. Conclusion: TSCPC with the diode laser appears to be a relatively effective method for reducing discomfort and high IOP in eyes with advanced refractory glaucoma.</p>
<p>G-TS45 A Different Approach in the Treatment of Refractory Glaucoma Contact Diode Laser Cyclophotocoagulation Cherestes I. Hospital of district Covasna, Romanya Abstract 9-26. European Glaucoma Society. June 19-22, 1996</p>	<p>The intent of this study was to evaluate the effects of contact diode cyclophotocoagulation (CPC) on ocular hypotension, pain, and the incidence of side effects. The principal inclusion criteria was glaucoma that had not been adequately controlled by topical drugs and for which drainage surgery had not been thought appropriate. The patients' age was from 9 to 70 years. The most common diagnosis was absolute painful glaucoma (seven patients). Other diagnoses were: proliferative diabetic retinopathy with iris neovascularization (three patients), open angle glaucoma (two patients), aphakia (one patient), pseudophakia (one patient) and congenital glaucoma in which filtration surgery has failed (one patient). All patients were treated with the IRIS Medical continuous-wave semiconductor diode laser emitting at 810 nm. All exposures were applied with the specialized tip via a quartz fibre-optic contact probe (G-Probe). Local and topical anaesthesia was provided by a combination of retrobulbar injection of 4 ml 2% lidocaine and alcaine (0.5% proparacaine hydrochloride). The eyes were treated with a mean of 20 exposures over 180°, with the edge of the probe being placed adjacent to the limbus (1.5 mm). The exposures were thus targeted over the pars plicata region of the ciliary body. The</p>

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	<p>powers selected ranged between 1.2 and 2.0 W (mean 1.5 W) and the exposure time was 2 s. Post-treatment evaluation was carried out at 1 hour, daily for 1 week, at 1 month, and at 3 months. Postoperatively, all patients were treated with 0, 1 % dexamethasone or Tobradex (tobramicin and dexamethasone) eye drops 6 times a day for 1 week. If at 1 month the hypotensive effect was considered inadequate, a new CPC was made.</p> <p>Results:</p> <ol style="list-style-type: none"> 1. There was a significant decrease of postoperative IOP in 10 of 15 patients (from 60 mm Hg to 20 mm Hg) after 1 month. Two patients were retreated after 1 month. 2. CPC was successful in relief of pain in six patients with absolute painful glaucoma. 3. Evaluation of visual acuity measurements recorded before and following treatment was inconclusive due to the very poor pre-treatment levels, which reflected the advanced stage of the disease. 4. Post-operative ocular complications occurred in three patients. All of them had a hyphema.
<p>G-TS46 Diode Laser Transscleral Cyclophoto-coagulation in Advanced Refractory Glaucoma Ruangvaravate N, Metheetrairut A, Tuchinda R. Department of Ophthalmology, Siriraj Hospital, Mahidol Univ., Bangkok, Thailand. Mid-year Thai Meeting. July, 1996</p>	<p>Thirty-three eyes of 32 patients with severe medically uncontrolled, high surgical risk glaucoma, were treated with the OcuLight diode (810 nm) laser and transscleral contact G-Probe. Each eye received 12 laser applications on 180°, centered 1.2 mm behind the surgical limbus. Power ranged from 1.2 to 2 Watts with a duration of 2.0 seconds. Mean pretreatment intraocular pressure (IOP) was 37 mm Hg; mean post-treatment IOP was 17 mm Hg at 6 months (range of follow-up 2 to 13 months). Five eyes (15.2%) had complete success (IOP ≤ 21 mm Hg without medications), 17 eyes (51.5%) had relative success (IOP ≤ 21 mm Hg with medications), and 11 eyes (33.3%) had fail-response (IOP ≥ 21 mm Hg with medications). The vision was stable in 26 eyes (78.9%) and decreased in 7 eyes (21.2%). Treatment caused mild inflammation and minimal discomfort; phthisis occurred in 1 eye (3%) Conclusion: Diode laser transscleral cyclophotocoagulation is an effective treatment for advanced glaucoma.</p>
<p> G-TS47 Long-Term Outcome of Initial Ciliary Ablation with Contact Diode Laser Transscleral Cyclophotocoagulation for Severe Glaucoma Kosoko O, Gaasterland D, Pollack I, Enger C, The Diode Laser Ciliary Ablation Study Group: Abrams D, Belcher CD, Gaasterland D, Liebmann J, Pollack I, Ritch R, Schuman J, Shields MB, Wise J. Ophthalmology 103:1294-1302, 1996</p>	<p>Twenty-seven eyes of 27 patients with medically and surgically uncontrollable glaucoma and no previous ciliary ablation enrolled in this study. After baseline measurements and informed consent, the authors performed contact TSCPC. There were 14 pseudophakic, 7 aphakic, and 6 phakic eyes: 15 of these had primary open-angle glaucoma and the remainder had various secondary or open-or closed-angle glaucomas. Median follow-up was 19 months (range, 6 weeks to 27 months). Initially after laser surgery, glaucoma medications were continued, except for a 2-week interruption of miotic; the ophthalmologist later adjusted medications in accordance with the patient's status. The authors define failure of TSCPC in two ways, based on IOP measurements during two consecutive study examinations 6 weeks or more after intervention or at the final examination: (1) less than 20% intraocular pressure (IOP) reduction from baseline, and (2) either less than 20% reduction of IOP from baseline or IOP greater than 22 mm Hg. With failure definition 1, with cumulative probability of success was</p>

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	<p>84% at 1 year and 62% at 2 years. With failure definition 2, the cumulative probability of success was 72% at 1 year and 52% at 2 years. At the last examination, 19 eyes (70%) had visual acuity improved within one line of visual acuity at eligibility. One of these eyes, with light perception vision at entry, declined to no light perception. Three eyes (11%) lost two lines of vision and five (19%) lost three or more lines. Conclusion: Contact diode laser TSCPC yields long-term improvement of IOP and preservation of visual acuity in a substantial proportion of eyes with severe, medically uncontrolled glaucoma.</p>
<p>G-TS48 Effectiveness of Semiconductor Diode Laser Transscleral Cyclophotocoagulation in Refractory Glaucoma Aikawa H,¹ Mito T.² ¹Eye Clinic, NTT Tohoku Hospital, ²Department of Ophthalmology, Tohoku University School of Medicine, Japan Journal of the Eye 13(7):1103-1106, 1996</p> <p>Abstract - English/Japanese Article - Japanese</p>	<p>The authors studied the effectiveness of semiconductor diode laser transscleral cyclophotocoagulation in patients with refractory glaucoma comprising two cases of neovascular glaucoma, two of secondary glaucoma and one of congenital glaucoma. Mean pretreatment intraocular pressure (IOP) was 48.8±11.5 mm Hg (range: 30 to 58 mm Hg). Diode laser was used at 2.0 W power and 2 second duration, with 15 to 20 burns placed 1.5 mm posterior to the corneoscleral limbus over 3 quadrants. In 3 of the 5 eyes, IOP was well controlled below 20 mm Hg for 19 months. These findings suggest that semiconductor diode laser transscleral cyclophotocoagulation may control IOP for longer periods.</p>
<p>G-TS49 Transscleral Cyclophotocoagulation in Neovascular Glaucoma Lima FE, Ávila M, Ribeiro C. Revista Brasileira de Oftalmologia. 55(8):627-633, 1996</p> <p>Abstract - English/Spanish Article - Spanish</p>	<p>To evaluate the efficacy in reducing intraocular pressure (IOP) with diode laser contact TSCPC in neovascular glaucoma, the authors studied, retrospectively, 22 eyes of 22 patients affected by uncontrolled neovascular glaucoma secondary to retinal ischemia who underwent diode laser contact TSCPC, between 1991 and 1994. All eyes were treated with 16 spots over 360°, 1.5 mm posterior to the limbus, using 3.9 J (2.6 W x 1.5 s). The follow-up ranged from 6 to 36 months (mean 13.8±8.8 months). The mean pre and post-treatment IOPs were 42.5±10.2 and 29.9±16.5 mm Hg, respectively (p<0.001). Defining success as the achievement of an IOP lower than 21 mm Hg in seeing eyes and the remission of pain in blind eyes, the authors found 33% of success among seeing eyes and 85% of success among blind eyes. Postoperative complications included mild to moderate inflammatory reaction (84%), early transitory ocular hypertension (44%), pain (9%), phthisis bulbi (9%), vitreous hemorrhage (4%), hypotony (4%) and hyphema (4%). Transscleral diode laser cyclophotocoagulation is effective in lowering IOP and relieving pain in eyes with neovascular glaucoma, although loss of visual acuity remains an important concern.</p>
<p>G-TS50 A Matched Comparison between Tube Surgery, Nd:YAG and Diode Laser Cyclophotocoagulation in the Management of Refractory Glaucoma Bloom P, Nouredin BN, Sharma K, Hitchings RA, Khaw PT. Scientific Poster. 220. AAO. Chicago, IL October, 1996</p>	<p>Forty-five patients with uncontrolled glaucoma treated by Nd:YAG laser cyclophotocoagulation were compared with two matched groups of 45 patients; one group received tube surgery, the other transscleral diode laser cyclophotocoagulation. Mean pre-treatment intraocular pressures (IOP) were 38.6, 41.3, and 37.3 mm Hg for the YAG, tube and diode groups; mean posttreatment IOPs were 20.0, 15.9, and 18.8 mm Hg respectively, at minimum 12 months follow-up. Cost of both laser treatments was less. Tubes had more complications (including one phthisis). All treatments lowered IOP significantly. Cyclophotocoagulation is less effective than tubes, but safer and cheaper.</p>

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<p>G-TS51 Transscleral Diode Cyclophotocoagulation Nagpal PN, Sharma RK, Hindocha CR. Indian Ophthalmology - Proceedings: 54th All India Ophth. Conf. Chandigarh: 210-213, 1996</p>	<p>A prospective study in which 12 eyes with intractable glaucoma underwent TSCPC with the IRIS Medical G-Probe. The power was kept at 1200-1500 mW, duration was 0.9-1 sec., and an average of 15 applications were applied. The results were assessed by the fall in the IOP, the decreased requirement of medications and the relief of pain, if any. Any complications or change in the visual acuity post-op were also noted. Results: At final 6 months post-op follow-up, 5 out of 12 patients (41.6%) had an IOP less than 21 mm Hg with medical treatment. The average IOP decreased from 40.92 mm Hg to 28.83 mm Hg at the end of 1 month, and 25.17 mm Hg at the end of 6 months. The average number of medications decreased from 2.1 to 1.8. There was a remarkable decrease in pain in 5 out of 8 patients (62.5%). One patient showed a steep rise in IOP associated with pain, in spite of the treatment. No major complication occurred due to the procedure. Conclusion: TSCPC is a useful alternative to other available modes of cyclo-destruction. It is less painful and devoid of major complications.</p>
<p>G-TS52 Contact Transscleral Cyclophotocoagulation with Diode Laser in Refractory Glaucoma. A Mid-Term Follow-up Study Hamard P, Gayraud JM, Kopel J, Valtot F, Quesnot S, Hamard H. J French Ophthalmol. 20(2):125-133, 1997</p> <p>Abstract - English/French Article - French</p>	<p>The 810 nm OcuLight photocoagulation system was used to treat 50 eyes of 47 patients with therapy resistant glaucoma and a poor prognosis with filtering surgery. All eyes had maximal hypotonic therapy and 40 (82%) patients were using carbonic anhydrase inhibitors. Laser energy was delivered to the eye through the G-Probe using 3.5 J. Mean follow-up was 19.4±9.1 months (12 to 29 months). IOP significantly decreased from mean baseline 32.4±9.1 mm Hg to 19.7±8.1 mm Hg at the end of the follow-up (p<0.001). An IOP below 20 mm Hg was obtained in 66% of the eyes. In 13 patients, the carbonic anhydrase inhibitors were discontinued. Six of the 8 painful eyes had pain relief. Visual acuity decreased in 17 (34%); cataract progression in 5 eyes, uncontrolled IOP in 4 eyes, glaucoma progression despite controlled IOP in 3 eyes, and corneal dystrophy in 3 eyes. Chronic uveitis occurred in 5 (10%) eyes. No conjunctival, scleral, or direct lens damage was detected. Contact TSCPC with the diode laser system can be successfully used to reduce IOP in therapy resistant glaucoma. The incidence of complications is low with no loss of vision related to cyclodestruction.</p>
<p>G-TS53 Transscleral Contact Diode Laser Cyclophotocoagulation for Refractory Glaucoma Mistlberger A, Tschiderer H, Ruckhofer J, Grabner G. Spektrum der Augenheilkunde. 11(2):45-48, 1997</p> <p>Abstract - English/German Article - German</p>	<p>Sixty-four eyes of 62 patients with refractory glaucoma of different etiology were treated with TSCPC using the OcuLight SLx, diode laser. Within the follow-up period from 3 to 15 months, 73% of the cases were regulated by one operation and sometimes a change of topical therapy. Only 8 eyes required one and 5 eyes required two retreatments to achieve a sufficient regulation and/or loss of pain. The complications were mild iritis, hyphema, choroidal effusion or cystoid macula edema. They could be easily managed with conservative treatment. No phthisis bulbi was observed. Compared to cyclocryotherapy, this method seems to offer a higher success rate with relatively few complications, a short surgery time and the possibility of several retreatments.</p>
<p>G-TS54 Long-Term Hypotensive Effect of Diode Laser Cyclophotocoagulation for Neovascular Glaucoma Kimura Y. Department of Ophthalmology, Gunma Univ., Maebashi, Japan ARVO Abstract. Invest Ophthalmol Vis Sci. 38(4,suppl):838, 1997</p>	<p>The purpose of this study was to evaluate the long-term outcome of ciliary ablation by contact TSCPC using an 810 nm diode laser for neovascular glaucoma and to evaluate reactions in the ciliary body of monkey eyes after experimental TSCPC. Sixty-three eyes with neovascular glaucoma were treated with TSCPC. Causative lesions were diabetic retinopathy 51 eyes, central retinal vein occlusion 6, central retinal artery occlusion 3, and 3 others. The 810 nm, OcuLight photocoagulation system</p>

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	<p>was used with a contact G-Probe delivery device. Each eye received 15-18 laser applications over the pars plicata 1.0-1.2 mm behind the limbus, at a power output of 1.4 - 1.8 W and duration of 2 seconds each. Retreatment was performed for 39 of the 63 eyes. Follow-up ranged 12-36 months, average 22 months. Additionally, 8 eyes of Japanese monkeys were treated similarly with TSCPC at the power output of 1.4-1.8 W to the pars plicata and at the power output of 0.8 - 1.2 W to the pars plana. At the end of follow-up, 46 of 63 eyes (73%) maintained IOP under 21 mm Hg with or without systemic medication, and 34 eyes (54%) had IOP under 21 mm Hg with or without topical medication. Nine eyes lost two or more lines of vision. No eye became phthisic following TSCPC. Following TSCPC to the pars plana in monkeys, ultrasound biomicroscopy (UBM) showed intense reflex in the subepithelial area immediately after treatment. UBM also showed ciliary detachment 3 days after treatment in the treated eyes. There was no ciliary detachment 3 days after TSCPC applied to the pars plicata only. Conclusions: TSCPC to the pars plicata using diode laser with contact probe induced long-term control of IOP in 73% eyes with neovascular glaucoma. TSCPC to the pars plana in monkey eyes caused ciliary detachment.</p>
<p>G-TS55 Diode Laser Transscleral Cyclophotocoagulation in the Treatment of Glaucoma After Vitreo-Retinal Surgery with Silicone Oil Injection Montanari P, Marangoni P, Pinotti D, Ratiglia R, Miglior M. 1st Institute of Ophthalmology of the Univ. of Milan Ospedale Maggiore di Milano IRCCS. Glaucoma Research and Study Center [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S170. Abstract nr 841, 1997</p>	<p>In a series of 301 patients who underwent pars plana vitrectomy with silicone oil injection, 62 patients (prevalence 18.5%) had postoperative glaucoma and in 7 cases the glaucoma was refractory to all treatments (all these eyes had silicone oil removal within 3 months from vitreoretinal surgery). In these 7 cases (6 seeing eyes and 1 blind and painful eye) the authors performed transscleral cyclophotocoagulation using the IRIS Medical 810 nm OcuLight Photocoagulator. All eyes were treated with 16 spots over 360°, 1.5 mm posterior to the limbus, using 2 W of energy for 2 seconds. Mean follow-up period was 11.5±7.89 months. Five cases had only 1 treatment and 2 cases had 2 treatments. The mean pre and post-treatment IOPs were 32±3.4 and 14.8±6.6 mm Hg respectively (p=0.000). In 5 cases, (71.4%) an IOP ≤21 mm Hg was reached and in the blind eye, the remission of pain was obtained. No major complications were observed. This study suggests that diode laser TSCPC is a non-invasive, safe and effective technique in the management of glaucoma after intravitreal silicone oil injection.</p>
<p>G-TS56 A Prospective Randomized Trial of Diode and Nd:YAG Lasers in Treating Glaucoma Zweifach E, Wilensky J, Hillman I, Quinones R, Gemperli A. Department of Ophthalmology and Visual Sciences, Univ. of Illinois at Chicago [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S170. Abstract nr 844, 1997</p>	<p>Patients to be treated by transscleral cyclodestruction due to failure to respond to other modes of treatment or deemed not to be candidates for other treatments were randomized to treatment with either the Nd:YAG or diode lasers in a prospective fashion. Nd:YAG treatment consisted of 32 spots circumferentially 1.5 mm posterior to the limbus with energy of 8 W for 0.7 seconds. Treatment with the infrared diode laser utilized the G-Probe to place 24 spots with the probe edge at the limbus for 2 seconds with energy of 1500 - 2000 mW, titrated to a barely audible pop. Twenty-six patients who were randomized were included in the study. Twelve of these patients received treatment with the diode laser, and 14 with the Nd:YAG. Mean duration of follow-up was 32 weeks for the diode group (range 15-54 weeks), and 18 weeks (range 4-51 weeks) for the Nd:YAG group. Mean preoperative intraocular pressure (IOP) for the diode group was 40 mm Hg (range 20-80 mm Hg), and 30 mm Hg for the Nd:YAG group (range 20-47 mm Hg). Mean</p>

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	<p>postoperative IOP at the last follow-up examination was 15 mm Hg (range 4-33) in the diode group and 23 mm Hg (range 12-39) in the Nd:YAG group. The authors conclude that both types of lasers may be efficacious in lowering IOP; however, from this limited study it appears that the diode laser might lower IOP to a greater degree than the Nd:YAG.</p>
<p>G-TS57 Diode Laser versus Contact Transscleral Nd:YAG Cyclophotocoagulation (CPC): A Short-Term and Mid-Term Follow-up Study Youn J, Cox TA, Herndon LW, Allingham RR, Shields MB. Duke Univ. Medical Center, Durham, NC, Department of Ophthalmology [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S170. Abstract nr 845, 1997</p>	<p>To compare the short-term (1 month) and mid-term (6 months) effect of diode and Nd:YAG laser CPC, the authors retrospectively studied 60 patients who underwent diode or Nd:YAG laser CPC between 1991 and 1996. Those with at least 6 months follow-up were included in this study. Preoperative intraocular pressure (IOP) was 35.78±13.15 mm Hg in diode laser patients and 40.51±16.66 mm Hg in Nd:YAG laser patients (P=0.227). The decrease in IOP at 1 month follow-up was 15.89±15.57 mm Hg in diode and 20.34±15.71 mm Hg in Nd:YAG laser patients. The decrease in IOP at 6 months follow-up was 15.62±13.53 mm Hg in diode and 20.03±15.16 mm Hg in Nd:YAG laser patients. There was no statistically significant difference between the decrease of IOP in diode and Nd:YAG laser patients at both 1 month (P=0.283) and 6 months follow-up (P=0.238). There was no statistically significant difference in the change of visual acuity in the two groups at both 1 month (P=0.345) and 6 months follow-up (P=0.461). There was satisfactory decrease in IOP in both diode and Nd:YAG laser patients, but there was no significant difference in the decrease of IOP and the change of visual acuity in both diode and Nd:YAG laser patients.</p>
<p>G-TS58 Cyclodiode Transscleral Diode Laser Cyclophotocoagulation in the Treatment of Advanced Refractory Glaucoma Bloom PA, Tsai JC, Sharma K, Miller MH, Rice NSC, Hitchings RA, Khaw PT. Ophthalmology 104:1508-1520,1997</p>	<p>Two-hundred-ten eyes of 195 patients, ages 1 to 89 years (mean 51 years) were followed for 3 to 30 months (mean, 10 months) after cyclodiode with the OcuLight and G-Probe. Pre-treatment IOP was 34 mm Hg. The overall success rate (IOP <22 mm Hg) was 66% at 10 months (mean) follow-up. VA decreased in 59 eyes (28%), remained unchanged in 130 eyes (62%), and improved in 21 eyes (10%). Treatment parameters: 40 applications of 1.5 W applied for 1.5 seconds (2.25 J) each over 360° of the ciliary body. About half the eyes treated needed more than one treatment session in order to achieve success. Advantages of cyclodiode treatment include a reduction of the number of drugs needed to control IOP by an average of over half a medication, usually by sparing treatment with oral acetazolamide, and the low incidence rate of hypotony (1%) and phthisis (0.5%) over other cyclodestructive modalities. This study confirms the findings of previous studies involving smaller numbers of patients, and demonstrates the efficacy and relative safety of contact TSCPC to reduce IOP in patients with advanced glaucoma. Conclusion: Cyclodiode treatment is a useful tool as an adjunctive or primary treatment and is probably quicker and cheaper than more traditional methods of IOP reduction.</p>
<p>G-TS59 Transscleral Diode Laser Cyclophotocoagulation for Refractory Pediatric Glaucomas Bock CJ, Freedman SF, Buckley EG, Shields MB. J Pediatr Ophthal Strabismus 34:235-239,1997</p>	<p>Twenty-six eyes of 20 patients with therapy-resistant pediatric glaucomas were treated with the IRIS Medical OcuLight and G-Probe and followed-up for a minimum of 6 months or until time of failure. Failure was defined as IOP greater than 21 mm Hg, repeat of TSCPC, progression to another procedure, or serious complications. Baseline mean pretreatment IOP was 34.2±10.4 mm Hg. The final mean IOP for all eyes, was 21.2±10.00 mm Hg. The overall success rate was 50% after an average of 2.2±1.3 procedures per eye. Average treatment parameters were 27±8.5 applications placed over 360° with</p>

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	<p>power 2100±300 mW applied for 2.0±0.1 seconds. Postoperative inflammation was controlled with prednisolone acetate 1% or a topical steroid/antibiotic combination applied every 2 to 6 hours. Most patients received topical cycloplegia. Pain was controlled without narcotics. Conclusion: TSCPC is an effective means of decreasing IOP in some patients with refractory pediatric glaucomas. Although the retreatment rate is high (possibly due to buphthalmia or other anatomic abnormalities), the procedure generally is well tolerated with few complications.</p>
<p>G-TS60 Histopathologic Findings Following Contact Transscleral Semiconductor Diode Laser Cyclophotocoagulation in a Human Eye Feldman RM, El-Harazi SM, LoRusso FJ, McCash C, Lloyd WC, Warner PA. J Glaucoma 6:139-140, 1997</p>	<p>Contact TSCPC using the G-Probe was performed to the left eye of a 72-year-old woman who was blind from chronic angle closure glaucoma. Treatment parameters: 16 applications covering 270° with the anterior margin of the G-Probe at the limbus; power: 1180 mW; duration: 2 seconds (just under the power required to create a pop). Three days later, the patient died of acute pneumonia, and the eye was harvested 17 hours after death. Gross examination showed 16 laser treatment spots ~0.5 mm posterior to the surgical limbus externally. Gray-white circular lesions correlating with the laser spots were present on the pars plicata. The appearance of the ciliary body in the untreated areas showed no changes, and no distant effects of the laser were found. These findings confirm the G-Probe is effective in targeting the pars plicata. Its effects were localized to the site of laser treatment causing the desired destruction of the ciliary epithelium and underlying tissue.</p>
<p>G-TS61 Transscleral Diode Laser Cyclophotocoagulation on Autopsy Eyes with Abnormally Thinned Sclera Palmer DJ, Cohen J, Torczynski E, Deutsch TA. Ophthalmic Surg Lasers 23:495-500, 1997</p>	<p>In the laboratory, the superior 180° of sclera at the limbus was dissected to the level of barely visible anterior uvea and the opposite 180° of sclera served as the control in three human cadaver eyes. The G-Probe was placed at the limbus, and settings of the OcuLight laser were increased in increments from 1.0 to 9.0 J at 4 burns per setting in each location. On gross examination, circular hypopigmented lesions were seen in the ciliary body beginning at 3.0 J in thin sclera and at 5.0 J in normal sclera. On light microscopic examination of thin scleral sections, ciliary body damage began at 2.9 J and ciliary body/ciliary body epithelium (CB/CBE) damage occurred beginning at 3.5 J. In normal sclera, minimal CB/CBE changes occurred at 6.0 to 7.5 J. No scleral damage was visible in either experimental or control groups. Cycloablation energy adjustments are indicated on eyes with abnormally thin sclera to achieve similar histologic endpoints using the OcuLight laser and G-Probe.</p>
<p>G-TS62 Dose-Response Relationship of Trans-scleral Contact Cyclophotocoagulation Krott R, Diestelhost M, Zollweg M, Kriegelstein GK. Universitäts-Augenklinik Köln Ophthalmologie 94(4);273-276, 1997</p> <p>Abstract – English Article - German</p>	<p>In recent years, contact TSCPC has increasingly been used for the treatment of therapy-refractive glaucomas. The dose-effect correlation varies according to different authors. In this retrospective study, the authors tried to determine whether there is a dose-effect correlation of contact TSCPC. Following diagnosis, 124 eyes of 113 patients (age range 49.9 ± 26.5 years) were included in the study. The laser parameters used were reviewed along with the IOP before treatment, after treatment and during the follow-up (mean 6 months). Results: The IOP of 45.2% (56) of 124 eyes was < 22 mm Hg. In 25.8% (32 eyes) a retreatment was necessary. No correlation between energy and decrease of IOP was found (Prs = 0.08 nonsignificant, Spearman rank correlation). The IOP was reduced from 35.8 ± 10.5 mm Hg preoperatively to 26.3 +/- 10.5 mm Hg at the end of follow-up (P approximately 0, Wilcoxon test). Therapy could be reduced by</p>

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	<p>up to three antiglaucomatous drugs in therapy-refractive eyes. Conclusion: These data show that a decrease of about 10 mm Hg of the IOP is possible using contact TSCPC. In therapy-refractive eyes, fewer drugs were needed to reach an IOP < 22 mm Hg. Regardless of the diagnosis, a dose-effect correlation between the decrease of IOP and laser energy was not found.</p>
<p>G-TS63 Peripheral Transscleral Retinal Diode Laser for Rubeosis Iridis Flaxel CJ, Larkin GB, Broadway DB, Allen PJ, Leaver PK. Retina 17:421-429, 1997</p> <p><i>Also listed as RTD-TS30, pg. 196</i></p>	<p>Peripheral TSRPC was performed with the OcuLight 810 nm photocoagulator and DioPexy Probe in 15 eyes of 13 patients. TSRPC was performed in an attempt to promote regression of rubeosis in which the fundal view was insufficient to allow transpupillary laser panretinal photocoagulation (PRP) or to allow viewing of the transscleral PRP delivery during treatment. Mean pre-treatment IOP was 35 mm Hg. Nine of the 15 eyes were also treated with TSCPC with the OcuLight 810 nm photocoagulator and G-Probe. Mean pre-treatment IOP was 41 mm Hg. Mean follow-up was 14 months. All eyes showed regression of rubeosis. The best-corrected VA either remained the same or improved in 11 of 15 eyes (73%). The final mean IOP was 13 mm Hg in all patients (range 0 - 27 mm Hg). Of the nine eyes treated with combination therapy, six had stabilized IOP, and three developed hypotony. None of the eyes developed a peripheral retinal detachment, and one eye lost the ability to perceive light. The final mean IOP was 9 mm Hg (range 0 - 27 mm Hg). Even when TSRPC is combined with TSCPC, the inflammatory reaction is significantly less than that which occurs with cryotherapy or intraocular surgical intervention, and no studies have shown an increased risk of retinal detachment. In the event IOP is not controlled, cyclodiode treatment can be repeated; likewise, if rubeosis continues to progress, additional transscleral retinal treatment can be given with no serious adverse effects.</p>
<p>G-TS64 Cyclophotocoagulation with the Diode Laser. Study of Long-Term Results Werner A, Vick HP, Guthoff R. Augenklinik, Universitat Rostock. Ophthalmologie 95(3);176-80, 1998</p> <p>Abstract - English Article - German</p>	<p>To assess the clinical effectiveness of glaucoma therapy with diode laser cyclophotocoagulation, 106 eyes (51 eyes with primary open-angle glaucoma, 22 eyes with secondary glaucoma, 10 eyes with narrow-angle glaucoma, 23 eyes with other glaucomas) of 87 patients were treated. Using a diode laser coupled with a fiberoptic probe, ending in a focusing tip, all eyes were treated with 24-30 spots over 360° and 2.8-3.5 J of energy, 1.5 mm posterior to the limbus. The IOP was obtained over a period of time until 8-24 months after operation. Additionally, morphological changes of the ciliary body were observed in 25 eyes by means of ultrasound biomicroscopy. Results: The IOP decreased from a baseline mean of 25.0 +/- 5.7 mm Hg to 17.6 +/- 5.3 mm Hg directly after operation and increased slightly to 18.0 +/- 6.0 mm Hg in the following 24 months. Successful control of IOP (IOP constantly < 22 mm Hg or pain relief in blind eyes) occurred in 90 of 106 eyes (84.9%). In 23 eyes more than one treatment was given. In 6 eyes another IOP-reducing operation had to be performed. In 19 eyes slightly elongated intraocular inflammatory reactions were seen, without any serious complications. The morphological investigations showed in 22 of 25 cases temporary edema of the ciliary body. A temporary detachment of the ciliary body was seen in 8 eyes. Conclusion: Diode laser cyclophotocoagulation is an effective and safe procedure to reduce IOP in different types of glaucoma over a long time. Postoperatively, a temporary inflammatory reaction of the ciliary body was observed with no correlation to the degree of reduction of the IOP.</p>

<p>G-TS65 Diode Laser Transscleral Cyclophoto-coagulation for Refractory Glaucoma Tschiderer H,¹ Mistlberger A,^{1,2} Liebmann JM,^{2,3} Ritch R,^{2,3} Ruckhofer J,¹ Grabner G.¹ ¹LKA Salzburg, Austria; ²New York Eye and Ear Infirmary, NY, NY; ³New York Medical College, Valhalla, NY [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S941. Abstract nr 4337, 1998</p>	<p>The authors evaluated the efficacy of 810 nm diode laser TSCPC for refractory glaucoma in 249 eyes between 4/91 and 9/97 with up to 4.5 years follow-up. Success was defined as IOP \leq22 mm Hg for sighted eyes and absence of pain in blind eyes. Mean patient age was 63.9\pm19.8 (range, 4-96) years. Mean follow-up was 9.0\pm11.3 (range, 1-56) months. Mean pre- and postoperative IOPs were 42.23\pm11.0 (range, 24-76) mm Hg, 17.8\pm10.5 mm Hg at 12 months (p<0.001), 18.9\pm12.7 mm Hg at 24 months (p<0.001) and 24.4\pm15.0 mm Hg at 48 months (p=0.16). The number of laser applications (18.5\pm4.1 spots (range, 10 to 40)) and laser power (2345 \pm 398.7 mW (range, 1500 to 3000)) were not associated with a lower postoperative IOP. An IOP \leq22 mm Hg was achieved in 75.7% of eyes at the mean follow-up of 9 months. Forty-three eyes (15.3%) required at least one retreatment. Phthisis occurred in 3 eyes (1.1%). Conclusion: TSCPC is useful in eyes with refractory glaucoma in which the risks of outflow surgery are deemed unacceptable.</p>
<p>G-TS66 Diode Laser Cyclophotocoagulation of Secondary Glaucoma Caused by Anterior, Necrotizing Scleritis Schlote T, Mielke J, Zierhut M, Jean B, Thiel H. Klin Monatsbl Augenheilkd 213:306-308, 1998</p> <p>Abstract - English/German Article - German</p>	<p>A 60 year old female patient presented with recurrent anterior, necrotizing scleritis with inflammation and a newly developed secondary glaucoma in the right eye. Anterior uveitis occurred some years before. Severe scleral thinning was circumferentially present and focal scleral ectasia was found. Physical examination revealed no systemic association of scleritis. Immunosuppressive therapy with metotrexate was initiated and control of scleritis achieved. Intraocular pressure elevation persisted and was refractory to glaucoma medication. Diurnal pressure curve showed IOP values of 40 mm Hg despite the use of systemic carbonic anhydrase inhibitors. Visual acuity was 20/50 in the right and 20/25 in the left eye. Diode laser TSCPC using the OcuLight SLx and G-Probe was performed under general anesthesia using reduced parameters for application (12 laser spots, 1 second, 1.25 W). No complications occurred during and after laser application. Postoperatively, intraocular pressure was within normal range between 14 and 18 mm Hg. No reactivation of scleritis or uveitis was seen. In the author's experience, diode laser TSCPC is effective and safe in treating secondary glaucoma associated with anterior, necrotizing scleritis with inflammation and uveitis using reduced parameters for application.</p>
<p>G-TS67 Intraocular Pressure Control After Contact Transscleral Cyclophotocoagulation in Eyes with Intractable Glaucoma Yap-Veloso MIR, Simmons RB, Echelman DA, Gonzales TK, Veira WJX, Simmons RJ. J Glaucoma 7:319-328, 1998</p>	<p>The charts of 41 consecutive patients (43 eyes) who underwent TSCPC for intractable glaucoma were reviewed. Laser power was initiated at 1,750 to 2,000 mW and then adjusted up or down by increments of 250 mW until a popping sound was heard. The number of applications and degrees treated were individualized according to each case. After surgery, data were collected from chart entries at 1 hour, 1 day, 4 to 6 weeks, 4 to 6 months, and at the final visit (6-24 months). Mean differences in IOP before and after treatment were compared using the paired Student t-test. Associated complications also were assessed. The mean \pm standard deviation follow-up period was 11.9 \pm 5.3 months (range, 6-24 months). One patient who died after 1 month of follow-up and another patient with neovascular glaucoma who underwent an anterior chamber washout 1 week after laser to treat an uncontrolled IOP spike were excluded from the study. Repeat treatment was done in 12 (28%) eyes. At each</p>

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	<p>follow-up visit postoperatively, a significant reduction from preoperative IOP was obtained (mean reduction of 50% at the final visit). At the final visit, 64% of patients achieved an IOP of <22 mm Hg and a reduction of $\geq 20\%$. An IOP spike occurred in three (7%) eyes. Long-term complications included loss of vision (≥ 2 lines) in eight (22%) patients, corneal decompensation in one (2%), phthisis bulbi in one (2%) and corneal graft rejection in one (2%).</p>
<p>G-TS68 Effect of Fiberoptic Diameter in Diode Laser Transscleral Cyclophotocoagulation in Human Autopsy Eyes Aventuro JA, Gaasterland DE, Buzawa D. J Glaucoma 7:349-352, 1998</p>	<p>This study compared the use of a 600 μm diameter fiberoptic G-Probe to a 800 μm diameter fiberoptic G-Probe for TSCPC in six (three pairs) human autopsy eyes to evaluate whether laser delivery through a larger-diameter fiberoptic affects the size of the burns at the target ciliary tissue. Each eye received eight diode laser applications at 1.75 W (2 eyes) or 2.0 W (4 eyes) for 2.5 seconds - four applications per eye with the 600 μm G-Probe and four with the 800 μm G-Probe. Eyes were fixed in 10% formalin, then opened coronally at the equator. Inner surface burn diameters were measured parallel and perpendicular to the limbus using calipers and an operating microscope at 10x magnification. Ciliary body burns with the 600- and 800-μm fiberoptic G-Probes had nearly the same average diameter, range of diameter, average area and range of areas. The 800-μm fiber, which has a 78% larger cross-sectional area than a 600-μm fiber, reduces fluence through ocular surface tissue during diode laser TSCPC, theoretically decreasing the risk of surface burns. In this study, the larger fiber-optic gives essentially the same size ciliary body coagulation as obtained with the 600-μm fiberoptic. This suggests that the larger fiberoptic, compared with the standard 600-μm fiberoptic, will be safer yet equally effective for TSCPC.</p>
<p>G-TS69 A Clinical Comparison of Transscleral Cyclophotocoagulation with Neodymium: YAG and Semiconductor Diode Lasers Youn J, Cox TA, Herndon LW, Allingham RR, Shields MB. Am J Ophthalmol 126:640-647, 1998</p>	<p>The purpose of this study was 1) to compare the postoperative IOP and VA change after TSCPC using either the 20 ms Nd:YAG (MRII) or OcuLight infrared laser and G-Probe in refractory glaucoma, and 2) to determine which type of laser is preferable for the treatment of refractory glaucoma. Ninety-five eyes of 91 consecutive patients with refractory glaucoma were randomly assigned to either Nd:YAG or 810 nm infrared diode laser treatment. Diode laser treatments were evenly spaced for 360° using an initial power setting of 1,750 mW increased or decreased by 250 mW increments until it was 250 mW below that producing a “popping” sound at 2000 msec. One patient in the Nd:YAG group and 2 patients in the diode group needed repeat treatments. Patients were followed for a mean of 10.4 months (10.42 \pm 3.16). Data was compared preoperatively and at 1 week, 1 month, 6 months, and 12 months postoperatively. Hypotony was found in 1 patient in the Nd:YAG group and 2 patients in the diode group. Phthisis was found in 1 patient in the diode group after the first repeat treatment. The authors state that the complications in the diode group may be due to the more aggressive protocol of treating 360° vs. the original protocol of treating only 270°.</p> <p>IOP and VA Outcomes:</p> <p><u>IOP</u> - There was a statistically significant decrease in IOP after both Nd:YAG and diode TSCPC at each time period; however, there were no significant differences in postoperative IOP or VA</p>

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	<p>change between Nd:YAG and diode procedures.</p> <p>Postoperative IOP. Mean in mm Hg.</p> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <thead> <tr> <th></th> <th>Preop</th> <th>Postop <i>1 week</i></th> <th>p^*</th> <th>1 month</th> <th>p^*</th> <th>6 months</th> <th>p^*</th> <th>12 months</th> <th>p^*</th> </tr> </thead> <tbody> <tr> <td>Nd:YAG</td> <td>39.74</td> <td>22.96</td> <td>.0256</td> <td>20.70</td> <td>.0044</td> <td>19.88</td> <td>.0005</td> <td>15.80</td> <td>.0001</td> </tr> <tr> <td>Diode</td> <td>38.10</td> <td>22.48</td> <td>.0230</td> <td>21.24</td> <td>.0056</td> <td>19.82</td> <td>.0004</td> <td>16.82</td> <td>.0001</td> </tr> <tr> <td>p^\dagger</td> <td></td> <td>.5922</td> <td>.8488</td> <td></td> <td>.7941</td> <td></td> <td>.9711</td> <td></td> <td>.5361</td> </tr> </tbody> </table> <p>p^* value between the intraocular pressure of preoperative baseline and each of the follow-up periods in the Nd:YAG and the diode groups.</p> <p>p^\dagger value between the Nd:YAG and the diode groups at each time period.</p> <p><u>VA</u> - VA was increased (by 2 Snellen lines or 1 line in the low-vision category, or no change in corrected VA at the last follow-up visit) in 25 patients (83%) in the Nd:YAG group and 25 patients (74%) in the diode group. VA was decreased in 5 patients (17%) in the Nd:YAG group and 9 patients (26%) in the diode group.</p> <p>Conclusion: Compared with the Nd:YAG laser for TSCPC, the diode laser has technological advantages including portability, durability, and smaller size, while providing equivalent postoperative IOP and VA change. However, further evaluation of diode TSCPC is required to determine the optimal protocol for maximizing IOP reduction while minimizing complications.</p>		Preop	Postop <i>1 week</i>	p^*	1 month	p^*	6 months	p^*	12 months	p^*	Nd:YAG	39.74	22.96	.0256	20.70	.0044	19.88	.0005	15.80	.0001	Diode	38.10	22.48	.0230	21.24	.0056	19.82	.0004	16.82	.0001	p^\dagger		.5922	.8488		.7941		.9711		.5361
	Preop	Postop <i>1 week</i>	p^*	1 month	p^*	6 months	p^*	12 months	p^*																																
Nd:YAG	39.74	22.96	.0256	20.70	.0044	19.88	.0005	15.80	.0001																																
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<p>G-TS70 Neurotrophic Corneal Defects After Diode Laser Cycloablation Johnson SM. Am J Ophthalmol 12:725-7, 1998</p>	<p>This report describes two patients who experienced neurotrophic keratitis after diode laser TSCPC. Case 1: Before TSCPC, the patient's eye had undergone extracapsular cataract surgery with IOL implantation, treated with trabeculectomy surgery that failed after scleral buckle for rhegmatogenous retinal detachment. The patient was on maximum tolerated medical therapy and IOP was 20 - 25 mm Hg. TSCPC was performed with 6 applications along the inferior limbus using 2 W and 2 seconds. At one month follow-up, IOP was 6 - 14 mm Hg on two medications; however the patient had a 3.5 by 6 mm corneal epithelial defect with no complaints. A lateral tarsorrhaphy resulted in complete resolution over the next 4 weeks. Case 2: This patient had bilateral neovascular glaucoma and diabetic retinopathy in her right eye. PRP was administered in both eyes and medical therapy to reduce IOP. TSCPC was performed on her right eye for 13 applications at 2 W and 2 seconds, avoiding the superior temporal quadrant, and nasal and temporal horizontal meridians. At 1 month follow-up, IOP had decreased to high-normal range on fewer medications; however, she had an asymptomatic 6 by 4 mm corneal epithelial defect, reduced corneal sensation, and decreased VA to RE, light perception. After three attempts at tarsorrhaphy, the defect recurred with corneal perforation and loss of VA to RE, no light perception. Results: Neurotrophic keratitis, previously associated with cyclocryotherapy, may also be associated with ciliary body ablation with a contact diode laser. Conclusion: Practitioners who use the diode laser for ciliary body ablation should be aware of neurotrophic keratitis as a possible complication, especially because the patient population receiving this therapy may have diabetes, chronic eye inflammation, or other conditions predisposing to compromised corneal innervation, which is necessary for epithelial integrity.</p>																																								

G-TS71 Transscleral Cyclophotocoagulation with the Diode Laser for Neovascular Glaucoma

Oguir A, Takahashi E, Tomita G, Yamamoto T, Jikihara S, Kitazawa Y. Ophthalmic Surg Lasers 29:722-727, 1998

Thirty-nine eyes from 39 consecutive patients with neovascular glaucoma, uncontrolled IOP exceeding 23 mm Hg despite maximum tolerable medication and previous treatment with panretinal photocoagulation, were treated with 3 different laser sources of TSCPC: the OcuLight SLx 810 nm diode laser, the Microruptor II 1064 nm free-running Nd:YAG (FR-YAG), and the Microruptor III 1064 nm continuous-wave Nd:YAG (CW-YAG). Intraocular pressure, visual acuity, and complications are summarized:

IOP

Type of Laser	# of Eyes	Pre-op IOP (mm Hg)	Post-op IOP	
			Below 23 mm Hg # of Eyes	Follow-up (years)
Diode	21	36.9 ± 10.4	18 (86%)	1.3 (0.9 median)
FR-YAG	9	39.2 ± 10.4	5 (56%)	2.2 (1.3 mean)
CW-YAG	9	38.1 ± 8.9	3 (33%)	1.4 (0.8 mean)

VA

	# of Eyes	Improvement or Preservation		Decrease	
		in Visual Acuity		in Visual Acuity	
Diode	21	16 (76%)		5 (24%)	
FR-YAG	9	4 (44%)		5 (56%)	
CW-YAG	9	5 (56%)		4 (44%)	

Diode laser TSCPC was associated with improvement or preservation of visual acuity in 16 of 21 eyes (76%), and was the best of the three laser sources. Postoperative complications were minor following diode laser TSCPC. Two eyes had chronic hypotony (as defined by an IOP of <5 mm Hg) for over 3 months. However, neither eye showed any clinical signs (namely, choroidal folds, choroidal detachments, optic disc edema) associated with hypotony and both eyes retained their pretreatment VA. Pops were not heard continually with a consistent energy level, nor did any eyes have marked inflammation post-treatment. No phthisis was observed throughout the study.

Complication	Diode Laser (27)*	FR-YAG (10)	CW-YAG (15)
Eye Pain	14.8%	100%	46.7%
Fibrin	14.8%	0%	0%
Hyphema	11.1%	10%	6.7%
Phthisis Bulbi	0%	0%	6.7%

* Number of operations

This study demonstrates that diode laser TSCPC is as effective as FR-YAG TSCPC and is better than CW-YAG TSCPC in controlling IOP in neovascular glaucoma. It carries significant inherent risks (e.g. visual loss), as do other ciliary ablative techniques; however, diode laser TSCPC is useful and one of the treatments of choice in neovascular glaucoma. *Note: This study's success rate of 81% <21 mm Hg at a mean follow-up of 19 months for cyclodiode compares favorably with 87% at a mean of 8 months in other studies for seton surgery.*



G-TS72 “Cyclodiode”: Results of a Standard Protocol

Spencer AF, Vernon SA.
Br J Ophthalmol 83:311-316, 1999

Fifty-eight eyes of 53 patients with refractory glaucoma were followed for 6 - 37 months (mean 19 months) after initial TSCPC using the 810 nm, infrared OcuLight SLx and G-Probe. A standard treatment protocol was used at each session to treat 3/4 of the circumference of the ciliary body, which usually resulted in 14 applications. Duration was 2 seconds and power was 2.0 W (Note: the power was NOT altered even if “pops” were heard during treatment). Total energy delivered was 4.0 J per application (56 J per session for 14 applications). Outcomes were the following:

IOP

Treatment success was defined as (a) IOP <22 mm Hg; (b) IOP <17 mm Hg; and (c) a drop in IOP of greater than 30% despite the use of topical and/or oral medications. Another definition of success was used to identify the number of patients not requiring oral acetazolamide post-treatment. At a mean follow-up of 19 months, 81% (47 eyes) had an IOP of <22 mm Hg; 59% (34 eyes) had an IOP of <17 mm Hg; and the IOP had dropped by more than 30% in 45 eyes (78%). Twelve of the 13 patients where IOP had reduced by less than 30% were no longer taking oral acetazolamide.

Medication

The mean antiglaucoma medication score per eye was significantly reduced from 2.4 to 1.4 at last visit ($p < 0.0001$) with 91% of patients able to stop oral acetazolamide.

Repeated Treatments

Forty-five percent of eyes required more than one treatment and the overall mean treatment per eye was 1.6 (range 1-5). Thirty-two (55%) eyes had one treatment, 18 had two, 6 had three, 1 had four, and 1 had five treatments.

Visual Acuity (VA)

Of eyes with VA 6/60 or better pretreatment, 12 (32%) lost more than two lines of Snellen and 2 eyes with poorer acuity initially dropped to no light perception. Poor visual outcome was associated with the presence of diabetic retinopathy. Of eyes with initial VA less than 6/60, 2 (9%) had improved VA; one improved one grade* and the other, two grades. The same VA grade was retained in the remaining 14 eyes (67%).

**Grades. The authors defined one grade of VA to be the difference between 6/60 and counting fingers (CF), between CF and hand movements (HM), between HM and perception of light (PL), and between PL and NPL.*

The authors' treatment protocol, repeated if necessary, appears relatively safe and effective at lowering IOP in eyes with refractory glaucoma. It is not necessary to change power/time settings as neither excessive uveitis or hypotony/phthisis is common. The authors state that cyclodiode has rapidly become the treatment of preference in their unit for refractory glaucoma.





G-TS73 Contact Transscleral Diode Cyclophotocoagulation for Refractory Glaucoma

Threlkeld AB, Johnson MH.
J Glaucoma 8:3-7, 1999

This study evaluated the effect of contact TSCPC, using the OcuLight SLx and G-Probe, on intraocular pressure (IOP), vision, number of medications, and complications in 47 eyes of 47 patients with refractory glaucoma. Each eye was initially treated for 360° using 1.5 W to 2.5 W, titrated to 2 popping sounds in increments of 250 mW, at 2000 msec. Subsequent treatments that were required in 11 (23%) patients included 270° to 360° depending on the response to previous treatment and level of IOP. Follow-up ranged from 1 to 24 months, with a median of 9 months. Thirty-five (75%) patients were observed for more than 6 months. The average decrease in IOP was 21 ± 16 mm Hg. At final follow-up, 31 (66%) patients had final IOP between 7 and 21 mm Hg, and a total of 38 (81%) patients had an IOP less than 21 mm Hg. Medications were decreased by an average of 1.1. Twenty-six (62%) of 42 patients with vision before surgery had stable or improved visual acuity (postoperative visual acuity better by 2 Snellen lines or more, or by one low vision category, relative to baseline) at the final follow-up visit; 16 (38%) had a deterioration in visual acuity (loss of 2 or more Snellen lines or one low vision category). Neovascular glaucoma was associated with a post-treatment IOP less than 7 mm Hg. Complications included anterior chamber cell and flare, hyperemia, and chemosis; however, they resolved within weeks with the use of topical steroids. One patient developed choroidal detachment 5 months after treatment, which resolved spontaneously. Conclusions: Contact TSCPC is effective in lowering IOP in eyes with refractory glaucoma. It also serves to reduce the number of medications required for appropriate IOP control. Loss of visual acuity remains an important concern. Acute complications tend to be transient.

G-TS74 Contact Diode Laser Cyclocoagulation: A Long Term Comparison of Shorter-Duration, Higher-Power vs. Longer-Duration, Lower-Power Treatment in Uncontrolled Glaucoma

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[ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S271. Abstract nr 1431, 1999

Diagnoses of neovascular glaucoma, secondary angle closure glaucoma and secondary open-angle glaucoma were approximately equally distributed between two groups of patients to be treated with the G-Probe and OcuLight SLx at either a shorter duration/higher power or a longer duration/lower power.

	Shorter Duration/ Higher Power	Longer Duration/ Lower Power
# of Patients	16	17
Mean Duration	2266 ms	4000 ms
Mean Power	1853 mW	1250 mW
Mean Treatment Spots	18	15
Mean Energy	65 J	89 J
Mean # of Retirements	8	8

Outcomes

IOP (Mean mm Hg)

Pre	40 ± 12	36 ± 13
12 months post	19 ± 4	13 ± 5

Medication (mean # of drops)

Pre	3.1 ± 0.9	3.4 ± 0.8
12 months post	3.3 ± 0.5	2.0 ± 1.7

The two modalities were statistically comparable in effect with a possible clinical advantage of the LDLP treatment with regard to lower IOP, fewer drops and fewer retreatments at 12 months.

<p>G-TS75 Diode Laser Cyclophotocoagulation in the Management of Paediatric Glaucomas Kirwan JF, Shah P, Khaw PT. Paediatric Glaucoma Clinic, Moorfields Eye Hospital [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S271. Abstract nr 1432, 1999</p>	<p>To report the efficacy and complications of diode laser cyclophotocoagulation (DLCPC) in the management of refractory pediatric glaucomas, the authors reviewed case records of 53 eyes of 46 patients who underwent DLCPC. A minimum of 6 months follow-up from last treatment session was required for inclusion into the study. In all patients, the ciliary body was identified by transillumination prior to DLCPC. Mean age was 6.9 years (0.5 to 17 years). Diagnoses included aphakic glaucoma (n=19), congenital glaucoma (n=17), juvenile chronic arthritis (n=4), aniridia (n=4), anterior segment dysgenesis (n=4), Sturge Weber syndrome, and rubella. Fifty-six percent of eyes were aphakic and 72% had undergone at least one previous surgical procedure for glaucoma. Patients underwent a mean of 2.4 treatment sessions per eye (maximum 8 sessions). Mean pre-treatment intraocular pressure (IOP) was 31.8 mm Hg (range 24-50 mm Hg). Following one session of DLCPC, 70% had a clinically useful reduction in IOP (<22 mm Hg or by 33%), but this had fallen to 34% by 6 months. With repeat DLCPC, 53% had a clinically useful reduction in IOP for a year or more (mean 9.9 month interval). In a further 21% of eyes, DLCPC gave temporary IOP control prior to more definitive surgery. Of treatment failures, 13% had no useful IOP response and two predisposed eyes developed subsequent retinal detachment and loss of vision. No other eyes lost vision due to DLCPC related complications. In 5.5% of treatment sessions there was a significant post treatment inflammatory episode. Conclusions: With repeated treatment, DLCPC can provide effective control of IOP. However the success rate is much lower than with the authors' previous adult series, and younger eyes may recover from DLPCP more rapidly. While response may be temporary, DLCPC has a lower rate of severe adverse effects than surgical modalities and has roles as a temporising measure, as an adjunct to surgery, or in selected patients in whom surgery is undesirable due to a high risk of surgical complications.</p>
<p>G-TS76 Transscleral Diode Laser Cyclophotocoagulation in Refractory Glaucoma in Korea Youn J, Moon I. Department of Ophthalmology, St. Paul's Hospital, The Catholic University of Korea, Seoul, Korea [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S271. Abstract nr 1433, 1999</p>	<p>To evaluate the short-term (1 week to 1 month) and mid-term (3-4 months) effect of TSCPC in refractory glaucoma cases, the authors retrospectively studied 38 patients who underwent TSCPC between January, 1997 and June, 1997. Those with at least 4 months follow-up were included in this study. Preoperative IOP was 47.26 ± 9.25 mm Hg. The IOP at 1 week follow-up was 19.29 ± 8.09 mm Hg and those at 1 month and 4 months follow-up were 17.55 ± 7.51 mm Hg and 15.08 ± 8.58 mm Hg. There was statistically significant difference between preoperative IOP and postoperative IOP at 1 week ($p < 0.01$). There was no significant difference between postoperative IOP at 1 week and that at 1 month and 4 months follow-up time ($p=0.072$, $p=0.11$ consecutively). Conclusion: There was satisfactory decrease in IOP after diode TSCPC and there was no significant difference in the change of VA between preoperative and postoperative TSCPC.</p>

<p>G-TS77 “Pop” Sound and Tissue Disruption in Diode Transscleral Cyclophotocoagulation Kim MK, Park KH, Shin KC, Kim TW, Kim DM. Department of Ophthalmology, Seoul National University College of Medicine, Seoul, Korea [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S271. Abstract nr 1434, 1999</p>	<p>TSCPC was performed with the infrared OcuLight SLx and G-Probe using various powers (1-3 W) and durations (1-4 seconds) on human cadaver eyes obtained within 24 hours of death. The histologic change was evaluated by light microscopy. With a power equal to or above 2 W, “pop” sound always occurred even with 1 second of duration. With a duration of 2 seconds, no “pop” sound was produced below 2 W of power. With a duration of 4 seconds, “pop” sound was produced in 50% of the cases below 2 W of power. The “pop” sound was more closely related with the power (W) than the energy (J) delivered. The disruptions of ciliary body were observed in 78% of “pop” sound positive cases. However, they were also observed in 50% of “pop” sound negative cases. Conclusion: To reduce the incidence of “pop” sound, low power and long duration of the laser setting may be preferred than high power and short duration. However, it should be considered that even without “pop” sound the tissue disruption can be incurred in half of the cases.</p>
<p>G-TS78 Endoscopic versus Transscleral Diode Laser Cyclophotocoagulation Abdo D, Rasheed SS, Schuman JS, Pakter HM, Hertzmark E, Wang N. New England Eye Center, Tufts University School of Medicine, Boston, MA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S272. Abstract nr 1436, 1999</p>	<p>To determine the acute and chronic effects of endoscopic diode laser cyclophotocoagulation (ECP) versus transscleral contact diode laser cyclophotocoagulation (CDC), a prototype endoscopic diode laser delivery system was attached to the 810 nm OcuLight SLx.</p> <p><u>Acute Study:</u> Four rabbits each underwent either ECP or CDC in both eyes. Animals were sacrificed and all eight eyes enucleated immediately after surgery and the eyes were evaluated for location and intensity of lesions.</p> <p><u>Longitudinal Study:</u> Eight animals underwent ECP in one eye and another 8 animals had unilateral CDC. Intraocular pressure (IOP) was measured postoperatively on day 1 and then every 2-3 days for 4 weeks. On day 28, operated eyes were enucleated and the gross and histopathological changes in the ciliary body were evaluated. At the end of follow-up there was significantly greater IOP reduction in CDC than in the sham group ($p=0.0001$). ECP treated eyes were not significantly different from sham ($p=0.57$). Gross pathological exam of the acute lesions revealed the presence of blanching of the ciliary processes. The lesions tended to be more extensive in CDC than ECP. Chronic lesions for ECP and CDC were in the form of atrophy, fibrosis and fusion of the ciliary processes. The lesions were broader, deeper and involved more of the posterior part of the ciliary body in CDC as compared to ECP. Histopathological exam of the acute lesions in CDC showed coagulation necrosis in ciliary muscle and stroma with epithelial coagulation. In ECP the lesions were localized and adjacent areas of the ciliary body maintained normal integrity. Chronic lesions of CDC showed full thickness atrophy of areas of ciliary body with pigment-laden macrophages. ECP lesions showed localized atrophy of the anterior most ciliary processes, which were the only portions accessible for treatment by limbal approach. Conclusion: Both CDC and ECP affect destruction of the ciliary body. ECP spares adjacent tissue, even within a single ciliary process, while CDC tends to create a broader zone of tissue damage. These IOP results most likely reflect the peculiar anatomy of the rabbit, which permits treatment only of the anterior portion of the ciliary body with a limbal ECP approach.</p>

<p>G-TS79 Corneal Nerve Changes Secondary to Laser Cyclophotocoagulation Johnson SM,¹ Stone RT,¹ Geller AM,^{1,2} Peiffer RL.¹ ¹Department of Ophthalmology, University of North Carolina, Chapel Hill; ²US EPA, Research Triangle Park, NC [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S272. Abstract nr 1437, 1999</p>	<p>To determine whether diode CPC induces similar histopathology in limbal corneal nerves in rabbits as cyclo-cryotherapy, one group of pigmented Dutch-belted rabbits was treated with diode CPC in their right eyes with the left serving as control. These corneas were harvested at 48 hours, 1, 2, and 4 weeks. Each treated cornea and its control were processed for histologic analysis which identified the corneal innervation through anticholinesterase staining. The specimens subsequently underwent computer analysis for innervation density. A second group of rabbits underwent diode CPC in the right eye and YAG laser CPC on the left, and a separate rabbit served as control. Corneas were harvested, nerve trunks stained with methylene blue and excised, then processed for transmission electron microscopy (TEM) at 48 hours, 2 and 4 weeks. Results: Histologic examination of corneas grossly suggested that the nerve plexus was less dense in treated eyes; however the more sensitive computer analysis for density showed no change. Thus there was not quantitative change found in corneal innervation following diode CPC. However, TEM revealed qualitative changes with disruption of myelin sheaths in the lasered specimens. An unexpected finding was disrupted keratocytes in both laser specimens at 48 hours. Disrupted myelination was noted for all time points. Conclusion: Transmission electron microscopy of rabbit corneas following laser CPC reveals early damage to keratocytes and damage to limbal corneal innervation. This suggests that laser CPC does place patients at risk for neurotrophic keratitis post-operatively, as has been noted clinically.</p>
<p>G-TS80 Effect of Diode Laser Trans-scleral Cyclophotocoagulation in the Management of Glaucoma after Intravitreal Silicone Oil Injection for Complicated Retinal Detachments Han SK, Park KH, Kim DM, Chang BL. Br J Ophthalmol 83:713-717, 1999</p>	<p>The authors evaluated the effect of TSCPC using the OcuLight SLx and G-Probe on IOP in 11 eyes of 11 patients with medically uncontrolled glaucoma secondary to intravitreal silicone oil injection for complicated retinal detachments. Medically uncontrolled glaucoma was defined as IOP \geq 25mm Hg in spite of the use of two or more antiglaucoma medications, and when eyeball pain, headache, or a sign of corneal edema presented as a secondary symptom. Treatment Parameters:</p> <p>Power: Starting from 1.75 W, power was increased by 0.25 W up to 2.5 W if there was no tissue disruption reaction (an audible “pop”) during two subsequent applications. If a “pop” occurred in more than one laser application, power was reduced by 0.25 W to 1.5 W and treatment was completed.</p> <p>Duration: 2 seconds</p> <p>Applications: 20 to 27 laser applications were delivered to all four quadrants of the circumference of the ciliary body.</p> <p>After 52.5 weeks (mean) follow-up, the mean pretreatment IOP of 43.0 mm Hg had fallen to 14.5 mm Hg ($p=0.003$). The IOP of all patients (100%) was lowered below 20 mm Hg after treatment but was reduced to 81.8% because 2 patients lost light perception after treatment. (1 case was due to poorly controlled IOP for 14 months before the treatment that caused total cupping of disc and the remaining visual field of the central island disappeared immediately after treatment. The other case was thought to be hemophthalmos secondary to the aggravation of proliferative diabetic retinopathy.) The number of glaucoma medications was reduced from 2.6 to 0.6 ($p=0.005$). Qualified success (final IOP</p>

	<p>≤ 21 mm Hg regardless of glaucoma medication without visual loss or hypotony) was achieved in 9 eyes (81.8%) and complete success (final IOP ≤ 21 mm Hg without glaucoma medication) in 6 (54.5%). After TSCPC, patients' retinal status had not changed. All patients were relieved of ocular pain and corneal edema which were the causes of treatment in some patients. No hypotony or sympathetic ophthalmia occurred. Conclusion: Semiconductor diode laser appears to be a promising method for the treatment of medically uncontrolled glaucoma secondary to intravitreal silicone oil injection.</p>
<p>G-TS81 Nd:Yag and Diode Cyclophotocoagulation in Eyes with Ambulatory Vision Kammer JA, Viana M, Hillman DS, Wilensky JT. Ophthalmology, Univ. of Illinois, Chicago, IL [ARVO Abstract] Invest Ophthalmol Vis Sci. 41(4): S279. Abstract nr 1465, 2000</p>	<p>Seventeen consecutive cases of patients with vision >20/80 who underwent either Nd:Yag or diode cyclophotocoagulation between 1991 and 1998 and who were followed for at least 6 months were evaluated. Pre and post-operative vision, IOP and medications were recorded. Results: <u>IOP</u>: The mean pretreatment IOP level was 29.1±10.4mmHg on an average of 3.1±0.8 glaucoma medications. Following the cyclodestructive procedures, this level decreased dramatically to a mean IOP of 18.1±4.1mmHg (P<0.003) using only 2.7±1.3 glaucoma agents at 12 months post-treatment. The decrease in IOP was similarly impressive at the final visit (24 and 36 months post-treatment) with a mean IOP of 18.8±5.6mmHg on 2.5±1.1 glaucoma medications (P<0.018). While there was an impressive decrease in mean IOP during the follow-up, 8 eyes required a second cyclodestructive procedure and one of these eight ultimately needed a seton valve to achieve the target pressure. <u>Visual Acuity</u>: These cyclodestructive procedures facilitated a desirable decrease in IOP without significantly affecting vision. The median pretreatment VA was 20/60. The median VA at both 12 months and 24 months post-cyclophotocoagulation was 20/60. At 12 months post-treatment, 62% of the subjects maintained vision within 2 lines of baseline and all of them had vision >20/200. More impressively, 76% of the patients had vision within two lines of their pre-treatment level at the final visit (24 or 36 months post-treatment) and none of the patients had a VA of 20/200 or worse. The drops in VA could be explained by iritis, corneal edema and progression of glaucoma. Conclusions: Laser cyclophotocoagulation is an effective method for decreasing IOP (32% reduction in IOP from the baseline to the final visit) while maintaining good long-term VA (76% within 2 lines of baseline vision after 24 months) in patients with pre-treatment vision >20/80. This limited study not only refutes the notion that cyclodestructive procedures are inevitably associated with significant visual loss but also offers it as a pressure lowering option in patients with good vision.</p>
<p>G-TS82 Is Cyclodiode Laser Therapy Indicated for Painful, Blind Glaucomatous Eyes? Broadway DC. Dept of Ophthalmology, Norfolk & Norwich Health Care NHS Trust, UK. [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S283. Abstract nr 1488, 2000</p>	<p>Twenty-six painful blind (no perception of light /vague perception of light) hypertensive eyes of 26 glaucoma patients underwent cyclodiode laser therapy with the aim of reducing IOP and relieving ocular discomfort or pain. The patients were asked to subjectively assess their pre- and post- laser pain. In 6 eyes the laser therapy was repeated since the initial procedure was inadequate. After a minimum follow-up of 6 months (mean of 12 months) a single cyclodiode treatment lowered mean IOP from a baseline level of 51mmHg (95% C.I. = ±4.3) to 24 (±5.9)mmHg providing pain relief in 73% (19/26). After repeat treatments in 6 eyes mean IOP for all the eyes was reduced to 20 (±4.8)mmHg and pain relief was obtained in 96% (25/26). One eye with</p>



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	<p>hypotony remained painful. The single most important factor in achieving pain relief appeared to be a reduction in IOP of >30% from baseline. For eyes in which pain relief was achieved after one treatment, IOP was reduced by >30% in 84% (16/19). For eyes in which pain relief was not achieved after one treatment, IOP was reduced by >30% in only 14%; (1/7)[p=0.001]. Complications included hypotony in 2 cases, transient, but significant uveitis in 2 cases and hyphaema in one case. Conclusions: Cyclodiode therapy was highly successful in providing pain relief in painful blind hypertensive glaucomatous eyes.</p>
<p> G-TS83 Diode Laser Cyclophotocoagulation: Longer Term Follow Up of a Standardized Treatment Protocol Walland MJ. Clinical and Experimental Ophthalmology 28:263-267, 2000</p>	<p>The aim of this study was to establish whether a reproducible dose-effect relationship exists following a single standardized cyclodiode treatment to lower IOP. This paper reports results from a longer-term follow-up of a trial involving the study of 30 patients with uncontrolled IOP and advanced glaucoma (18/30 cases had neovascular glaucoma) who were treated with a single episode of either a full standardized (22 patients) or half standardized (8 patients) dose of laser depending on clinical risk of phthisis and monitored for IOP control, VA, postoperative inflammation and phthisis. Success was based on IOP < 22 mm Hg or a decrease in IOP of > 30 % from preoperative baseline.</p> <p><u>Treatment Parameters</u> Full Treatment: 40 shots x 1500 mW x 1500 ms through 360° Half Treatment: 20 shots x 1500 mW x 1500 ms through 180°</p> <p>Results: <u>Full treatment</u>: Preoperative IOP was 49.4±11.2 mm Hg and postoperative IOP was 28.5±200 mm Hg, a 42% reduction. 45% of patients achieved IOP < 22 mm Hg and 68% gained an IOP reduction > 30%. The mean number of medications preoperatively was 2.0 and 0.3 at final follow-up. Hypotony was seen in 4/22 (18%) of full standardized laser dose cases. Retirements improved IOP control to a final IOP < 22 mm Hg in 59.1% of patients, and a reduction of IOP > 30% in 77.3% of patients.</p> <p>Results: <u>Half treatment</u>: preoperative IOP was 29.4±4.3 mm Hg and the postoperative IOP was 18.3±10.0 mm Hg, a 38% reduction; 63% of patients achieved IOP < 22 mm Hg and 50% gained an IOP reduction of > 30%. Of 22 sighted eyes, 9 (41%) recorded no change in vision; and 9 (41%) lost and 4 (18%) gained vision. The mean number of medications preoperatively was 1.9 and 1.5 at final follow-up. At 21 months (mean) follow-up, a lower IOP was achieved in 83% of patients. Retirements improved IOP control to a final IOP < 22 mm Hg in 75% of patients; reduction of IOP> 30% in 75% of patients.</p> <p>Conclusion: Longer follow-up times confirm that TSCPC is a convenient and useful therapy in the control of IOP in end-stage glaucoma. Response of IOP to the laser therapy is highly variable, particularly in the neovascular glaucoma group, and it does not appear to be possible to predict an IOP outcome for an individual eye. Circumferential treatments in neovascular eyes should be avoided. Prospects for long-term vision retention in end-stage eyes are poor, perhaps due to progression of the underlying disease.</p>

<p>G-TS84 Diode Laser Cyclophotocoagulation as a Primary Surgical Procedure Becker M, Funk J. Deutschen Ophthalmologischen Gesellschaft. Berlin, 21 – 24, September 2000</p>	<p>The authors wanted to determine if TSCPC is suitable as a primary surgical procedure after failure of medical treatment. The charts of 21 patients (26 eyes) were retrospectively reviewed between February 1997 and May 1998. All patients had elevated IOP despite maximum tolerated medical treatment. Usually 15 burns were applied (2000 mJ, 2.5 seconds per treatment session). The mean follow-up was 17.5 months. There was a mean reduction of the IOP from 29.9 mm Hg preoperatively to 16.9 mm Hg postoperatively. In 3 cases (11.5%), repeated treatment was necessary. The only complication was a mild to moderate iritis in 4 cases (15.4%), while a shallow anterior chamber or an immediate postoperative elevation in IOP higher than 40 mm Hg did not occur. No severe visual loss occurred. Conclusion: TSCPC leads to a reduction of IOP of 43.5% without any severe complications. So, it can be recommended as an alternative to filtering surgery, particularly in older patients with mild to moderate glaucoma damage.</p>
<p>G-TS85 Transscleral Diode Laser Cyclophotocoagulation for the Treatment of Refractory Glaucoma Secondary to Inflammatory Eye Diseases Schlote T, Derse M, Zierhut M. Br J Ophthalmol 84:999-1003, 2000</p>	<p>The purpose of this prospective study was to determine whether TSCPC using the infrared OcuLight SLx and G-Probe may be an effective, as well as safe, procedure for lowering IOP in glaucoma caused by inflammatory ocular diseases. Twenty-two eyes of 20 consecutive patients with inflammatory, medically uncontrollable, glaucoma secondary to chronic uveitis/trabeculitis, chemical injury, episcleritis, or necrotising scleritis with inflammation were treated by TSCPC. Nine eyes (41%) had had previous failed glaucoma surgery (trabeculectomy, cyclocryocoagulation) and 15 eyes (68.2%) had had previous anterior segment surgery. Treatment was defined successful if the IOP could be reduced to 5 – 21 mm Hg with or without medication in all eyes with a VA of at least 0.02 or more and in monocular patients. In eyes with a VA of hand movements or less (including blind eyes) TSCPC was performed to reduce a very high IOP to less than 30 mm Hg and, additionally, to reduce pain and avoid further complications and enucleation. A further aim of the treatment was reduction of the use of systemic carbonic anhydrase inhibitors in all patients. All patients were followed for 1 year after the initial treatment.</p> <p><u>Treatment Parameters</u> 10 - 15 applications of 2.0 W energy applied for 2 seconds to treat not more than 270° (not more than 180° in patients with glaucoma secondary to chemical injury). The energy level and length of treatment were reduced in cases of thinned sclera such as necrotising scleritis and after the occurrence of pop effects. Number of treatments: Single treatment: 8 eyes; 2 treatments: 7 eyes; 3 treatments: 6 eyes; and 4 treatments: 1 eye (mean 2 treatments per eye).</p> <p>Results: Within 12 months of the first treatment the IOP was controlled in 17/22 eyes (77.3%). VA remained the same in 8 eyes (38.1%), improved in 5 (23.8%), and decreased in 8 eyes (38.1%). In eyes with uveitic glaucoma, TSCPC was successful in 13/18 eyes (72.2%). Decreased VA was caused by cataract progression (2 eyes), increased corneal opacification/scarring (2 eyes), and progression of glaucomatous optic neuropathy (4 eyes). No serious side effects such as activation of the inflammatory process, phthisis bulbi or persistent hypotonia were observed, with the exception of one patient with a temporary fibrin reaction. More than one treatment was necessary in 63.6% of the</p>



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	<p>patients. The use of systemic carbonic anhydrase inhibitors was reduced from 68.2% before treatment to 27.3% after 1 year.</p> <p>Conclusions: TSCPC seems to be a safe and effective procedure for the treatment of inflammatory glaucoma and may become an alternative to trabeculectomy with antimetabolites in uveitic glaucoma. TSCPC may become the surgical procedure of choice in treating secondary glaucoma caused by chemical injury and also in scleritis associated glaucoma, because the risk of complications is probably lower than with other procedures. Nevertheless, further information is required, especially on the long-term effects of TSCPC. <i>Additional Note:</i> Compared to cyclocryotherapy: TSCPC acts selectively by melanin absorption and therefore the inflammatory reaction may be less intense than with cyclocryotherapy. Because the incidence of severe complications is lower with TSCPC, it should be preferred. Cyclocryotherapy should therefore only be performed if all other medical and surgical interventions (including cyclophotocoagulation) have failed to reduce the high IOP.</p>
<p>G-TS86 Treatment of Aqueous Misdirection by Trans-scleral Diode Laser Photocoagulation Sengupta R, Austin M, Morgan J. Eye 14:808-810, 2000</p>	<p>Malignant glaucoma describes a rare, difficult to manage condition characterized by elevated IOP, a flat or very shallow anterior chamber (AC), failure to respond to a patent peripheral iridectomy (PI), exacerbation by miotic therapy and the presence of a degree of misdirection of aqueous humor within the vitreous gel. Current best practice recommends medical management with intensive cycloplegic therapy, proceeding to a pars plana procedure should topical therapy fail. Unfortunately such radical surgery is technically demanding and this, together with the severity of the condition, has meant that outcomes have often been poor. The authors describe two cases where aqueous misdirection has been successfully managed by TSCPC. The aims of the treatment are to address the site of the block and allow the release of intravitreal aqueous.</p> <p>Case #1: A patient with left angle closure glaucoma failed to respond to medical therapy and following a repeat laser PI, developed features of aqueous misdirection. Her anterior chamber was only one-quarter corneal thickness. Transscleral diode laser sector ciliary ablation was performed with laser applications being applied in 3 rows aligned along the underlying ciliary processes with a 1 mm space between applications. One day later AC had deepened to 1.8 mm.</p> <p>Case #2: A patient with right phacotrabeculectomy for uncontrolled chronic angle closure glaucoma and IOP of 25 mm Hg received transscleral photocoagulation superonasally in a pattern similar to case #1 with 9 applications of 2 seconds at 2 W, following which the AC deepened nasally. At last review, the AC depth was in excess of 2.5 mm and the IOP was 17 mm Hg.</p> <p>Conclusions: This straightforward extraocular procedure can be performed under local anesthesia and is associated with only minor degrees of pain and inflammation in most eyes. It can be performed in the absence of clarity of the ocular media and does not compromise the conjunctiva with respect to future glaucoma drainage surgery. The authors would therefore advocate its consideration in cases of aqueous misdirection unresponsive to medical therapy.</p>

Reference Catalog: Summaries of Studies

<p>G-TS87 Combined Transscleral Cyclophotocoagulation and Panretinal Photocoagulation in Neovascular Glaucoma Dao JT, Ghauri RR, Feldman RM, Fellman RL, Starita RJ. AAO Scientific Poster #42, Dallas, TX, 2000</p>	<p>The authors performed combined TSCPC and transscleral retinal photocoagulation (TSRPC) on 24 eyes of 20 patients presenting with neovascular glaucoma.</p> <p><u>Treatment Parameters</u> Power: 1.5 – 2.0 W Duration: 2 seconds Applications: 16 to 20 applied circumferentially.</p> <p>Results: A mean follow-up of 12 months showed an 81% success rate of IOP control (< 25 mm Hg without phthisis). If hypotony is also considered as failure, the success rate is 54%. The rate of decreased VA (46%) and loss of light of perception (25%) is similar to comparable studies. The phthisis rate of 8% is equal to that found in comparable studies.</p> <p>Conclusion: The major advantage of combined TSCPC and TSPRC are low cost and ease of procedure. It is an effective treatment of severe neovascular glaucoma, although hypotony and visual loss are causes for concern, as they have been in other studies of cyclodestruction.</p>
<p> G-TS88 Cyclodiode Laser Therapy for Painful, Blind Glaucomatous Eyes Martin KRG, Broadway DC Br J Ophthalmol 85:474-476, 2001</p>	<p>The aim of this prospective, longitudinal, and observational study was to establish 1) the ability of cyclodiode to improve comfort in patients with painful, blind eyes due to glaucoma; and 2) which treatment related variables correlated with the achievement of a comfortable eye. The OcuLight SLx and G-Probe were used to perform cyclodiode treatment on 30 eyes of 30 patients who had VA worse than hand movements at 1 meter, significant ocular discomfort, IOP > 30 mm Hg, and no previous cyclodestructive procedures.</p> <p><u>Treatment Parameters</u> 40 laser spots applied, 10 in each quadrant of the ciliary body sparing the 3 and 9 o'clock positions Initial treatment - Power: 1.5 W; Duration: 1.5 seconds (90 J per session) Retreatments - Power: 1.5 W; Duration 2 seconds (120 J per session)</p> <p>Minimum follow-up was 6 months (mean 10.8 months, range 6 – 22 months). After one treatment, pain relief was reduced in 22 of 30 eyes (73.3%) with an IOP reduction > 30%; and complete pain relief in 21 eyes (70%). Of these 21 eyes, IOP was reduced by > 30% in 81% (17/21). For eyes not achieving pain relief after one treatment, IOP was reduced by > 30% in only 22.2% (2/9). After retreatments, pain was reduced in 29 of 30 eyes (96.7%) and abolished in 26 of 30 eyes (86.7%). The treatment was well tolerated and only one of 30 eyes (3.3%) remained painful at final follow-up. Complications occurred in 6 eyes. Three patients (10%) developed persistent hypotony (IOP <5 mm Hg); one hypotonous eye remained painful at final follow-up but none developed phthisis. Post-treatment uveitis occurred in 2 eyes and transient hyphaema in one eye.</p> <p>Conclusions: Cyclodiode was highly successful in providing pain relief in painful blind hypertensive glaucomatous eyes. The best predictor of successful pain relief was IOP reduction of > 30% from baseline.</p>



<p>G-TS89 Diode Laser Cyclophotocoagulation in Refractory Glaucoma: Comparison Between Pediatric and Adult Glaucomas Izgi B, Demirci H, Yesim F, Demirci K, Turker G. Ophthalmic Surg Lasers 32(2):100-107, 2001</p>	<p>Forty-one eyes of 39 patients underwent TSCPC with the OcuLight SLx and G-Probe for the treatment of advanced glaucoma. Of 39 patients, 13 were pediatric glaucoma patients, and 26 were adult glaucoma patients. Patients were followed at least for 6 months or until failure of the procedure, if shorter than 6 months. For all cases, the mean pre-treatment IOP was 34.5 ± 10.9 mm Hg; and the mean pre-treatment antiglaucoma medications was 1.75 per eye (range 1 –4). Treatment failure was defined as IOP > 22 mm Hg on two consecutive visits after the first TSCPC treatment, or patients who underwent an alternative surgical procedure. Treatment success was defined as IOP < 22 mm Hg with pressure reduction of at least 20% from the preoperative IOP on the same or reduced medication after the first or subsequent TSCPC treatments. The follow-up of all patients was 10 months mean (range 3 – 24 months). For all eyes, the mean reduction in IOP after the first treatment was 12.11 ± 10.5 mm Hg. The success rate among all enrolled eyes was 59% after the first TSCPC treatment and 75% after repeated treatments. The mean number of antiglaucoma medications at last follow-up for both groups was 1.56 per eye (range 0 – 3). The most common complications were conjunctival hyperemia and anterior chamber reaction; however, complication rates were low in both adult and pediatric glaucoma cases. No phthisis bulbi or retinal detachment were observed during follow-up. This may be explained by the low laser parameters used. In patients with buphthalmia or anatomic abnormalities that obscured the limbus, transillumination was used to help the identification of the ciliary body.</p> <p><u>Treatment Parameters</u> 18 – 20 applications placed over 270° Power: 1.7 – 2 W; Duration: 2 seconds (61.2 – 80 J per session) Retreatments: An overall mean of 1.46 treatments (range, 2 – 4) were applied in 13 of 41 eyes (32%) (6 eyes in the pediatric group and 7 eyes in the adult group).</p> <p>Conclusions: Diode laser TSCPC appears to be a simple, effective, and safe treatment method for advanced, refractory glaucoma in the short-term. However, in the long-term, multiple applications may be necessary in some cases. The response of adult and pediatric glaucoma cases were found to be similar in efficacy and safety. TSCPC reduced the number of drugs needed to control IOP; therefore, TSCPC may be clinically useful for reducing antiglaucoma medications, avoiding their associated side effects in the long-term.</p>
<p>G-TS90 Diode Laser Transscleral Cyclophotocoagulation as a Primary Surgical Treatment for Primary Open-Angle Glaucoma Egbert PR, Fiadoyor S, Budenz DL, Dadzie P, Byrd S. Arch Ophthalmol 119:345-350, 2001</p>	<p>A prospective trial was conducted to evaluate the feasibility of diode TSCPC for the primary surgical treatment of POAG in developing countries; and to determine whether a change in energy settings would influence results. One eye each of 92 patients with POAG received TSCPC with the OcuLight SLx and G-Probe (while 32 fellow eyes received a trabeculectomy and 47 fellow eyes received medication only). Eyes that were treated with TSCPC were randomly assigned to receive treatment by 20 applications: Group 1 received 1.5 W applied for 1.5 seconds (2.25 J); Group 2 received 1.25 W applied for 2.5 seconds (3.125 J). Power was not adjusted for the occurrence of pops. The change in IOP was the principal outcome of interest for establishing overall efficacy and for comparing Group 1 with Group 2. In patients with relatively normal IOP of 22 mm Hg or less because</p>



of medications, the principal outcome was a reduction of medications. Secondary outcome measures were changes in visual acuity (VA) and complications.

Results:

Seventy-nine patients completed at least 3 months of follow-up. Acceptance of TSCPC was good—most patients liked the idea of a laser and found the procedure less frightening than an operation, such as trabeculectomy. There was no difference in the outcome of the 2 laser energy settings:

IOP: IOP decreased in 53 eyes (67%). IOP decreased more in eyes with a high pretreatment IOP than in those with a low pre-treatment IOP. There was no significant difference between the effect of the 2 laser settings on IOP. No eye developed an IOP lower than 10 mm Hg. Two eyes had an increase in IOP of more than 20 mm Hg that the authors couldn't fully explain, although both patients had failed to continue taking glaucoma medications.

Medications: Eleven (14%) of 79 eyes had a final IOP of 22 mm Hg or less without medications. In the 20 eyes with an IOP of 22 mm Hg or less before treatment that were treated in an attempt to eliminate medications, only 2 eyes (10%) were receiving no medications at the last examination while maintaining IOP at less than 22 mm Hg.

VA: Eighteen (23%) of 79 eyes had a decrease (≥ 2 lines) in VA, 55 (70%) had no change, and 5 (6%) had an increase (≥ 2 lines). In the subset of 19 eyes that had relatively good pretreatment VA (20/60 or better), only 1 (5%) had a decrease in VA. The fellow eyes that had treatment by medications only, with no TSCPC, lost vision at the same rate as the eyes treated by TSCPC. The vision loss in fellow eyes is consistent with the idea that many of the study patients had advanced glaucoma and were at risk to lose vision from the natural progression of glaucoma.

Complications: Most patients experienced mild to moderate pain for a few days, but none complained of severe pain. There were no serious complications and no cases of hypotony, phthisis bulbi, or sympathetic ophthalmia. An atonic pupil was noted in 27 (29%) of the 92 eyes (13 from Group 1 and 14 from Group 2) and may have been present more often because the authors did not prospectively look for this characteristic.

Retreatments: Only 16 (20%) of 79 eyes were retreated (7 in Group 1 and 9 in Group 2). Fourteen of those eyes had 1 retreatment and 2 had 2 retreatments. Using a 20% decrease in IOP as a measure of success, none of the retreated eyes was a success before retreatment, but 9 (57%) of 16 were a success after retreatment.

Conclusions: TSCPC with the G-Probe was quick and relatively simple to apply. It is a practical, rapid, and well-tolerated procedure that may provide a modest and variable lowering of IOP. It seems safe in that no major complications were recognized, but the effect of TSCPC on IOP was unpredictable. The

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	<p>OcuLight SLx was reliable even in the face of tropical heat and humidity. The previously unrecognized complication of atonic pupil needs further evaluation. The role of diode TSCPC in the management of POAG in developing countries warrants further study.</p>
<p>G-TS90-A Accompanying Editorial: A New Role for Diode Laser Transscleral Cyclophotocoagulation? Wilson MR. Arch Ophthalmol 119; 424-425, 2001</p>	<p>Dr. Wilson examines Dr. Egbert's study and its outcomes to determine if early treatment with TSPCP is appropriate by addressing considerations such as success of the treatment, complications of the treatment, timeframe for assessing success and complications, and local factors such as the societal burden of disease, level of health care infrastructure, and availability of resources to provide alternate treatment options.</p> <p>Dr. Wilson concludes that from a global context, any reasonably successful intervention that lowers IOP, has minimal complications and can be delivered within the resource limitations of the local population, is welcome.</p> <p>Because of the short follow-up duration and the low energy levels used for treatment, the effectiveness of diode laser TSCPC for primary treatment of POAG was not fully assessed by Egbert et al. Nonetheless, if it is assumed that glaucomatous eyes left untreated will likely result in functional visual impairment, and if the health care resources are such that delivery of more standard alternative treatments is impractical, then diode TSPCP deserves consideration as the primary glaucoma treatment.</p>
<p>G-TS91 The Use of Diode Laser Cyclophotocoagulation (CYC) for Prevention and Treatment of Glaucoma Associated with Keratoprosthesis (KPro) Kim EC¹, Kahn B², Dohlman CH², Grosskreutz CL.² ¹Biological Sci, UCSF Sch of Medicine, San Francisco, CA; ²Dept of Ophthalmology, Massachusetts Eye & Ear Infirmary, Harvard Medical School, Boston, MA [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): Abstract nr 2945, 2001</p>	<p>This study aimed to determine whether CYC in patients with severe corneal disease undergoing KPro and concurrent Ahmed valve placement for IOP control, contributes to the prevention of the long-term KPro complication of glaucoma-associated blindness. Ten eyes in 10 patients who received CYC either before or during (n=5) or after (> 1month, n=5) KPro placement with follow-up of 19.4 +/- 13.3 months (range 5-49) were reviewed. All but one patient received an Ahmed valve either with or after KPro placement. Glaucoma was found in 80% of the patients before KPro placement with 100% of the patients requiring additional medications to control IOP post-operatively. Before KPro placement, VA ranged from LP to CF at 4 feet. Results: All 5 patients who received CYC before or during KPro/Ahmed placement, had a most recent VA ranging from 20/20 to 20/60 (follow-up: 21.5 +/- 7.8 months). Of the five patients who received post-operative CYC for markedly elevated IOP, the most recent VA ranged from NLP to CF at 4 feet, with 3 of 5 of these patients progressing to blindness secondary to progressive GON (follow-up: 17.4 +/- 18 months). An additional patient who received pre-operative CYC never received a KPro due to an inoperable retinal detachment after the laser cyclodestructive treatment. The most common short-term post-operative complications included retroprosthesis membranes causing decreased VA, tissue necrosis and subsequent leak, and high IOP. Conclusions: Elevation of IOP is common in KPro recipients with severe corneal disease. The results of this study suggest promise for better glaucoma control for patients with severe cicatrizing disease who receive CYC before KPro/Ahmed, if it is performed before the patient has suffered from end-stage glaucomatous damage.</p>

Reference Catalog: Summaries of Studies

<p>G-TS92 Subconjunctival Anesthesia in Contact Diode Laser Cyclophotocoagulation Schlote T, Derse M. Ophthalmic Surg Lasers 32:289-293, 2001</p>	<p>A prospective study of 120 eyes of 120 patients with advanced glaucoma was started to evaluate the use of subconjunctival anesthesia with 2% mepivacaine. (Retro- or peribulbar anesthesia are the standard procedures for cyclodestructive surgery.) Mepivacaine was injected at least 6 to 8 mm from the limbus to avoid bleeding at the injection site near the limbus. The eye was patched for 15 minutes with low pressure to reduce chemosis and increase diffusion of mepivacaine. Although application of subconjunctival anesthesia is a simple technique, a very careful application is needed to avoid disruption of conjunctival vessels, because conjunctival bleeding may also compromise TSCPC because of absorption of energy. No sedation by oral or intravenous medication was given. Complications and pain during TSCPC (5 point rating scale) and on the first postoperative day were recorded. Only the first TSCPC in every patient was included for evaluation. Results: During TSCPC, 82.5% of patients experienced no pain, 11.7% mild pain, and 5.8% moderate pain. No instances of pain or excess motion occurred that required peribulbar anesthesia or discontinuation of the procedure. Conclusion: Most of the patients experienced no pain during diode laser TSCPC using subconjunctival anesthesia. Therefore, risks and side effects of retro- or peribulbar anesthesia can be successfully avoided by this simple modification.</p>
<p>G-TS93 Alteration of the Vascular Supply in the Rabbit Ciliary Body by Transscleral Diode Laser Cyclophotocoagulation Schlote T, Beck J, Rohrbach JM, Funk RHW. Graefe's Arch Clin Exp Ophthalmol 239:53-58, 2001</p> <p><i>Also listed as HIST21, pg 239</i></p>	<p>This study evaluates the alteration of the ciliary body vascularization by contact diode TSCPC (IRIS Medical OcuLight SLx and G-Probe) in pigmented chinchilla bastard rabbits. Preliminary experiments were conducted to determine the parameters for diode laser TSCPC of the pars plana or pars plicata. Then, treatment of the pars plicata (3 rabbits) or pars plana (3 rabbits) was performed in the right eye of 6 rabbits. After 2, 6 and 12 weeks, histologic and transmission electron microscopic studies were performed. Furthermore, 3 rabbits received pars plicata cyclophotocoagulation of the right and pars plana cyclophotocoagulation of the left eye. After 2, 6 and 12 weeks, vascular casts of the ciliary body were investigated by scanning electron microscopy.</p> <p><u>Treatment Parameters</u> For treatment of the pars plicata that induced a homogeneous whitening of the ciliary processes: Power: 2.0 W Duration: 2.0 seconds Limbus Distance: 0.3 mm with paraxial orientation of the G-Probe.</p> <p>For treatment of the pars plana: Power: 1.0 W Duration: 2.0 seconds Limbus Distance: 1.2 mm with paraxial orientation of the G-Probe.</p> <p>Results: Histologic and transmission electron microscopic studies showed a marked coagulation necrosis with subsequent ciliary body atrophy, destruction of the ciliary epithelium, pigment dispersion in the ciliary body stroma and peripheral anterior synechiae. Examination of vascular casts of the ciliary body revealed a marked rarefaction of the capillary network within the treated areas of the ciliary body in all eyes and at every time of investigation. Anterior to the laser burns, the capillary network</p>

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	<p>was not markedly affected in the eyes with cyclophoto-coagulation of the pars plana. After 3 months, short vessel sprouts were seen, but regeneration was mostly incomplete. Results indicate that the pressure-lowering effect of photocoagulation of the pars plicata is a synergistic effect of the direct destruction of the ciliary epithelium and the indirect, ischemic damage of ultrafiltration and ciliary epithelium caused by extensive, probably irreversible destruction of the capillary network. The pressure-lowering effect of photocoagulation of the pars plana is not caused by an extensive ischemic reaction in the pars plicata. This may support the hypothesis of increased uveoscleral outflow as the main pressure-lowering mechanism. Conclusions: The vascular casting technique is an excellent method for the investigation of changes in ciliary body vascularization after cyclodestruction. This study is the first to demonstrate a marked rarefaction of the ciliary body vascularization after diode laser TSCPC using vascular casts. The results suggest that alteration of vascularization probably acts as a strong synergistic mechanism in the decrease of intraocular pressure after cyclophotocoagulation of the pars plicata.</p>
<p>G-TS94 Diode Laser Transscleral Cyclophotocoagulation for Refractory Glaucoma Mistlberger A, Liebmann JM, Tschiderer H, Ritch R, Ruckhofer J, Grabner G. J Glaucoma 10:288-293, 2001</p>	<p>Two hundred six eyes of 204 patients with refractory glaucoma were treated with the OcuLight SLx and G-Probe to evaluate the optimal treatment parameters for TSCPC and to determine the outcome for different subgroups of primary and secondary glaucomas. Subgroups: Group 1 received 20 applications or fewer; group 2 received more than 20 applications. Success was defined as an IOP equal to or less than 22 mm Hg with or without medication, or absence of pain for poorly sighted and blind eyes.</p> <p><u>Treatment Parameters</u> Power: Initially set at 1750 mW, a stepwise increase (250 mW increments) up to an audible tissue disruption that was followed by a stepwise reduction to a threshold just below this level, or an increase if there was no audible tissue disruption, up to a maximum of 3000 mW. Duration: 2 seconds Treatment Circumference: 270° Retreatments: 33 (16%) eyes required at least 1 retreatment.</p> <p>Mean follow-up was 9.3 ± 11.2 months (range, 3-56 months). An IOP less than or equal to 22 mm Hg was achieved in 72.7% of eyes at the mean follow-up of 9 months. The total number of applications was not correlated with the final success. VA decreased 2 or more lines in 32 (18.7%) of 171 sighted eyes; 14 (8.1%) eyes lost light perception; and 5 (2.4%) eyes improved vision. Postoperative complications included anterior segment inflammation in 131 (63.6%) eyes, hyphema in 14 (6.8%) eyes (all of which had neovascular glaucoma), choroidal detachment (1.5%) in one aphakic and two pseudophakic eyes, and cystoid macular edema in 4 (1.9%) pseudophakic eyes. Phthisis occurred in 4 (1.9%) eyes, all of which had neovascular glaucoma. There was no statistically significant difference in the success rates between the three subgroups of patients with neovascular glaucoma, pseudo-phakia, and aphakia; however, eyes with neovascular glaucoma tended to have a better success rate (60.19%) at the 2 year follow-up interval. Conclusions: Contact diode laser TSCPC is useful in eyes with refractory glaucoma in which the risks of outflow surgery are deemed unacceptable.</p>

 New

New

G-TS95 Efficacy and Safety of Contact Transscleral Diode Laser Cyclophotocoagulation for Advanced Glaucoma

Schlote T, Derse M, Rassmann K, Nicaeus T, Dietz K, Thiel HJ. J Glaucoma 10:294-301,2001

One hundred eyes of 100 patients with advanced glaucoma refractory to medical treatment were consecutively treated by TSCPC with the OcuLight SLx and G-Probe to evaluate the efficacy and safety of TSCPC. Success was defined as a final IOP between 5 and 21 mm Hg in eyes with a VA of hand movements or less including blind eyes, and reduction of carbonic anhydrase inhibitor use in all eyes.

Treatment Parameters

Anesthesia: Subconjunctival anesthesia of 1.5 to 2.5 mL of 2% mepivacaine was used. The needle was carefully placed 6 to 8 mm from the limbus to avoid bleeding at the injection site near the limbus. The eye was patched for 10 minutes with low pressure.

Power: 2.0 W

Duration: 2.0 seconds

Applications: 10 to 15

Treatment Circumference: Not more than 270° (in glaucoma secondary to chemical injury, not more than 180°)

In cases of thinned sclera (e.g. buphthalmus) an energy and duration of 1.5 W and 1.5 to 2 seconds were used as initial parameters. After occurrence of pops, energy was also reduced 250 mW.

Ninety-three patients were followed-up for 1 year after initial treatment. The overall success rate was 74.2%. Of 60 eyes with a VA of more than hand movements, IOP between 5 and 21 mm Hg was achieved in 41 (68.3%) eyes. Relief of pain was achieved in 28 (84.8%) of 33 eyes. Reduction of systemic carbonic anhydrase inhibitor use was highly significant (P < 0.0001). In eyes with a VA of more than hand movement, VA decreased in 13 eyes by 2 lines or more whereas VA increased by 2 lines or more in 11 eyes. Five eyes with a VA of hand movement and light perception before TSCPC had no light perception after 12 months. No significant relationship between loss of VA and failure of treatment could be found. Within 1 year, a mean of 1.9 procedures per patient were performed. No pressure-lowering effect or relief of pain was seen in 9 (9.7%) of the 93 patients. No phthisis bulbi or persistent hypotonia developed. Conjunctival burns were seen in only two eyes. Conclusions: TSCPC is an effective and safe method for the treatment of advanced, refractory glaucoma. The procedure is more effective in POAG (89.5%), neovascular glaucoma (86.7%) and inflammatory glaucoma (75%) than in congenital or juvenile glaucoma (62.5%), traumatic glaucoma (57.1%), and aphakic glaucoma (57.1%). Success of treatment depends on the age of patients, previous surgery, and the type of glaucoma. Repeated treatments are often necessary. Currently, TSCPC should be regarded as the cyclodestructive procedure of choice for the treatment of neovascular glaucoma.

New

G-TS96 Cyclodiode Photocoagulation for Refractory Glaucoma after Penetrating Keratoplasty

Shah P, Lee GA, Kirwan JK, Bunce C, Bloom PA, Ficker LA, Khaw PT. Ophthalmology 108:1986-1991, 2001

Twenty-eight eyes of 28 patients were treated with TSCPC using the G-Probe for refractory glaucoma after complicated penetrating keratoplasty. The median time between the penetrating keratoplasty and TSCPC was 9 months. Preop IOP was a median of 33 mm Hg. The number of glaucoma medications before treatment was 2.6. Postop IOP, graft status, VA and number of antiglaucoma medications were recorded after TSCPC treatment.

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	<p><u>Treatment Parameters</u> Power: 1.5 W Duration: 1.5 seconds (2.25 J per application) Applications: 40 applications Treatment Circumference; 270° to 300° of the ciliary body avoiding the long ciliary nerves and arteries at the 3 o'clock and 9 o'clock positions. Retreatments: 16 patients (57%) required more than one treatment to control the IOP. <i>Transillumination to identify the position of the ciliary body is a crucial step.</i></p> <p>All patients had at least 6 months follow-up (median of 30.5 months). IOP: Postop IOP was a median of 15 mm Hg. IOPs of 6 to 21 mm Hg at final follow-up were achieved in 22 patients (79%). Graft status: 3 of 19 patients (1%) with originally clear grafts developed corneal opacification which compares very favorably to the rate found by Threlkeld and Shields of 11 of 25 patients (44%) after noncontact transscleral Nd:YAG. VA: VA could be assessed in 27/28 patients. Twenty patients (71%) were able to improve or maintain their VA: VA improved (> 2 Snellen lines) in 3 patients (11%), remained the same (\pm 1 line Snellen line) in 17 patients (61%) and decreased (> 2 Snellen lines or decrease in one low-vision category) in 7 patients (26%) of which only 2 could be directly attributable to TSCPC treatment. Medications: The number of medications was reduced to 1.6. One patient with nanophthalmos had delayed-onset hypotony (IOP < 6 mm Hg) that was diagnosed 46 months after TSCPC and was related to the development of refractory uveal effusion syndrome. Two patients had minor conjunctival burns, one related to diode uptake in an area of subconjunctival hemorrhage. Four of the six patients who had an episode of rejection were aphakic. Three patients who had TSCPC within days of their penetrating keratoplasty achieved good IOP control and no episodes of rejection. In certain patients who have compromised optic nerves and are at risk of field loss caused IOP spikes, TSCPC is an option for acute management when medical treatment has not been effective. In patients who are intolerant of oral acetazolamide, TSCPC can also be used to allow reduction of the dosage or cessation of treatment. Clinical response after each session can be used to modify the number of burns, extent, and laser parameters for further TSCPC. Conclusions: TSCPC for the treatment of refractory glaucoma after penetrating keratoplasty is an effective technique with a good safety profile; however, multiple treatments may be required to achieve IOP control. It is useful when maximum medication is not adequate and when filtration surgery or tube drainage surgery are associated with unacceptable risks and complications. Longer-term follow-up and larger series are required to further define the role of this treatment modality.</p>
<p> G-TS97 Cyclophotocoagulation. A Report by the American Academy of Ophthalmology Pastor SA, Singh K, Lee DA, Juzych MS, Lin SC, M.D, Netland PA, Nguyen NTA. Ophthalmology 108:2130-2138, 2001</p>	<p>The goal of an Ophthalmic Technology Assessment (OTA) is to evaluate the peer-reviewed and published scientific literature, to distill what is well established about the technology, and to help refine the important questions to be answered by future investigations. After appropriate review by all contributors, assessments are submitted to the Academy's Board of Trustees for consideration as official Academy statements. One hundred-thirty citations were found from a literature search for the years</p>

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	<p>1968 to 2000. Of these, 34 articles were reviewed and 19 were selected for the panel methodologist to review and rate according to the strength of evidence. A Level I rating = properly conducted, well-designed, randomized clinical trials; Level II = well-designed cohort and case-control studies; Level III = case series and poorly designed prospective and retrospective studies, including case-control studies. This assessment describes four TSCPC procedures: 1) transpupillary CPC 2) transvitreal endophotocoagulation, 3) transscleral CPC: noncontact and contact Nd:YAG and semiconductor diode laser; 4) Endoscopic CPC. Conclusion: Cyclophotocoagulation based on Level III evidence is indicated for patients with refractory glaucoma who have failed trabeculectomy or tube shunt procedures, patients with minimal useful vision and elevated IP, patients who have no visual potential and need pain relief, and patients with complicated glaucoma and conjunctival scarring from previous surgery. It may be useful for patients whose general medical condition precludes invasive surgery or who refuse more aggressive surgery. It is also useful in emergency situations, such as the acute onset of neovascular glaucoma. There is insufficient Level I evidence to definitively compare the relative efficacy of the cyclophotocoagulation procedures for glaucoma. It is the panel's opinion that semiconductor diode systems appear to possess the best combination of effectiveness, based on Level III evidence, portability, expense, and ease of use at this time. Unlike endoscopic CPC, transscleral treatment can usually be performed in an office setting. However, visualizing the treatment target tissue directly is impossible with transscleral treatment and can potentially cause more collateral tissue damage.</p>
<p> G-TS98 Diode Laser Cyclophotocoagulation as a Primary Surgical Procedure in Glaucoma Becker M, Funk J. Der Ophthalmologe. 98(12):1145-1148, 2001.</p>	<p>This study was conducted to determine if TSCPC is suitable as a primary surgical procedure after failure of medical treatment. The charts of 20 patients (25 eyes) were retrospectively reviewed between February 1997 and May 1998. All patients had elevated IOP despite maximum tolerated medical treatment. Usually 15 burns were applied (2000 mW, 2.5 seconds per treatment session). The mean follow-up was 17.5 months (range 6 – 32 months). There was a mean reduction of the IOP from 29.9 mm Hg preoperatively to 17.4 mm Hg postoperatively. In 3 cases (12%), repeated treatment was necessary. No severe complications such as endophthalmitis or phthisis bulbi were observed. No acute postoperative elevation in IOP greater than 40 mm Hg occurred. VA remained stable during the follow-up in all eyes with a preoperative measurement of 20/60. Conclusion: Diode laser cyclophotocoagulation is suitable as a primary surgical procedure. The authors mostly perform TSCPC instead of filtering procedures when the patient refuses the filtering operation or when the patient is not able to visit an ophthalmologist.</p>
<p> G-TS99 Glaucoma Surgery in Very Severe Eye Burns Kuckelkorn R, Keller GKI, Redbrake C. Der Ophthalmologe 98(12):1149-1156, 2001</p>	<p>In this retrospective study, the records of 12 patients with 14 severe eye burns (grade IV) were analyzed. Nine eyes were treated with an aqueous shunt device (6 von Denffer and 3 Ahmed implants). Five eyes received diode laser TSCPC with the 810 nm OcuLight laser and G-Probe. The mean time interval between surgery and accident was 88.3 months (aqueous shunt) and 32.8 months (cyclophotocoagulation). The mean follow-up was 45±36 months (von Denffer implant), 38±5 months (Ahmed</p>

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	<p>implant), and 11±8 months (cyclophotocoagulation). IOP was reduced from 39±7 to 23±6 (von Denffer implants) and from 38±3 to 8±10 (Ahmed implants). Mean IOP before treatment with cyclophotocoagulation was 33±8 and 18±2 after treatment. Systemic carbonic anhydrase inhibitors were stopped in all patients. VA deteriorated in 5 of 9 eyes treated with aqueous shunt devices and was unchanged or better in all eyes treated with cyclophotocoagulation. Multiple re-operations were necessary after aqueous shunt implantation. Severe complications leading to failure in these eyes were encapsulated bleb in 4 eyes, expulsive hemorrhage in 1 eye and phthisis in 1 eye. Cyclophotocoagulation was repeated in 2 eyes. Severe complications were not observed. Conclusion: IOP reduction was effective and comparable in both procedures. Because of the high incidence of severe complications after shunt surgery, the authors prefer cyclophotocoagulation for the treatment of intractable glaucoma after severe eye burns.</p>
<p> G-TS100 Subconjunctival Anesthesia in Contact Diode Laser Cyclophotocoagulation Schlote T, Derse M. Ophthalmic Surg Lasers 32:289-293, 2001</p>	<p>A prospective study of 120 eyes of 120 patients with advanced glaucoma were treated with the TSCPC using the OcuLight SLx and G-Probe. Subconjunctival anesthesia with 2% mepivacaine was used to evaluate whether subconjunctival anesthesia is an appropriate alternative to retrobulbar and peribulbar techniques for diode laser TSCPC. (Retro- or peribulbar anesthesia are the standard procedures for cyclodestructive surgery.)</p> <p><u>Treatment Parameters</u> Oxybuprocaine, approximately 4 to 6 drops, was instilled in the eye. Two to 2.5 mL of 2% mepivacaine was placed beneath the conjunctiva. The needle was carefully placed at least 6 to 8 mm from the limbus to avoid bleeding at the injection site near the limbus. The eye was patched for 15 minutes with low pressure to reduce chemosis and increase diffusion of mepivacaine. Diode laser TSCPC was performed 15 minutes after subconjunctival injection. Power: 2.0 W Duration: 2 seconds Note: Energy and duration were reduced in cases of thinned sclera and after occurrence of pop effects. Applications: 10 to 15 Treatment Circumference: Not more than 270° was treated.</p> <p>Complications and pain during TSCPC and on the first postoperative day were recorded based on a 5 point rating scale. During TSCPC, 82.5% (99/120) of patients experienced no pain, 11.7% (14/120) mild pain, and 5.8% (7/120) moderate pain. Of the 7 patients with moderate pain, 4 had inflammatory glaucoma, 1 juvenile, 1 chronic open-angle, and 1 pseudoexfoliation glaucoma. No instances of pain or excess motion occurred that required peribulbar anesthesia or discontinuation of the procedure. Complications were almost all transient and mild. No phthisis, bulbus hypotonia or scleral perforation occurred. Conclusions: Since most of the patients experienced no pain during diode laser TSCPC using subconjunctival anesthesia, the risks and side effects of retro- or peribulbar anesthesia can be successfully avoided by this simple modification. Although application of subconjunctival anesthesia is a simple technique, a very careful application is needed to avoid disruption of conjunctival vessels, because conjunctival bleeding may also compromise TSCPC because of absorption of energy.</p>

New

**G-TS101 Diode Laser Cyclophotocoagulation
Role in the Management of
Refractory Pediatric Glaucomas**
Kirwan JF, Shah P, Khaw PT.
Ophthalmology 109: 316-323, 2002

The purpose of this study was to report the efficacy and complications of diode laser cyclophotocoagulation (cyclodiode) in the management of refractory pediatric glaucomas. All treatments were performed using the IRIS Medical G-Probe. Seventy-seven eyes of 61 patients underwent cyclodiode. Mean age was 7.4 years (range, 0.4-17 years). Diagnoses included aphakic glaucoma, congenital glaucoma, juvenile chronic arthritis, aniridia, anterior segment dysgenesis, and Sturge-Weber syndrome. Sixty percent of eyes were aphakic, and 64% had undergone at least one previous surgical procedure for glaucoma. Mean pretreatment IOP was 32.0 mmHg.

Treatment Parameters

Power: 1500 mW for 1500 ms. Power was reduced if pops were heard during treatment.

Applications: 40

Treatment Circumference: 300°, sparing the 3- and 9-o'clock positions.

Retreatments: Once on 33 of 77 eyes (44%), twice on 20 eyes (26%), 3 times on 12 eyes (15%), and 4 or more times on 12 eyes (15%).

Topical corticosteroids were prescribed for 6 weeks after treatment.

Median follow-up was 21 months (range, 13-56 months).

Treatment was defined as successful if IOP was reduced by 30% or more or if IOP was reduced to less than 22 mm Hg). After one treatment session, 62% had a clinically useful reduction in IOP, but this had fallen to 37% by 12 months. With repeat cyclodiode, 73% had a clinically useful reduction in IOP for a year or more (mean, 8.4-month interval between treatments). Aphakic eyes had a more sustained IOP reduction ($P < 0.01$ log rank test). Of treatment failures, 13% had no useful IOP response, and 3 eyes developed subsequent retinal detachment and loss of vision. No other eyes lost vision because of cyclodiode-related complications. In 5.5% of the treatment sessions there was a significant post-treatment inflammatory episode. Cyclodiode treatment did not enable a reduction in the number of medications. VA remained constant for most patients. Overall, one or more level of vision was lost in 4 of 53 eyes (8%). All eyes losing vision had a pretreatment VA of 6/60 or worse; 3 had hand movements or worse. Patients lost vision either because of adverse effects or because of progression of severe glaucoma. Conclusions: With repeated treatment, cyclodiode can provide effective control of IOP. However, the success rate is lower than with adults, and younger eyes may recover from treatment more rapidly. Although response may be temporary, cyclodiode has a lower rate of severe adverse effects than surgical modalities and has roles as a temporizing measure, as an adjunct to surgery, or in managing selected patients in whom surgery is undesirable because of a high risk of surgical complications. Cyclodiode is a useful addition to the armamentarium of the ophthalmologist managing pediatric glaucomas.



G-TS102 Supplemental Transscleral Diode Laser Cyclophotoagulation after Aqueous Shunt Placement in Refractory Glaucoma
 Semchyshyn TM, Tsai JC, Joos KM.
 Ophthalmology 109; 1078 – 1084, 2002

To assess the outcome of supplemental TSCPC after aqueous tube shunt placement to obtain effective IOP control, a retrospective non-comparative case series was conducted. Twenty-one eyes in 21 subjects (12 adults and 9 children) with uncontrolled IOP, despite the presence of an aqueous tube shunt and maximally tolerated glaucoma medications, were treated with the IRIS Medical G-Probe.

Treatment Parameters

Transpupillary transillumination was performed to identify the location of the ciliary body

Duration: 2000 msec per spot.

The shunt tube, 3-o'clock, and 9 o'clock positions were avoided. Subjects received cycloplegic and steroid drops postoperatively. Retreatment: 7 of 21 (33%) subjects required additional treatment.

A complete success was defined as a final IOP of < 21 and >5 mm Hg without medications; qualified success as a final IOP of < 21 and >5 mm Hg aided by glaucoma medications; qualified failure as an IOP > 21 mm Hg with or without glaucoma medications; and failure as phthisis or loss of light perception. At a mean follow-up of 26.9 ± 13.4 months (range, 7-58 months), with the IOP outcome measure, 1 subject was identified as a complete success (5%), 14 were qualified successes (66%) and 6 were failures (29%). The average IOP was significantly reduced from a preoperative level of 35.7 ± 14.7 (SD) mm Hg to a postoperative level of 13.6 ± 7.1 (SD) mm Hg (P <0.001) with the mean number of medications significantly reduced from 3.4 ± 1.0 (SD) to 1.5 ± 1.3 (SD) (P < 0.001). Seven subjects (33%) had additional laser treatment to achieve IOP control. Vision either remained same or improved in 10 of 21 (48%) eyes. Fifty-two percent (11 of 21) of the subjects lost at least 1 line of central VA between the preoperative and last examination. Six subjects who were therapy failures included 3 who developed no light perception in the setting of proliferative diabetic retinopathy; 1 subject with chronic angle-closure glaucoma who gradually developed no light perception after refusing further treatment or medication; and 2 subjects who developed retinal detachments. One child who was a qualified success underwent enucleation and debulking of an enlarging neurofibroma that caused significant proptosis and disfigurement.

Conclusions: Supplemental diode TSCPC is therefore not only useful to lower IOP to target ranges but also to reduce the number of glaucoma medications, thereby decreasing the risk of medication side effects. Reapplication of the diode laser treatment may be necessary to achieve long-term IOP control. In cases of glaucoma that are uncontrolled despite a glaucoma aqueous tube shunt and multiple medications, adjunctive TSCPC treatment is an available option to lower IOP.

New

G-TS103 Correlation between Iris Color and Ciliary Body Pigmentation. Possible Implications for Cyclophotoablation Treatment.

Nesher R,¹ Meshulam H,² Assia E,¹ Zamir E,² Peer J.²
¹Sapir Medical Center, Kfar Saba, Tel-Aviv University Medical School, Israel.²Hadassah Hebrew University Medical School, Jerusalem, Israel. International Congress of Ophthalmology Meeting. Sydney, Australia. 2002

Also listed as HIST24, pg. 241

Cyclophotoablation is dependent on the amount of laser absorbed by the tissue, which is related to the degree of tissue pigmentation. Current guidelines for laser power adjustment during treatment are not fully determined and some patients require repeated procedures. The authors hypothesized that if a correlation between iris color and degree of pigmentation of ciliary processes exists, this information would be valuable in pre-selection of treatment parameters, and possibly lead to better results. Thirty-one enucleated eyes were studied. The pigmented epithelium of the ciliary processes was qualitatively scored for 6 histological parameters: information on iris color was received by telephone interviews in 22 cases. In 9 cases, iris color was defined from the wet tissue. Nineteen eyes had brown iris (group A) and 12 eyes had light colored iris (group B). Group A had significantly increased cell pigmentation, blurring of cell margins, number and aggregation of melanosomes, and ciliary vascularization, and significantly decreased number of vacuoles, compared to group B (Mann-Whitney test, $p < 0.01$). These results suggest a correlation between iris color and the degree of pigmentation of the ciliary processes. Iris color may serve as one of the factors determining laser power for cyclophotocoagulation. Future studies on correlation of iris color with cyclophotocoagulation treatment results are in order.

New

G-TS104 Pathology of Cyclodiode Laser: A Series of Nine Enucleated Eyes

McKelvie PA, Walland MJ.
 Br J Ophthalmol 86:381–386, 2002

Also listed as HIST28, pg. 243

A detailed histological examination of 9 enucleation specimens was undertaken in conjunction with a retrospective review of patient case notes to study the histological effects of cyclodiode laser treatment in humans, and to compare these findings with the clinical course, treatment response, complications, and indications for enucleation. The time to enucleation ranged from 2 weeks to 4 years 1 month after diode (median 7 months). Causes of glaucoma were neovascular glaucoma in 4, chronic open angle glaucoma in 1, chronic angle closure following penetrating keratoplasty in 1, epithelial downgrowth in 2, and absolute pseudoexfoliation glaucoma in 1. All patients received diode laser therapy with the OcuLight SLx laser.

Treatment Parameters

Power: 1500 mW to 2200 mW
 Duration: 1500 ms to 2100 ms
 Treatment Circumference: 180°– 360°
 Retreatments: 3 (33%) patients received 2 or more treatments

Although all globes showed damage to pars plicata, intact ciliary processes within the treatment zone were present in all cases. Pars plana injury was also noted in two thirds of cases. Inflammation was mild. Ciliary epithelial proliferation was seen in most cases with increasing time following treatment, in a disorganized pattern, without replication of the ciliary epithelial bilayer. No regeneration of the ciliary processes with fibrovascular cores was found. The 3 patients with good IOP control at enucleation had all had multiple diode treatments. Neither phthisis nor sympathetic ophthalmia was seen. Conclusions: Diode laser TSCPC produces very characteristic injury to pars plicata, which frequently extends into pars plana, but with only mild persisting inflammation. Ciliary processes are, however, frequently spared within the treatment zone and may account for early or late treatment failure. Histological examination in

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	<p>this series of patients with refractory glaucoma and enucleation has shown that diode laser is associated with much less long term inflammation of intraocular structures than Nd:YAG laser or cryotherapy.</p>

Reference Catalog: Summaries of Studies

GLAUCOMA - OTHER

<i>Suture Lysis</i>	
<p>G-SLY1 Diode Laser Suture Lysis Following Trabeculectomy with Mitomycin Lieberman M. Arch Ophthalmol 114:364, 1996</p>	<p>Dr. Lieberman shares his observations using the OcuLight and Slit Lamp Adapter for suture lysis following trabeculectomy with Mitomycin. Problem: The diode laser set at 1 W for 0.1 to 0.2 seconds with a 75 µm beam did not consistently break sutures (using a Zeiss four-mirror gonioscens or Hoskins suture lysis lens). Solution: Use of the Mandelkorn suture lysis lens (Ocular Instruments) increased the power density of the diode laser beam so 100% of sutures were reliably lysed. The diode laser, unlike the argon laser, does not create thermal burns in thin-walled mitomycin blebs. Because of its small diameter, the Mandelkorn lens does not require viscous coupling agents. The use of the Mandelkorn lens appears to increase the versatility of the OcuLight 810 nm diode laser in glaucoma management.</p>
<i>Peripheral Iridoplasty/Iridotomy</i>	
<p>G-PI1 Comparison of Corneal Transmissibility of 810 nm Diode Laser With 488 nm Argon Laser; Diode Laser Peripheral Iridoplasty/Iridotomy in Acute Angle Closure Glaucoma Wong JS,¹ Chew P,² Chee C.¹ ¹Singapore National Eye Centre; ²National Univ. of Singapore. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S472. Abstract nr 2162, 1998</p> <p><i>See related article, HIST13, pg. 236</i></p>	<p>The authors compared the transmissibility of argon (488 nm) and diode (810 nm) laser through clear and hazy human-donor corneal buttons. Five dark-irides Asian patients with acute angle closure glaucoma and hazy cornea underwent laser iridoplasty and/or sequential diode/YAG laser peripheral iridotomy (PI). Transmissibility of diode laser was 89% and 82% through clear and hazy cornea respectively and was superior to argon blue-green (85% and 73% respectively) (p<0.01, paired t-test). All patients had successful diode laser iridoplasty/PI with immediate reversal of pupillary block. Conclusion: Transmission of diode laser is superior than argon laser in patients with edematous cornea and diode laser PI may be the ideal laser in dark irides patients with AACG.</p>
<p>G-PI2 Efficacy and Safety of Inferior 180 Degrees Goniosynechialysis Followed by Diode Laser Peripheral Iridoplasty in the Treatment of Chronic Angle-Closure Glaucoma Lai JS, Tham CC, Chua JK, Lam DS. J Glaucoma 9(5);388-391, 2000</p>	<p>Five eyes of 5 patients with chronic angle-closure glaucoma and total synechial angle closure, whose IOPs were higher than 21 mm Hg while taking maximally tolerated medications, underwent goniosynechialysis followed by diode laser peripheral iridoplasty to the inferior half of the angle. Intraoperative complications, postoperative visual acuity, IOPs, and complications were evaluated. Results: Mean follow-up was 7.6 months (range, 6-12 months). The mean preoperative IOP was 33.8 ± 5.8 mm Hg. The mean postoperative IOP at most recent follow-up was 15.8 ± 2.2 mm Hg. Postoperative complications included transient increase in IOP, hyphema, and cataract. The success rate (IOP <20 mm Hg with or without medication) was 80.0%. Conclusion: It appears that 180° goniosynechialysis followed by diode laser peripheral iridoplasty is an effective and safe surgical procedure for treating chronic angle-closure glaucoma with total synechial angle closure.</p>
<p>G-PI3 Immediate Diode Laser Peripheral Iridoplasty as Treatment of Acute Attack of Primary Angle Closure Glaucoma: A Preliminary Study Lai JS, Tham CC, Chua JK, Lam DS J Glaucoma 10(2);89-94, 2001</p>	<p>Nine consecutive patients with acute primary angle-closure glaucoma (PACG) were recruited to study the efficacy and safety of diode laser peripheral iridoplasty as a first-line treatment of acute primary angle-closure glaucoma without the use of systemic anti-glaucoma medications. Each patient received topical pilocarpine (4%), timolol (0.5%), apraclonidine (1%), and immedi-</p>

	<p>ate diode laser peripheral iridoplasty as primary treatment. IOPs were documented 15, 30, and 60 minutes after treatment. Results: The mean IOP was reduced from 66.3 ± 9.7 mm Hg, before diode laser peripheral iridoplasty, to 36.6 ± 16.4 mm Hg at 15 minutes, 26.3 ± 12.6 mm Hg at 30 minutes, and 18.9 ± 8.4 mm Hg at 60 minutes after diode laser peripheral iridoplasty. In 7 of the 9 patients, the corneal edema cleared up 1 hour after diode laser peripheral iridoplasty. In the remaining patient, the cornea cleared up 12 hours after treatment. No significant complications were encountered. Conclusion: Diode laser peripheral iridoplasty, together with topical antiglaucoma medications without adjunctive systemic carbonic anhydrase inhibitors and hyperosmotic agents, appeared to be effective and safe in controlling IOP in acute PACG.</p>
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Laser-Cured Glue for Bleb Leaks

<p>G-LCG1 Laser-Cured Fibrinogen Glue to Repair Bleb Leaks in Rabbits Wright MM, Brown EA, Maxwell K, Cameron JD, Walsh AW. Arch Ophthalmol 116:199-202, 1998</p>	<p>The authors used IRIS Medical's OcuLight SL photocoagulator to determine whether 810 nm diode laser-cured fibrinogen glue can close bleb leaks in rabbits. Full-thickness filtration surgery was performed in the right eye of 19 New Zealand albino rabbits. Ten rabbits served as controls and 9 rabbits made up the treatment group where a 2 - 3 mm hole was punched into the bleb. The fibrinogen glue was made from single-donor human plasma with indocyanine green dye (ICG) and was applied to the hole using a pipette. An endolaser probe was held approximately 5 mm above the glue and passed back and forth over the glued area until the glue turned into a dry, firm, golden-brown adhesive and was repeated until all the glue was cured. (Power: 700-800 mW; Duration: 5 seconds) The cured glue remained on the conjunctiva for an average of 1.9 ± 1.8 days (range, 0-5 days). The last day of bleb leak for the rabbits with glued eyes was 1.6 ± 2.4 days; for the control rabbits, it was 8.0 ± 4.4 days. ($p = 0.001$). The fibrinogen glue alone does not adhere well to the conjunctiva, particularly with a constant seepage of aqueous. The fibrinogen glue and ICG dye, on the other hand, adheres firmly to the conjunctiva after it is cured with the diode laser. There was no difference between the appearance of blebs in the glued and the control rabbit eyes after the leak had stopped. The authors believe that the use of laser-cured fibrinogen glue may offer another useful approach to the treatment of bleb leaks after filtration surgery. Although it has yet to be tested in humans, it has the theoretical advantages of being an office procedure that uses a commercially available laser, is able to be repeated, and does not expose the patient to exogenous blood-borne pathogens.</p>
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Additional Education Material Available on:

Glaucoma

GLT-A Applications Note: Diode Laser Trabeculoplasty

This Applications Note provides a summary of clinical studies demonstrating that the diode laser can obtain comparable laser trabeculoplasty results to those of the argon laser. It also details recommended parameters and treatment methodology using the IRIS Medical infrared diode laser system, and includes a chart of laser lenses and selected spot size suggested for trabeculoplasty.

GTS-T Treatment Guidelines*:

Diode Laser Transscleral Cyclophotocoagulation

A two-page reference source that summarizes:

1. G-Probe Treatment:
 - What to do prior to treatment
 - How to treat within the treatment quadrants
 - How to adjust treatment parameters based on pigmentation
2. Keys to Success: This section reviews the importance of:
 - G-Probe fiber cleanliness
 - G-Probe and eye moistness
 - G-Probe placement and indentation

3. Postoperative Care

*This guideline should be used in conjunction with the IRIS Medical G-Probe Operator's Manual and with the video tape: "Transscleral Cyclophotocoagulation for Refractory Glaucoma with the G-Probe".

GTS-P Patient Education Brochure:

Understanding a New Therapy for Refractory Glaucoma: Diode Laser Transscleral Cyclophotocoagulation

An 8 page brochure created to help the patient understand the types of glaucoma and treatment options. It also reviews the use of the G-Probe for TSCPC and includes a glossary of terms.

Reference Catalog: Summaries of Studies

OCULAR TUMORS

Chemothermotherapy	
<p>OCU-CH1 Alternatives to the Use of External Beam Radiotherapy in Bilateral Retinoblastoma Murphree AL, Malogolowkin M, Gomer CJ, Sato J. Scientific Paper SP473. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>External beam radiotherapy significantly increases the incidence of second malignant neoplasms in people genetically predisposed to retinoblastoma. As treatment alternatives, the authors have introduced chemoreduction and thermochemotherapy, the combination of systemic carboplatin therapy and focal transpupillary laser hyperthermia. Since 1990, the authors have treated 60 tumors in 38 eyes of 30 patients with thermochemotherapy; 13 of the 30 patients had recurrent disease. In all of the recurrences, the tumor was large, or diffuse vitreous seeding was present. Results show that thermochemotherapy is effective in the treatment of small posterior pole retinoblastomas. Chemoreduction, the use of VP-16, carboplatin and vincristine systematically, was effective initial therapy in 13 large retinoblastomas.</p>
<p>OCU-CH2 Chemoreduction in the Management of Retinoblastoma Shields J, Shields C, De Potter P, Meadows A. Philadelphia, PA Abstract. Retina Society. Santa Fe, NM September 6-10, 1995</p>	<p>Chemoreduction is a method by which chemotherapeutic agents are given in order to reduce the size of a neoplasm so that a more conservative treatment method may be used. We employed chemoreduction with carboplatin, etoposide, and vincristine to initially manage 10 children with retinoblastoma. All tumors showed a very favorable response to chemoreduction, with a dramatic decrease in tumor size. Chemoreduction can reduce the size of a large tumor so that radiotherapy, rather than enucleation, may be employed. It can reduce the size of selected tumors so that local plaque radiotherapy, rather than external beam irradiation, may be used. It can reduce some medium-sized tumors so that radiation can be avoided and the tumor treated with photocoagulation or cryotherapy. In one case, chemoreduction totally destroyed a macular tumor, so that no additional treatment was necessary. It appears that chemoreduction can shrink selected retinoblastoma to the point that a more conservative treatment method can be employed, with a better visual outcome and excellent systemic prognosis.</p>
<p>OCU-CH3 Chemotherapy Plus Local Treatment in the Management of Intraocular Retinoblastoma Murphree AL, Villablanca JG, Deegan WF, Sato JK, Malogolowkin M, Fisher A, Parker R, Reed E, Gomer CJ. Arch Ophthalmol 114:1348-1356, 1996</p>	<p>Platinum levels were measured by atomic absorption analysis in the tumors of 2 patients with retinoblastoma given carboplatin 5 or 2.5 hours before enucleation. Platinum levels in heated vs. non-heated Green melanoma tumors in rabbits were compared. A retrospective review of 172 affected eyes in 136 consecutive patients treated for retinoblastoma between January 1990 and December 1995 was performed. From 1990 to 1992, all treated eyes initially received systemic carboplatin, 560 mg/m², followed by 15 to 30 minutes of continuous diode laser hyperthermia (thermochemotherapy). Since 1992, larger tumors were treated initially with 3 monthly cycles of carboplatin, etoposide, and vincristine sulfate to reduce tumor volume (chemoreduction) followed by sequential aggressive local therapy (SALT) during examinations under anesthesia every 2 to 3 weeks. Treatment success was defined as eradication of tumor without enucleation or external beam radiotherapy. Transfusions were required in 15% of patients. Radiation retinopathy occurred in all 6 eyes treated with iodine 125 plaques. Conclusion: Thermochemotherapy is successful primary treatment for Reese-Ellsworth</p>

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	<p>group 1 and 2 retinoblastomas. For larger tumors in the absence of vitreous or extensive subretinal seeding, 3 cycles of chemoreduction followed by SALT eradicates residual viable tumor. Chemoreduction plus SALT was not successful in eyes with diffuse vitreous or extensive subretinal seeding. Prior chemotherapy increases the risk for radiation retinopathy following 125 plaque therapy. External beam radiotherapy can safely be avoided in the primary treatment of Reese-Ellsworth groups 1 through 4 nondispersed retinoblastoma.</p>
<p>OCU-CH4 Thermotherapy and Chemotherapy for Retinoblastoma De Potter P, Shields CL, Shields JA, Kheterpal S, Hamoda A, Needle M. Oncology Service, Wills Eye Hospital, Philadelphia, PA Free Paper. AAO. Chicago, IL October 29, 1996</p> <p><i>Also listed as OCU-TTT6, pg. 155</i></p>	<p>To evaluate the effectiveness of thermotherapy alone or combined with chemotherapy for selected retinoblastoma, the authors conducted a prospective study analyzing tumor response after thermotherapy. Among twenty eyes, 16 tumors were treated with thermotherapy and 11 with chemo-thermotherapy. All tumors (mean base, 4.3 mm; mean thickness, 2.2 mm) were within 6.5 mm from the disc. After a mean follow-up of 12 months, all tumors (27) were completely regressed without requiring further treatment. The treatment induced focal RPE damage at the tumor site without remote complications. Thermotherapy appears to be a safe and effective alternative treatment for selected posterior pole retinoblastoma.</p>
<p>OCU-CH5 Turning Up the Heat on Retinoblastoma Shields C. Review of Ophthalmology 4(3):116-118, 1997</p> <p><i>Also listed as OCU-TTT8, pg. 156, and OCU-TS1, pg. 177</i></p>	<p>This article summarizes three relatively new retinoblastoma treatment options. Two of the options* use the 810 nm OcuLight system.</p> <p>*Thermotherapy Thermotherapy involves applying infrared (810 nm) radiation to heat the cancerous cells to around 50° or 60° C, killing them. It's used to treat small tumors 8 mm or smaller in base, and 4 mm or less in thickness. Thermotherapy can be delivered two ways: 1) Transpupillary Thermotherapy (TTT) is used to treat tumors in the post-equatorial region. TTT takes patience, since treatment is "slow cooking" the tumor over 20 to 40 minutes. TTT offers benefits over traditional laser photocoagulation: Doctors can treat tumors in the macula or papillomacular bundle and still spare some vision, something almost impossible to accomplish with photocoagulation. 2) Transscleral Thermotherapy is used to treat tumors anterior to the equator and is replacing cryotherapy for small, peripheral tumors. Using indirect ophthalmoscopy with a 20 D lens to visualize the tumor, the surgeon places a DioPexy™ Probe (810 nm) probe on the outside of the eye in the area of the tumor and begins heating it. In 2 to 5 minutes, the tumor will turn white and begin to scar down (smaller than what can be achieved with cryotherapy). Transscleral thermotherapy destroys tumors more quickly than transpupillary thermotherapy because the direct infrared energy quickly heats the choroid and RPE.</p> <p>Chemotherapy Chemoreduction involves introducing an initial jolt of medication that can shrink large tumors to half their thicknesses and 30% of their base sizes. Chemotherapy is given intravenously in 2 to 6 cycles, delivered over 2 days, with each cycle spaced 3 to 4 weeks apart. Chemotherapy can flatten retinas in three-quarters of eyes with retinoblastoma and total detachments. Chemotherapy may induce secondary tumors in children with bilateral tumors. Because of the IV delivery, patients lose their hair, and</p>

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	<p>experience bone marrow suppression and possible infections; however, these side effects are not permanent.</p> <p>*Chemothermotherapy Tumors flattened by chemotherapy (to 4 mm or less in thickness) can then be treated with TTT or other focal methods. For larger tumors, giving chemotherapy immediately prior to thermotherapy can be effective. The author has had no recurrences using this on appropriately sized tumors.</p>
<p>OCU-CH6 Role of Chemoreduction and Thermochemotherapy in the Management of Intraocular Retinoblastoma Munier FL,¹ Balmer A,¹ Nenadovbeck M.² ¹Jules Gonin Eye Hospital, and ²Pediatric Oncology Unit, Dept of Pediatrics, Lausanne Univ., Switzerland Abstract. International Symposium on Ocular Tumors. Jerusalem, Israel April 6 - 10, 1997</p>	<p>Between September 1995 and September 1996, 16 retinoblastoma patients (21 eyes) were eligible for the chemoreduction or thermochemotherapy protocols. Mean follow-up was 9 months. Complete response was obtained in 14 eyes (67%), partial response in 4 eyes (19%), and progressive disease in 3 eyes (14%) requiring enucleation (2 eyes) or external beam radiotherapy. Chemoreduction and thermochemotherapy represent powerful therapeutic tools minimizing the need for external beam radiotherapy.</p>
<p>OCU-CH7 Thermotherapy for Retinoblastoma Shields CL, Shields JA, Needle M, De Potter P. Oncology Service, Wills Eye Hospital, Philadelphia, PA Abstract. International Symposium on Ocular Tumors. Jerusalem, Israel April 6 - 10, 1997</p> <p><i>Also listed as OCU-TTT9, pg. 157</i></p>	<p>Thirty-six retinoblastomas in 26 eyes of 21 patients were treated with thermotherapy and followed for a mean of 9 months. The mean age at first treatment was 11 months. The mean tumor base was 4.0 mm and thickness 2.2 mm. All tumors were within 8 mm of the optic disc and/or foveola. For thermotherapy, the parameters were 440 mW at 15 minutes and for chemothermotherapy 420 mW at 16 minutes. Tumor control was 89% with thermotherapy and 100% with chemothermotherapy. Ocular side effects included iris atrophy (27%), lens opacity (15%), vein obstruction (15%), retinal fibrosis (4%). Thermotherapy and chemothermotherapy represent a promising option in the management of selected small retinoblastoma.</p>
<p>OCU-CH8 Role of Chemotherapy Alone or in Combination with Hyperthermia in the Primary Treatment of Intraocular Retinoblastoma: Preliminary Results Levy C, Doz F, Quintana E, Pacquenment H, Michon J, Schlienger P, Validire P, Asselain B, Desjardins L, Zucker JM. Br J Ophthalmol 82:1154-1158, 1998</p>	<p>The objectives of this study were to evaluate the efficacy and toxicity of the combination of etoposide and carboplatin and thermochemotherapy in 23 patients with intraocular retinoblastoma. Twenty patients had bilateral retinoblastoma and 3 patients had unilateral retinoblastoma. Tumor diameter was between 1.5 mm and 10 mm (median 4.5 mm). Of the 23 patients, 15 patients were treated (17 eyes, 21 tumors) with the combination of carboplatin and the OcuLight 810 nm diode laser. The authors used a 1.2 mm spot at 600 mW; however, if the treatment induced wide edema around the lesion, the hyperthermia was probably too intense and a smaller spot size and energy were used, especially when treating lesions close to the macular or optic disc. (Underdosage carries a risk of tumor recurrence. Overdosage carries a risk of damage to macular or optic disc. The authors considered that even when the tumor is totally flattened and replaced by pigment disturbance after one cycle, the treatment was probably too light; so as a safety measure, they preferred to complete treatment by cryotherapy when possible.) No relapse of tumors treated by 3 cycles of thermochemotherapy occurred in 9 tumors (7 eyes of 6 patients) with a median follow-up of 19.2 months (range 12-32 months). No relapse occurred in 3 tumors (3 eyes of 3 patients) treated by one cycle of thermochemotherapy and completed by cryotherapy with</p>

Reference Catalog: Summaries of Studies

	<p>a follow-up of 13.2, 20, and 23 months. Local relapses occurred in 9 tumors (9 eyes of 8 patients) and retreatment consisted of thermochemotherapy in 1 eye, cryotherapy in 1 eye, radioactive iodine plaque in 1 eye, thermochemotherapy and radioactive iodine plaque on the peripheral part of the tumor in 2 eyes, and external ocular irradiation in 3 eyes. The median follow-up after treatment of eyes with local relapse was 13.8 months (range 4-29 months). External irradiation had been avoided in 14 of the 17 eyes. Conclusions: The combination of carboplatin chemotherapy and hyperthermia with the 810 nm diode laser seems to be an advance in the treatment of retinoblastoma. It should represent a new therapeutic approach, avoiding the need for external beam radiation in small to moderately large posterior pole lesions. Nevertheless, the results presented here are preliminary and need to be re-evaluated with a longer follow-up.</p>
<p>OCU-CH9 Recent Developments in the Management of Retinoblastoma Shields CL, Shields JA. J Pediatr Ophthalmol Strabismus 36:8-18, 1999</p> <p><i>Also listed as OCU-TTT17, pg. 161</i></p>	<p>This article reviews available techniques for the treatment of retinoblastoma. Two of the techniques reviewed that can be performed with the OcuLight infrared photocoagulator are thermotherapy and chemothermotherapy. These two treatments, and plaque radiotherapy, play an important role in the current management of many children with retinoblastoma. The selection of the modality of thermotherapy or chemothermotherapy depends on many factors, including tumor size, location, laterality, status of the opposite eye, presence of subretinal fluid and seeds, presence of vitreous seeds, and prior or ongoing chemoreduction.</p> <p>Thermotherapy Thermotherapy is a method of delivering heat to the eye using ultrasound, microwaves, or infrared laser radiation. It is the newest focal method for retinoblastoma. When combined with chemotherapy, thermotherapy provides satisfactory tumor control, leaving the child with a reasonably small scar, thus preserving more vision. The goal is to heat the tumor to 45°C to 60°C, leaving a gray-white scar at the site. In general, small tumors require approximately 300 mW power for 10 minutes or less, each delivered over three sessions at 1 month intervals.</p> <p>Chemothermotherapy Chemothermotherapy is especially suited for small tumors adjacent to the fovea and optic nerve where radiation or laser photocoagulation would possibly induce more profound visual loss. It is a time-consuming, tedious process that requires careful observations, recordings, judgements, and treatment of subtle tumor findings. The goal is to deliver a temperature of 42°C to 45°C, for 5 to 20 minutes, depending on the tumor size and location. The result from chemothermotherapy is a light gray scar with less risk for tractional and retinal vascular problems than is found with thermotherapy alone.</p> <p>Tumor size is important to the success of treatment. For instance, laser photocoagulation is usually limited to tumors 4.5 mm or less in base and 2.5 mm or less in thickness with no evidence of vitreous seeds. Cryotherapy is most successful if limited to tumors 3.5 mm or less in diameter and 2.0 mm or less in thickness with no evidence of vitreous seeds. Chemothermotherapy can be adequately used to treat tumors 15 mm or less in base, especially if the patient is receiving three agent chemoreduction.</p>

OCULAR TUMORS

<i>Continuous-Wave Photocoagulation</i>	
<p> OCU-CW1 Diode Laser Photocoagulation of Choroidal Tumors Colín A, García-Arumi J, Corcóstegui B, Mateo C. Autonoma Barcelona Univ., Spain [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 2117. Abstract nr 3994, 1994</p>	<p>Three posterior choroidal hemangiomas that produced visual loss because of serous detachment of the fovea were treated. Transpupillary diode laser with the indirect ophthalmoscope was performed in two cases, while vitrectomy, transscleral drainage of subretinal fluid and endophotocoagulation was employed in one case with total retinal detachment. Additionally, three posterior melanomas were photocoagulated using the indirect ophthalmoscope, one of them prior to enucleation. IRIS Medical diode laser (810 nm) was employed, using a spot size ranging from 200 to 500 µm, a duration of 0.2 seconds, and a power of 800-1000 mW for the transpupillary approach, and 600-700 mW for the intravitreal approach. Confluent laser burns were applied on the tumor surface and surrounding it in the choroidal hemangiomas, and in three sessions in the melanomas, as currently described. All patients with choroidal hemangiomas showed complete resolution of subretinal fluid with improvement in visual acuity within 1 to 2 weeks after treatment. One case needed two additional re-treatment sessions. Histopathologic studies in the enucleated eye with choroidal melanoma showed tumor necrosis of 4 mm thickness in the area treated with laser, and observed tumor regression in the other two treated melanomas. Diode laser photocoagulation may be employed as the treatment of choice in choroidal melanomas and hemangiomas not exceeding 4 mm in thickness.</p>
<p> OCU-CW2 Transpupillary Thermotherapy in the Management of Choroidal Melanoma Shields CL, Shields JA, De Potter P, Kheterpal S. Ophthalmology 103:1642-1650, 1996 <i>Also listed as OCU-TTT4, pg. 154</i></p>	<p>Seventeen patients with choroidal melanoma were treated with TTT (using the OcuLight 810 nm photocoagulator and a Haag-Streit Slit Lamp Adapter) delivered over one to four sessions and followed for at least a 6-month period. Immediately before treatment, topical anesthetic and a retrobulbar injection was given. Starting treatment parameters: Power: 300 mW; duration: 1 minute, in 1 spot. The initial spot* was applied in a region of the tumor most distant from the optic disc and foveola. Thereafter, spots were delivered in overlapping confluency, including 0.5 mm of clinically normal tissue around the margin of the tumor. If a light-gray endpoint at the completion of the treatment spot was not observed, power was increased by 50 mW steps for 1 minute until a light-gray endpoint at the completion of the treatment spot was achieved. If color change was observed early in the exposure or coagulation of the retinal vessels, then the power setting was lowered. Follow-up exams (clinical examination, fundus photography, and ocular ultrasonography) were performed at 1- to 3-month intervals. If the tumor was judged partially regressed, further treatments were performed to reach a completely regressed chorioretinal scar.</p> <p>At last follow-up (mean, 6 months) all patients were alive with no evidence of melanoma metastasis. All tumors showed some degree of regression to the thermotherapy. The overall tumor thickness reduction was 43% (21% for amelanotic melanoma and 50% for heavily pigmented tumors). None of the patients had local tumor recurrence. Complications included overlying branch</p>

	<p>retinal artery or vein occlusion (8 patients), less than a 500 μm retinal hemorrhage (4 patients), retinal traction (4 patients), macular edema (2 patients), focal neovascularization of the retina (2 patients), and choroidal hemorrhage (1 patient).</p> <p>*Spot Size: 3.0 mm to cover large portions of the melanoma tissue; 2.0 and 1.2 mm spot sizes were used to avoid the optic disc or retinal vessels. (Decreasing the spot size increases the power density; therefore, the power was decreased accordingly to achieve the light-gray endpoint.)</p> <p>The differences between laser photocoagulation and infrared thermotherapy:</p> <table border="1"> <thead> <tr> <th></th> <th><u>Laser Photocoagulation</u></th> <th><u>Thermotherapy</u></th> </tr> </thead> <tbody> <tr> <td>Beam Size</td> <td>50 to 500 μm</td> <td>3.0 to 4.5 mm</td> </tr> <tr> <td>Wavelength</td> <td>infrared, argon, krypton</td> <td>infrared only (810 nm)</td> </tr> <tr> <td>Duration</td> <td>fraction of a second</td> <td>1 minute or more</td> </tr> <tr> <td>Depth of tumor necrosis</td> <td>less than 1 mm</td> <td>3.0 to 4.5 mm</td> </tr> <tr> <td>Pathophysiology</td> <td>Rise in temperature above 65°C causes direct necrosis due to coagulation of tissue</td> <td>Subcoagulation temperatures of 45° to 60°C induce cell necrosis due to intracellular breakdown primarily of mitochondria.</td> </tr> </tbody> </table>		<u>Laser Photocoagulation</u>	<u>Thermotherapy</u>	Beam Size	50 to 500 μm	3.0 to 4.5 mm	Wavelength	infrared, argon, krypton	infrared only (810 nm)	Duration	fraction of a second	1 minute or more	Depth of tumor necrosis	less than 1 mm	3.0 to 4.5 mm	Pathophysiology	Rise in temperature above 65°C causes direct necrosis due to coagulation of tissue	Subcoagulation temperatures of 45° to 60°C induce cell necrosis due to intracellular breakdown primarily of mitochondria.
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<p>OCU-CW3 Diode Laser Photocoagulation of Choroidal Hemangioma Lanzetta P, Virgili G, Ferrari E, Menchini U. Department of Ophthalmology, Univ. of Udine, Italy International Ophthalmology 19:239-247, 1996</p>	<p>Two cases of choroidal hemangioma with a serous detachment of the neural retina were treated with surface photocoagulation with a diode laser (807 nm). The aim of the treatment was to create a chorioretinal adhesion to facilitate reattachment of the retina and the resolution of the subretinal fluid. To produce a white reaction on the tumor, surface photocoagulation was applied with the following treatment parameters: Powers between 800 and 1000 mW, Spot Size: 500 μm, Lens: Goldmann three-mirror, and the duration was regulated on the foot pedal by the operator according to the appearance of the retinal whitening (maximum duration was 0.5 seconds). The efficacy of photocoagulation was evaluated 3, 6, 12, and 15 months after laser treatment.</p> <p>Over a period of time ranging between 1 to 3 months, both eyes showed a re-settlement of the serous detachment of the neural retina after the first session of treatment. There was an improvement in visual acuity as a result of the resolution of the serous detachment of the neural retina; in patient 1 there was an improvement from 0.8 to 1 and in patient 2 from 0.5 to 0.9. The diode laser irradiation did not damage the internal limiting membrane and produced a coagulative effect without provoking excessive cellular breakage and pigment debris dispersion. No important changes were observed in the inner retinal layers. The damage produced at the sensory retina was confined to the photoreceptor cells and nuclei of the internal nuclear layer. No damage was seen in the various elements of the vessels or in the surrounding nerve fiber layer. Thus, the greater depth of photocoagulation using diode laser might help to safeguard the nerve fibers, reducing the risk of iatrogenic damage.</p>																		

Infrared Diode Laser Applications

<p>OCU-CW4 Episcleral Radioactive Plaque and Diode Endolaser Ablation of the Juxtapapillar Uveal Melanoma Volkov VV, Marchenko OA, Saveljeva IL. Ophthalmomicrosurgical and Laser Center, St. Petersburg, Russia Abstract. International Symposium on Ocular Tumors. Jerusalem, Israel April 6 - 10, 1997</p>	<p>Known methods of the organ-saving treatment of the uveal melanomas are impossible to realize if the tumor approaches or overhangs the optic disk margin. In such a situation, the authors used the following two-step method of treatment. At the first step the tumor base was irradiated through the sclera with the Sr⁹⁰ plaque placed closely to the optic nerve. The dose on the scleral surface was limited to 30.000 cGy. After 1 to 2 months at the second step the surface of the diminished tumor was destroyed with the diode endolaser (810 nm). The fiber probe (diameter 0.37 mm) was introduced into the eye through the pars plana and was drawn straight to the retina or the optic disk under control of the operative microscope. Generally from 10 to 25 impacts were performed. The radiation power was 1 W and the duration of the each affect was equal to 2.5 sec. The tumor was completely destroyed in 11 cases of 12; this was proven by ophthalmoscopic and ultra-sound (B-scan) control. There were 3 cases of vitreous hemorrhage that resolved within few weeks in all cases. One eye was forced to enucleate because of the aseptic scleral necrosis and then endophthalmitis. The combination of the diode endolaser and plaque radiotherapy can be the method of choice for the small juxtapapillar uveal melanomas in spite of the possibility some serious complications.</p>

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OCULAR TUMORS

<i>Transpupillary Thermotherapy (TTT) Photocoagulation</i>	
<p> OCU-TTT1 Transpupillary Thermotherapy by Infrared Irradiation of Choroidal Melanomas Oosterhuis J, Journée-de Korver HG, Kakebeeke-Kemme HM. Scientific Paper SP60. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>Based on experimental data, the authors carried out TTT with a diode laser at 810 nm as a conservative treatment in patients with choroidal melanomas. Patients with insufficient tumor regression after ruthenium 106 (¹⁰⁶Ru) applicator treatment were selected. Melanomas with a height of 5 mm or more were treated with TTT during ¹⁰⁶Ru applicator treatment. Good tumor regression was observed; however, long-term results are not yet available. Side effects were minimal, and there were no serious complications. TTT had the greatest effect at the top of the tumor, where ¹⁰⁶Ru irradiation has the least effect. TTT does not require surgery; it can be repeated, and there is no risk of overdose.</p>
<p>OCU-TTT2 Hyperthermia by Infrared Irradiation. Experimental Findings in Animal and Human Melanomas Journée-de Korver HG, Oosterhuis JA. Scientific Paper SP65. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>The tumoricidal effect of hyperthermia induced by infrared irradiation was studied in hamster Greene melanoma subcutaneously implanted in hamsters at different exposure times (one to 10 minutes) and temperatures (45°C to 60°C). It resulted in a depth of necrosis up to 6 mm. Transpupillary hyperthermia of human choroidal melanomas before enucleation resulted in a depth of necrosis of 3 mm to 4 mm. On histopathological examination, this compares favorably with photocoagulation, which only gives a depth of necrosis of less than 1 mm. Infrared hyperthermia differs from photocoagulation in technique and tissue pathophysiology. It can be performed by the transpupillary route as it combines a high tissue penetration with a low absorption by clear ocular media of less than five percent.</p>
<p> OCU-TTT3 Transpupillary Thermotherapy in Choroidal Melanomas Oosterhuis J, Journée-de Korver H, Kakebeeke-Kemme H, Bleeker J. Arch Ophthalmol 113:315-321, 1995</p>	<p>Twelve patients with choroidal melanoma were treated with TTT. An 810 nm diode laser was used with a beam diameter of 1.5 to 4.5 mm for a 1 minute exposure. Six patients had insufficient response to ruthenium 106 (¹⁰⁶RU) brachytherapy. Three patients with tumors more than 5 mm in height were treated simultaneously with ruthenium 106 and TTT. Three patients with juxta-papillary or macular tumors were treated by TTT only. All but one tumor exhibited a reduction of tumor height in a follow-up period of 3 to 14 months. One month after TTT, the decrease in tumor height was measurable. Treatment was started at a relatively low energy level, which showed no visible effect after exposure for one minute. The energy level was then raised stepwise until edema turned the tissue grayish during the exposure period. Sometimes a whitish coagulation effect was observed by the end of the 1 minute exposure, but energy levels that might produce an early coagulation effect were avoided. Side effects were minimal. Severe visual loss occurred in two patients due to radiation retinopathy, in two patients whose foveas were included in the TTT area, and in one patient resulting from a serous retinal detachment that extended over the posterior pole. Conclusion: Treatment with TTT may be useful as a complementary modality to brachytherapy. A longer follow-up period is required for final evaluation.</p>



OCU-TTT4 Transpupillary Thermotherapy in the Management of Choroidal Melanoma

Shields CL, Shields JA, De Potter P, Kheterpal S.
Ophthalmology 103:1642-1650, 1996

Also listed as OCU-CW2, pg. 149

Seventeen patients with choroidal melanoma were treated with TTT (using the OcuLight 810 nm photocoagulator and a Haag-Streit Slit Lamp Adapter) delivered over one to four sessions and followed for at least a 6-month period. Immediately before treatment, topical anesthetic and a retrobulbar injection was given. Starting treatment parameters: Power: 300 mW; duration: 1 minute, in 1 spot. The initial spot* was applied in a region of the tumor most distant from the optic disc and foveola. Thereafter, spots were delivered in overlapping confluency, including 0.5 mm of clinically normal tissue around the margin of the tumor. If a light-gray endpoint at the completion of the treatment spot was not observed, power was increased by 50 mW steps for 1 minute until a light-gray endpoint at the completion of the treatment spot was achieved. If color change was observed early in the exposure or coagulation of the retinal vessels, then the power setting was lowered. Follow-up exams (clinical examination, fundus photography, and ocular ultrasonography) were performed at 1- to 3-month intervals. If the tumor was judged partially regressed, further treatments were performed to reach a completely regressed chorioretinal scar.

At last follow-up (mean, 6 months) all patients were alive with no evidence of melanoma metastasis. All tumors showed some degree of regression to the thermotherapy. The overall tumor thickness reduction was 43% (21% for amelanotic melanoma and 50% for heavily pigmented tumors). None of the patients had local tumor recurrence. Complications included overlying branch retinal artery or vein occlusion (8 patients), less than a 500 µm retinal hemorrhage (4 patients), retinal traction (4 patients), macular edema (2 patients), focal neovascularization of the retina (2 patients), and choroidal hemorrhage (1 patient).

*Spot Size: 3.0 mm to cover large portions of the melanoma tissue; 2.0 and 1.2 mm spot sizes were used to avoid the optic disc or retinal vessels. (Decreasing the spot size increases the power density; therefore, the power was decreased accordingly to achieve the light-gray endpoint.)

The differences between conventional laser photocoagulation and infrared thermotherapy:

	<u>Conventional Laser Photocoagulation</u>	<u>Thermotherapy</u>
Beam Size	50 to 500 µm	3.0 to 4.5 mm
Wavelength	infrared, argon, krypton	infrared only (810 nm)
Duration	fraction of a second	1 minute or more
Depth of tumor necrosis	less than 1 mm	3.0 to 4.5 mm
Pathophysiology	Rise in temperature above 65°C causes direct necrosis due to coagulation of tissue	Subcoagulation temperatures of 45° to 60°C induce cell necrosis due to intracellular breakdown primarily of mitochondria.

Infrared Diode Laser Applications

<p>OCU-TTT5 Transpupillary Diode Laser Hyperthermia - Histopathologic Finding of Eyes with Melanoma and First Clinical Results Langmann G,¹ Kleinert R,² Faulborn J.¹ ¹Univ. Klinik Graz, ²Univ. Klinik f. Pathologie, Neuropathologisches Laboratorium Abstract. Retinologische Gesellschaft, München, Germany. June, 1996</p>	<p>While argon laser coagulation of tumors achieves only superficial coagulative effects, the longer wavelength diode laser (780 - 880 nm) creates tumor necrosis by heating up the tumor tissue (hyperthermia effect described by Oosterhuis). Three unsalvageable melanoma eyes, were treated prior to enucleation with hyperthermia using a diode laser (IRIS Medical - constant spot size: 3 mm, duration 1 minute, or 2 minutes) 2 hours, 3 days, 4 days, respectively. Distinguishing coagulation effects of central necrosis, edema, hemorrhage, and necrobiosis zones were observed histologically 2 hours after laser hyperthermia. The greatest necrosis depth of 4.7 mm was observed in the eye treated 4 days prior to enucleation using parameter settings of 700 mW and 1 minute duration. The authors treated 3 juxtapapillary choroidal melanomas (height between 2 and 4 mm, base between 6 and 12 mm) with transpupillary hyperthermia described by Oosterhuis (duration 1 minute, power between 270 and 490 mW). After 10 months, 2 fully regressed. After 6 months, the remaining tumor had regressed 60%. Diode laser hyperthermia for treatment of tumors appears to be superior to argon laser coagulation due to the deeper penetration, and enlarges the spectrum of therapies to salvage eyes with small to medium sized choroidal melanomas.</p>
<p>OCU-TTT6 Thermotherapy and Chemotherapy for Retinoblastoma De Potter P, Shields CL, Shields JA, Khetarpal S, Hamoda A, Needle M. Oncology Service, Wills Eye Hospital, Philadelphia, PA Free Paper. AAO. Chicago, IL October 29, 1996</p> <p><i>Also listed as OCU-CH4, pg. 146</i></p>	<p>To evaluate the effectiveness of thermotherapy alone or combined with chemotherapy for selected retinoblastoma, the authors conducted a prospective study analyzing tumor response after thermotherapy. Among twenty eyes, 16 tumors were treated with thermotherapy and 11 with chemo-thermotherapy. All tumors (mean base, 4.3 mm; mean thickness, 2.2 mm) were within 6.5 mm from the disc. After a mean follow-up of 12 months, all tumors (27) were completely regressed without requiring further treatment. The treatment induced focal RPE damage at the tumor site without remote complications. Thermotherapy appears to be a safe and effective alternative treatment for selected posterior pole retinoblastoma.</p>
<p>OCU-TTT7 Histopathological Findings in Human Choroidal Melanomas after Transpupillary Thermotherapy Journée-de Korver JG, Oosterhuis JA, de Wolff-Rouendaal D, Kemme H. Br J Ophthalmol 81:234-239, 1997</p>	<p>TTT was performed in 11 eyes of 11 patients. Four eyes received modified xenon photocoagulator with a red filter permitting 85% transmission between 780 and 880 nm, and 7 eyes received 810 nm laser radiation via a handheld fiber in front of the eye. Exposure time was 1 minute; the estimated temperature at the top of the tumor was about 65° C. Seven of the 11 tumors developed necrosis to a maximum depth of 3.9 mm with a sharp demarcation between the necrotic and the viable part of the tumor. The depth correlated with penetration of heat into the tumor. Scattered small hemorrhages in the transitional zone between the necrotic and the viable part of the tumor were observed in three eyes, but large hemorrhages were absent. Ocular structures in and outside the radiation area remained unchanged owing to the low rate of absorption of radiation at 810 nm by clear ocular media of about 5%. Results showed that TTT has potential as a conservative therapeutic treatment for choroidal melanomas. Furthermore, TTT did not cause significant scleral damage. Scleral alterations induced by heat are not an impediment to clinical thermotherapy; the inner layers of the sclera became edematous and sclerocytes disappeared, but the lamellar structure of the scleral collagen remained intact. The sclera is fairly heat resistant since tem-</p>

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	<p>peratures of 52.2°C for 45 minutes and 65°C for 1 minute did not cause significant damage. In one eye, intrascleral tumor cells with a viable appearance were located only 36 µm from a totally necrotic tumor. The distance was too short to explain this viability by a decrease in temperature. Moreover, the heat was sufficient to destroy the sclerocytes in the inner scleral layers. Since viable intrascleral tumor cells may be the source of tumor recurrences, the authors usually combine TTT with ruthenium 106 brachytherapy. The two treatments are complementary since the impact of the transpupillary infrared laser is maximal at the top of the tumor and that of the transscleral brachytherapy is maximal at its base.</p>
<p>OCU-TTT8 Turning Up the Heat on Retinoblastoma Shields C. Review of Ophthalmology 4(3):116-118, 1997</p> <p><i>Also listed as OCU-CH5, pg. 146, and OCU-TS1, pg. 177</i></p>	<p>This article summarizes three relatively new retinoblastoma treatment options. Two of the options* use the 810 nm OcuLight system.</p> <p>*Thermotherapy Thermotherapy involves applying infrared (810 nm) radiation to heat the cancerous cells to around 50° or 60° C, killing them. It's used to treat small tumors 8 mm or smaller in base, and 4 mm or less in thickness. Thermotherapy can be delivered two ways: 1) TTT is used to treat tumors in the post-equatorial region. TTT takes patience, since treatment is "slow cooking" the tumor over 20 to 40 minutes. TTT offers benefits over traditional laser photocoagulation: Doctors can treat tumors in the macula or papillomacular bundle and still spare some vision, something almost impossible to accomplish with photocoagulation. 2) Transscleral Thermotherapy is used to treat tumors anterior to the equator and is replacing cryotherapy for small, peripheral tumors. Using indirect ophthalmoscopy with a 20 D lens to visualize the tumor, the surgeon places a DioPexy™ Probe (810 nm) probe on the outside of the eye in the area of the tumor and begins heating it. In 2 to 5 minutes, the tumor will turn white and begin to scar down (smaller than what can be achieved with cryotherapy). Transscleral thermotherapy destroys tumors more quickly than transpupillary thermotherapy because the direct infrared energy quickly heats the choroid and RPE.</p> <p>Chemotherapy Chemoreduction involves introducing an initial jolt of medication that can shrink large tumors to half their thicknesses and 30% of their base sizes. Chemotherapy is given intravenously in 2 to 6 cycles, delivered over 2 days, with each cycle spaced 3 to 4 weeks apart. Chemotherapy can flatten retinas in three-quarters of eyes with retinoblastoma and total detachments. Chemotherapy may induce secondary tumors in children with bilateral tumors. Because of the IV delivery, patients lose their hair, and experience bone marrow suppression and possible infections; however, these side effects are not permanent.</p> <p>*Chemothermotherapy Tumors flattened by chemotherapy (to 4 mm or less in thickness) can then be treated with TTT or other focal methods. For larger tumors, giving chemotherapy immediately prior to thermotherapy can be effective. The author has had no recurrences using this on appropriately sized tumors.</p>

Infrared Diode Laser Applications

<p>OCU-TTT9 Thermotherapy for Retinoblastoma Shields CL, Shields JA, Needle M, De Potter P. Oncology Service, Wills Eye Hospital, Philadelphia, PA Abstract. International Symposium on Ocular Tumors. Jerusalem, Israel April 6 - 10, 1997</p> <p><i>Also listed as OCU-CH7, pg. 147</i></p>	<p>Thirty-six retinoblastomas in 26 eyes of 21 patients were treated with thermotherapy and followed for a mean of 9 months. The mean age at first treatment was 11 months. The mean tumor base was 4.0 mm and thickness 2.2 mm. All tumors were within 8 mm of the optic disc and/or foveola. For thermotherapy, the parameters were 440 mW at 15 minutes and for chemothermotherapy 420 mW at 16 minutes. Tumor control was 89% with thermotherapy and 100% with chemothermotherapy. Ocular side effects included iris atrophy (27%), lens opacity (15%), vein obstruction (15%), retinal fibrosis (4%). Thermotherapy and chemothermotherapy represent a promising option in the management of selected small retinoblastoma.</p>
<p>OCU-TTT10 Diode Laser Thermotherapy in Uveal Melanomas Langmann G, Müllner K, Faulborn J. Univ. Eye Hospital Graz, Austria Abstract. International Symposium on Ocular Tumors. Jerusalem, Israel April 6 - 10, 1997</p>	<p>The goal of this study was to show preliminary results of patients treated with the OcuLight 810 nm laser and a specially designed adapter. (Argon laser photocoagulation of tumors can cause only superficial tumor necrosis. The longer 810 nm wavelength and long exposure times can create deep tumor necrosis performed in a subcoagulation mode.) Spot size: 2 (3) mm; power: 270 to 950 mW; exposure: 1 minute. Thirteen uveal melanomas and one metastasis were treated. The maximum tumor prominence was 3.8 mm; the mean tumor base was 7.1 mm (range 3-10 mm). In 10 patients, diode thermotherapy was the only treatment, and in 4 patients, it was performed as an adjunctive therapy to radiotherapy. Globe preservation and tumor regression was achieved in 14/14 cases. Diode laser thermotherapy as the only treatment caused tumor regression in 8/10 patients in one treatment session; in 2 cases a secondary treatment session was necessary. As an early side effect, a transient increase of a serous retinal detachment with small hemorrhages occurred in all cases; in one case, a vitreous hemorrhage led to vitrectomy. As a late side effect, nerve fiber defects with deterioration of visual function occurred in tumors with involvement of the papillomacular bundle (3/14). All tumors with a prominence up to 3.8 mm could be destroyed with thermotherapy. Indications for diode laser thermotherapy seem to be juxtapapillary and juxtamacular tumors up to a prominence of 3 (4 mm) or tumors which could not be sufficiently treated with a radiotherapeutic modality. Visual function depends on the distance of the tumor to the fovea and the involvement of the papillomacular bundle.</p>
<p>OCU-TTT11 Ocular Tissue Heating Induced by Transpupillary Exposure With Krypton, Argon, and Diode Lasers Lee BL, Glickman RD, van Heuven WAJ. Univ. of Texas Health Science Center, Department of Ophthalmology, San Antonio, TX [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S1112. Abstract nr 5211, 1997</p>	<p>The authors evaluated the rate and tissue-heating endpoints produced in retina, choroid, and sclera by transpupillary exposure with argon green (514 nm), krypton red (647 nm), and diode laser (810 nm) wavelengths. A thermocouple externally sutured to the sclera of the posterior pole of rabbit eyes was used to measure the temperature rise transmitted to the retina. A temperature rise of 5 to 6° C at the sclera was generally accompanied by the onset of photocoagulative changes in the appearance of the retina, indicating that the retina temperature was increased by at least 10° C. Visible evidence of thermal changes in tissue was apparent when the irradiance of the retina approached ~100W/cm², e.g. 150 mW into a 500 μm spot. Tissue heating without photocoagulation was the easiest to achieve with the diode laser. The krypton was the hardest to control; on several occasions it produced hemorrhage. The diode laser appeared to be the most effective in producing a hyperthermic response in ocular tissue with minimal retinal</p>

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	<p>photocoagulation compared to the argon green and krypton red lasers. This wavelength may show promise in the future for the thermotherapy of posterior segment tumors.</p>												
<p>OCU-TTT12 Transpupillary Thermotherapy Reichel E. Abstract. Advanced Ophthalmic Laser Surgery Course. Interlaken, Switzerland, June, 1997</p> <p><i>Also listed as AMD-TTT1, pg. 15</i></p>	<p>Transpupillary thermotherapy (TTT) was used to treat choroidal lesions with the infrared 810 nm diode laser (OcuLight photocoagulator and Haag-Streit slit lamp adapter with adjustable beam widths of 1.2, 2.0 and 3.0 mm.) Treatment parameters – Power: start at 300 mW (average power of 500 to 700 mW), Spot Size: 2 or 3 mm, Duration: 1 minute, Endpoint: a very subtle gray-brown discoloration. The conditions treated included choroidal melanoma, idiopathic polypoidal choroidal vasculopathy, and well-defined and occult choroidal neovascularization (CNV). Treating choroidal melanomas may require multiple sessions and can treat tumors 5.0 mm in height. Fifty percent tumor thickness reduction can be seen within 6 months. Complications may include overlying BRAP/BRVO, retinal, choroidal, or vitreous hemorrhage, and retinal neovascularization. Closure in well-defined CNV can be obtained. A serous PED can be flattened in occult CNV. In all CNV, no thermal damage to the retina was observed and in most cases visual acuity was preserved.</p>												
<p>OCU-TTT13 Transpupillary Thermotherapy (TPTT) for Choroidal Malignant Melanoma Aaberg Jr. T, Bridges Jr. WZ, Waldron R, Capone Jr. A. Abstract. The Retina Society Vancouver, Canada. September 6-9, 1997</p>	<p>Eleven patients with choroidal melanoma were treated with TPTT as a primary mode of treatment since 1995. All tumors had either documented growth or metastatic risk factors prior to treatment. All tumors were COMS ineligible at presentation. All patients underwent pre-op metastatic work-up per COMS guidelines.</p> <table border="0"> <thead> <tr> <th></th> <th style="text-align: center;"><u>Pre-op</u></th> <th style="text-align: center;"><u>Post-op</u> (mean follow-up of 5 months)</th> </tr> </thead> <tbody> <tr> <td>Mean tumor height</td> <td style="text-align: center;">1.8 mm</td> <td style="text-align: center;">0.9 mm</td> </tr> <tr> <td>Mean tumor volume</td> <td style="text-align: center;">36.8 mm</td> <td style="text-align: center;">12.8 mm</td> </tr> <tr> <td>VA of 20/40 or better</td> <td style="text-align: center;">64%</td> <td style="text-align: center;">50%</td> </tr> </tbody> </table> <p>TPTT appears to be an effective method for treating small choroidal melanomas. Data regarding mortality await long-term follow-up.</p>		<u>Pre-op</u>	<u>Post-op</u> (mean follow-up of 5 months)	Mean tumor height	1.8 mm	0.9 mm	Mean tumor volume	36.8 mm	12.8 mm	VA of 20/40 or better	64%	50%
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<p>OCU-TTT14 Transpupillary Thermotherapy for Choroidal Melanoma. Tumor Control and Visual Results in 100 Consecutive Cases Shields CL, Shields JA, Cater J, Lois N, Edelstein C, Gündüz K, Mercado G. Ophthalmology 105:581-590, 1998</p>	<p>One-hundred consecutive patients with choroidal melanoma received TTT treatment using the OcuLight 810 nm laser system. Eligibility criteria included tumors measuring 12.0 mm or less in base and 4.0 mm or less in thickness, located posterior to the equator of the eye, and with evidence of documented growth or substantial tumor risk factors for growth or metastasis. The mean tumor basal diameter was 7.1 mm and tumor thickness was 2.8 mm. The tumor margin touched the optic disc in 34 eyes (34%) and was beneath the fovea in 42 eyes (42%).</p> <p><u>Treatment Parameters</u></p> <p>Mean number of treatment sessions per tumor: 3 (interval of 3 months) Power: 729 mW (range, 300 to 1200 mW) Duration: 11 minutes Spot Size: 3 mm Endpoint: The immediate treatment endpoint was a blanched</p>												

	<p>white appearance in 38 tumors (38%), grey-white in 48 (48%), and no change in tumor appearance in 14 tumors (14%).</p> <p>The authors believe it is essential to deliver the thermotherapy to at least 1.0 to 1.5 mm of normal surrounding choroid, with the attempt to spare the foveola and optic nerve if they are not touched by the tumor and if reasonable.</p> <p>Results: After a mean of three treatment sessions and 14 months of follow-up, the mean tumor thickness was reduced to 1.4 mm. Treatment was successful in 94 eyes (94%) and failed in 6 eyes (6%). The six eyes classified as treatment failures included four eyes with tumors that showed partial or no response to thermotherapy, thus requiring plaque radiotherapy or enucleation, and two eyes with recurrence, subsequently controlled with additional thermotherapy. After treatment, visual acuity was the same (within 1 line) or better than the pretreatment visual acuity in 58 eyes (58%) and worse in 42 eyes (42%). The reason for improved vision was resolution of subretinal fluid; the main reasons for poorer vision included treatment through the foveola for subfoveal tumor (25 eyes), retinal traction (10 eyes), and unrelated ocular ischemia (1 eye).</p> <p>Conclusion: TTT may be an effective treatment for small posterior choroidal melanoma, especially those near the optic disc and fovea. Despite satisfactory local tumor control, ocular side effects can result in decreased vision. Longer follow-up will be necessary to assess the impact of thermotherapy on ultimate local tumor control and metastatic disease.</p>
<p>OCU-TTT15 Transpupillary Thermotherapy. Results in 50 Patients With Choroidal Melanoma Oosterhuis JA, Journée-de Korver HG; Keunen JEE. Arch Ophthalmol 116:157-162, 1998</p>	<p>To determine the efficacy of TTT in treating choroidal melanoma, 50 patients with choroidal melanoma were treated with brachytherapy and TTT. TTT was performed with an 810 nm infrared laser. Patients fell into 3 categories of treatment:</p> <ol style="list-style-type: none"> 1. 21 patients were treated with TTT when regression of the melanoma was insufficient after ruthenium 106 (¹⁰⁶Ru) plaque treatment. Fifteen of 21 patients had tumors ≤ 3 mm from the fovea. 2. 10 patients with a tumor more than 5 mm in height were treated by an episcleral dose of 800 Gy ¹⁰⁶Ru brachytherapy and TTT. All patients had tumors > 3 mm from the fovea. 3. 19 patients with a melanoma of 5 mm or less in height were treated by an episcleral dose of 600 Gy ¹⁰⁶Ru brachytherapy and TTT. Eleven of 19 patients had tumors ≤ 3 mm from the fovea. <p>Treatment parameters: Irradiation beam diameter: 3.0 to 3.5 mm; a diameter of 2.0 to 2.5 mm was used when treating tumors close to the fovea or optic disc. Treatment started at the center of the tumor with a relatively low energy level that showed little or no visible effect after a 10 minute exposure. The power level was then raised stepwise until edema turned the</p>

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	<p>tissue grayish at the end of the 1-minute exposure.</p> <p>Power Density 6.0 to 13.0 W/cm²; in 54%, 8.0 to 9.5 W/cm²</p> <p># of Applications 5 to 15 depending on the diameter of the tumor</p> <p># of Treatments 37 eyes required 1 treatment; 11 eyes required 2 treatments; 2 eyes required 3 treatments</p> <p>Post-treatment care Mydriatic and 0.1% dexamethasone eyedrops were administered twice daily for 1 week</p> <p>Results: In 41 (82%) of 50 patients, the tumor flattened completely after ¹⁰⁶Ru treatment and TTT within a mean follow-up period of 20.5 months (range, 6-49 months). Visual acuity was 20/60 or better in 43 eyes (86%) before treatment and in 14 eyes (28%) at the last examination. Conclusion: TTT holds promise in the treatment of choroidal melanoma as an effective nonsurgical outpatient procedure that can be repeated. The two treatments, TTT and brachytherapy, (referred to as “sandwich therapy”), are complementary because the effect of TTT is maximal at the top of the tumor and that of brachytherapy at its base. Long-term results are necessary to properly appraise this form of therapy.</p>
<p>OCU-TTT16 Circumscribed Choroidal Hemangioma Managed by Transpupillary Thermotherapy (TTT) Othmane IS, Shields CL, Shields JA, Gunduz K, Mercado G. Arch Ophthalmol 117:136-137, 1999</p>	<p>This is a case study of a patient with circumscribed choroidal hemangioma who was treated with TTT using the infrared, 810 nm OcuLight diode laser. Her pre-treatment visual acuity (VA) was 20/20 OD and 20/100 OS. The choroidal mass (in her left eye) was initially treated with argon laser photocoagulation that resulted in a decrease of subretinal fluid and improvement of the VA to 20/40 OS. However, 9 months later, the VA declined to 20/200 OS due to an increase in subfoveal fluid. The late-onset laser failure prompted the use of deeper tumor treatment with TTT. Two sessions of TTT were performed with the infrared diode laser at 2 month intervals using an average power setting of 550 mW, duration of 10 minutes, spot size of 3 mm, and treating to an endpoint of a gray color change. Three months after TTT, VA improved to 20/40 OS. Ten months later, VA remained stable at 20/40 OU and the choroidal hemangioma showed a fibrotic, gray-white appearance. Conclusion: TTT can be a treatment option in selected cases of choroidal hemangioma that fail to respond to argon laser photocoagulation. Although there is no histopathologic confirmation, the authors speculate that heat may contribute to occlusion and sclerosis of the vascular cavernous spaces within the tumor, with a resultant decrease in thickness. The deeper penetration of the infrared thermotherapy also spares some of the internal retinal structures, which is an additional advantage.</p>

<p>OCU-TTT17 Recent Developments in the Management of Retinoblastoma Shields CL, Shields JA. J Pediatr Ophthalmol Strabismus 36:8-18, 1999</p> <p><i>Also listed as OCU-CH9, pg. 148</i></p>	<p>This article reviews available techniques for the treatment of retinoblastoma. Two of the techniques reviewed that can be performed with the OcuLight infrared photocoagulator are thermotherapy and chemothermotherapy. These two treatments, and plaque radiotherapy, play an important role in the current management of many children with retinoblastoma. The selection of the modality of thermotherapy or chemothermotherapy depends on many factors, including tumor size, location, laterality, status of the opposite eye, presence of subretinal fluid and seeds, presence of vitreous seeds, and prior or ongoing chemoreduction.</p> <p>Thermotherapy Thermotherapy is a method of delivering heat to the eye using ultrasound, microwaves, or infrared laser radiation. It is the newest focal method for retinoblastoma. When combined with chemotherapy, thermotherapy provides satisfactory tumor control, leaving the child with a reasonably small scar, thus preserving more vision. The goal is to heat the tumor to 45°C to 60°C, leaving a gray-white scar at the site. In general, small tumors require approximately 300 mW power for 10 minutes or less, each delivered over three sessions at 1 month intervals.</p> <p>Chemothermotherapy Chemothermotherapy is especially suited for small tumors adjacent to the fovea and optic nerve where radiation or laser photocoagulation would possibly induce more profound visual loss. It is a time-consuming, tedious process that requires careful observations, recordings, judgements, and treatment of subtle tumor findings. The goal is to deliver a temperature of 42°C to 45°C, for 5 to 20 minutes, depending on the tumor size and location. The result from chemothermotherapy is a light gray scar with less risk for tractional and retinal vascular problems than is found with thermotherapy alone.</p> <p>Tumor size is important to the success of treatment. For instance, laser photocoagulation is usually limited to tumors 4.5 mm or less in base and 2.5 mm or less in thickness with no evidence of vitreous seeds. Cryotherapy is most successful if limited to tumors 3.5 mm or less in diameter and 2.0 mm or less in thickness with no evidence of vitreous seeds. Chemothermotherapy can be adequately used to treat tumors 15 mm or less in base, especially if the patient is receiving three agent chemoreduction.</p>
<p>OCU-TTT18 ICG Angiography in Choroidal Melanomas Treated with Transpupillary Thermotherapy De Belvis V, Valenti M, Piermarocchi S, Midena E. Ocular Oncology Service, Institute of Ophthalmology, University of Padova, Padova, Italy Abstract. International Congress of Ocular Oncology. Philadelphia, PA May 2 – 6, 1999</p>	<p>The authors' objective was to evaluate the information given by ICG choroidal angiography in patients treated with TTT. Fifteen consecutive patients with small, posterior pole choroidal melanoma received TTT using the 810 nm OcuLight photocoagulator. A 2 – 3 mm beam diameter and a 1 minute exposure time was used. Static and dynamic fluorescein and ICG angiography were performed within 1 week, 3 months, 6 months, and every 6 months after treatment. Results showed significant flattening of choroidal melanomas (mean thickness: 2.3 mm pre-op vs. 0.5 mm post-op). Six cases showed complete flattening after one session; 9 cases flattened after two sessions. Visual acuity remained stable. Side effects included distortion of the pupillary border (1 case), CNV (2 cases), and BRVO (1 case). Fluorescein angiography of TTT treated choroidal melanomas showed retinal vessel hyperfluorescence and tumor hypofluorescence in</p>

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	<p>the very early post-op period; during follow-up fluorescence varies according to the regression pattern (gliosis: late hyperfluorescence; atrophy: prevalent hypofluorescence). Early post-op ICG angiography showed absence of medium and large choroidal vessel involvement well visible in hypopigmented tumors. Late post-op showed occlusion of choriocapillaris and medium sized choroidal vessels in all treated tumors, limited to the treated area; persistence of large choroidal vessels, visible when not masked by gliosis or hyperpigmentation; appearance of peripheral or central CNV in the treated area. Conclusions: This study shows ICG angiography is a diagnostic technique useful in the diagnosis of selected cases of intraocular tumors (particularly hypo-pigmented lesions). ICG angiography confirms that choroidal vascular damage is strictly limited to the treated area, but suggests that large choroidal vessels may be spared by the technique. New choroidal vessels documented by ICG angiography may represent a side effect of TTT. They may usually be classified as inactive neovascular membranes. ICG angiography may be useful to monitor, particularly in hypopigmented tumors, late side effects of TTT.</p>
<p>OCU-TTT19 Transpupillary Thermotherapy in the Management of Circumscribed Choroidal Hemangioma Rapizzi E, Grizard WS, Capone Jr. A. Am Journal Ophthalmol 127:481-482, 1999</p>	<p>The authors share a case study of a 53-year old man affected by extramacular circumscribed choroidal hemangioma (1.6 mm in height, with a base of 5.4 mm x 6.1 mm) treated with a single session of TTT. The patient had sustained a decline in visual acuity caused by subretinal fluid exudation into the macular area. Multiple attempts at treatment with scatter photocoagulation over the surface of the lesion for several years had been unsuccessful in reducing tumor-related exudation. TTT treatment was performed with the infrared laser set initially at 200 mW. Power was increased until a 5-minute application produced a light, white retinal burn. Multiple overlapping 2 mm burns were created. The lesion was treated to confluent coverage by contiguous applications extending at least 1 mm into normal choroid. At the end of the session, the lesion was light gray-white. At 6 months follow-up, visual acuity had improved from 20/100 to 20/60. In this instance, TTT resulted in precise tumor destruction with resolution of subretinal fluid.</p>
<p>OCU-TTT20 Thermotherapy for Retinoblastoma Shields CL, Santos MCM, Diniz W, Gündüz K, Mercado G, Cater JR, Shields JA. Arch Ophthalmol 117:885-893, 1999</p> <p><i>Also listed as OCU-TS4, pg. 178</i></p>	<p>The goals of this study were to assess tumor control provided by thermotherapy and its associated ocular complications. The authors treated 188 retinoblastomas in 80 eyes of 58 patients using either the OcuLight SLx and large spot operating microscope adapter (OMA) and a wide-angle contact lens, a laser indirect ophthalmoscope (LIO) and 20 diopter lens, or the transscleral DioPexy Probe. Mean tumor base was 3.0 mm and tumor thickness was 2.0 mm. Thermotherapy was coupled with chemotherapy in 108 cases (57.4%) Results: Complete tumor regression was achieved in 161 tumors (85.6%), and 27 tumors (14.4%) developed recurrence. Conclusion: Thermotherapy provides satisfactory control for selected retinoblastomas; however these results are preliminary with a maximum of only 4 years of follow-up. Longer follow-up may reveal a greater incidence of tumor recurrence or ocular complications. Treatment parameters: The endpoint of all methods was a gentle, light gray color change ("take") within the tumor during a 1- to 5-minute period without causing vascular spasm or rapid tumor whitening. Mean thermotherapy power was 437 mW. Mean</p>

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Mean total cumulated thermotherapy time for each individual tumor was 27 minutes.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;"><u>Tumor Location</u></th> <th style="text-align: left;"><u>Delivery Device</u></th> <th style="text-align: left;"><u>Contact Lens</u></th> <th style="text-align: left;"><u>Spot Sizes</u></th> <th style="text-align: left;"><u># of Eyes Treated</u></th> </tr> </thead> <tbody> <tr> <td>Nearest the optic disc and fovea; and large in size (>6mm)</td> <td>OMA</td> <td>Wide-Angle</td> <td>0.8, 1.2, 2.0 mm</td> <td>72 (38.3%)</td> </tr> <tr> <td>Peripheral to the macula and smaller in size</td> <td>LIO</td> <td>20 D</td> <td>1.2 mm</td> <td>109 (58%)</td> </tr> <tr> <td>At the ora serrata</td> <td>DioPexy Probe</td> <td></td> <td>1.0 mm</td> <td>7 (3.7%)</td> </tr> </tbody> </table> <p>Thermotherapy Variables as a Function of Tumor <i>Thickness</i> in 180 Retinoblastomas</p> <table border="1" style="width: 100%; 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<p>OCU-TTT21 Indocyanine Green Augmented Transpupillary Diode Thermotherapy of Circumscribed Choroidal Haemangioma Watts AR, Kamal A, Rennie IG. Royal Hallamshire Hospital [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S648. Abstract nr 3413, 1999</p>	<p>Four patients with symptomatic circumscribed choroidal hemangioma were treated using ICG augmented TTT. After retrobulbar anaesthesia, a diode laser was used to perform TTT following intravenous injection of ICG contrast media (25 mg in 5ml) to improve the take up of laser radiation within the tumor. Patients were followed up with visual acuity, B scan ultrasound and fluorescein angiography. Pre-treatment visual acuity ranged from 6/5 to CF. Visual acuity improved in 3 cases and remained stable in the fourth after treatment. Signs of regression of the hemangioma were observed in all cases. Conclusion: ICG augmented diode TTT is an effective treatment in selected cases of circumscribed choroidal hemangioma.</p>																																																																																																					

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<p>OCU-TTT22 Preliminary Results of Transpupillary Thermotherapy (TTT) in Choroidal Hemangioma Fuchs AV, Mueller AJ, Grueterich M, Ulbig MW. Eye Clinic of the University, Muenchen, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S956. Abstract nr 5047, 1999</p>	<p>Three patients with choroidal hemangioma were treated with TTT using the 810 nm infrared OcuLight photocoagulator and slitlamp-microscope. Treatment parameters - spot size: 1.2 - 3 mm; power: 0.3 - 1.1 mJ; and exposure time: 0.5 - 1 min. Each hemangioma was covered with confluent laser effects until the exposed area appeared greyish. The first patient had a parafoveal hemangioma with recurrent macular edema despite repeated grid argon laser photocoagulation. The second patient had a choroidal hemangioma in the midperiphery and deterioration of vision due to fluid-leakage into the fovea. The third patient showed a choroidal hemangioma in close proximity to the optic disc, also with fluid leakage affecting the visual acuity. The prominence of the lesions before TTT ranged from 2.8 to 3.1 mm. After 2 months, a flat scar resulted in all patients without repetition of TTT. Visual acuity had remained stable. Conclusions: These preliminary results suggest that TTT may effectively destroy choroidal hemangioma in the first instance and thus prevent recurrent fluid leakage. However, long-term follow-up and more cases are needed to evaluate the long-term visual outcome and potential risks.</p>
<p>OCU-TTT23 What is the Capability of Transpupillary Thermotherapy (TTT) in the Treatment of Flat Choroidal Melanomas at the Posterior Pole? A Survey of the Current Literature. Gruterich M, Mueller AJ, Ulbig M, Kampik A. Klin Monatsbl Augenheilkd 215:147-151, 1999</p> <p>Abstract - English/German Article - German</p>	<p>TTT is a relatively new, minimally invasive procedure for the treatment of flat choroidal melanomas of the posterior pole which is capable of achieving a good local tumor control. A temperature rise in the tumor ranging from 45-60°C is achieved by an infrared laser beam delivered through the dilated pupil. With a modified delivery system beam, widths between 1 and 3 mm and exposure times of 1 minute are generated. Thus, tumors of up to 4 mm thickness are treatable. TTT can be used as a single treatment procedure or in combination with brachytherapy. Several studies presented in the literature show a satisfactory local tumor control. However, there is a significant risk of vision threatening side effects such as retinal vascular occlusion or retinal traction in selected cases. Studies with more patients and longer follow-up will demonstrate if TTT is also beneficial in the long-term management of choroidal melanomas.</p>
<p>OCU-TTT24 An Update of Thermotherapy for Choroidal Melanoma Shields CL. Review of Ophthalmology 107-108, 1999</p>	<p>Transpupillary thermotherapy is a relatively new procedure that may destroy small tumors without destroying much vision. TTT is indicated for small choroidal melanomas less than 4 mm thick. For tumors thicker than 4 mm, TTT is usually combined with plaque radiotherapy. With proper tumor selection, TTT is quite successful. TTT advantages: a visible reduction of the tumor thickness over a few months; more focal treatment - TTT leaves the patient with a focal scotoma, rather than the whole field reduction, and the ability to work on an outpatient basis. TTT disadvantages: immediately affects the overlying retina; may result in worse long-term central acuity, especially in subfoveal choroidal melanoma; can induce heat damage to ocular structures, such as the iris, lens and optic disc, that may not be clinically evident for months or years; can't be used for larger tumors due to the lack of heat penetration; and requires multiple treatment sessions.</p>

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<p>OCU-TTT25 Transpupillary Thermotherapy as Primary Treatment for Small Choroidal Melanomas Robertson DM, Buettner H, Bennett SR. Arch Ophthalmol 117:1512-1519, 1999</p>	<p>Twenty eyes with suspected small choroidal melanomas (4.0 to 12.0 mm basal diameter; 1.0 to 3.2 mm thickness) were treated with TTT using the 810 nm OcuLight photocoagulator and large-spot Slit Lamp Adapter (SLA). Seven tumors (35%) were treated more than once. Eighteen (90%) of the 20 tumors were reduced to a flat scar. Follow-up ranged from 6 months to more than 3 years.</p> <p><u>Treatment Parameters</u> Duration: 60 seconds</p> <p>Power: Initially 550 mW (using the 3 mm spot size setting on the SLA). The power was raised stepwise by 50 to 100 mW until the surface of the tumor developed a grayish color during the second half of the 1 minute exposure (during the last 15 to 20 seconds of exposure.) If a gray color change became visible during the first 20 to 30 seconds of exposure, the intensity was reduced by 50 to 100 mW.</p> <p>Applications: Treatment applications were repeated to cover the entire surface of the tumor confluenty.</p> <p>Following treatment, the authors were unable to recognize any inflammation in the anterior segment or injuries to the cornea, the iris, or the lens; inflammation in the vitreous cavity was minimal. In most eyes, no cells were seen in the vitreous cavity, and the tumor thickness decreased in all cases, usually within 2 months. Progressive atrophy of tumor mass and loss of pigmentation within the tumor continued beyond 1 year of follow-up in some eyes. Conclusion: The short-term follow-up results suggest that TTT can promote local control of small choroidal melanomas while preserving central visual acuity, even when tumors are within 1000 μm of the fovea. Long-term follow-up is important to observe for recurrences and other complications.</p>
<p>OCU-TTT26 Transpupillary Thermotherapy for Small Choroidal Melanoma Godfrey DG, Waldron RG, Capone A. Am J Ophthalmol 128:88-93, 1999</p>	<p>Fourteen eyes of 14 patients with small choroidal melanomas were treated with TTT in a nonrandomized, uncontrolled study. Treatment was performed using the 810 nm OcuLight SLx diode laser delivered through a large spot operating microscope adapter, focused on the fundus with either a Rodenstock (for postequatorial tumors) or Goldmann (for preequatorial tumors) lens. Preoperative tumor height was 1.79 ± 0.59 mm.</p> <p><u>Treatment Parameters</u> Spot size was set at 2.5 mm. Initial laser settings were at 200 mW of power for 1 minute. The power was increased until a 1-minute application produced a light, white retinal burn. The lesion was then treated to confluent coverage by slightly overlapping contiguous applications extending at least 1 mm into normal choroid.</p> <p>Results: Six months after treating 14 eyes, the mean tumor height was 0.54 ± 0.57 mm. Ten eyes (71%) were effectively treated with a single session. (The treated lesion flattened entirely with a mean interval between treatment and flattening of 8.7 months.) Three eyes (21%) required retreatment because of absence of regression or documented recurrent growth on ultrasonography. The average time to retreatment was 11</p>

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	<p>months. Three amelanotic lesions were all treated in a single session without recurrence. The sole treatment failure occurred in an eye treated with a juxtapapillary tumor, with recurrence developing from a previously flattened lesion. The eye was enucleated. No eye had more than two treatments. VA decreased in six eyes (43%) because of the proximity of the melanoma to the optic nerve or macula. VA slightly increased in 3 eyes because of resolution of subretinal fluid and resolution of surrounding vitritis over the treated lesions. Complications included retinal hemorrhage, retinal vascular occlusion, retinal traction, exudative serous neurosensory detachment, vitritis, and postoperative pain. No correlation was seen between tumor size, location, or laser energy used. Conclusion: TTT was effective in treating 93% (13/14) of eyes.</p>
<p>OCU-TTT27 Transpupillary Thermotherapy for Circumscribed Choroidal Hemangiomas Garcia-Arumi J, Ramsay LS, Guray BC. Ophthalmology 107:351-357, 2000</p>	<p>A noncomparative, prospective, interventional case series of 8 eyes of 8 patients with circumscribed choroidal hemangiomas was conducted. Each case was treated with the 810 nm OcuLight laser with Haag-Streit delivery, and a panfunduscope lens when the VA decreased because of serous retinal detachment that affected the macula. All hemangiomas were located in the posterior pole, near the optic disk, or in the temporal vascular arcades, predominantly in the upper temporal arcade (5 of 8 patients) and involving the foveola in two cases. The mean tumor diameter was 4.8 mm (range, 3.0 - .2 mm); and mean tumor thickness was 2.2 mm (range, 1.8 – 3.4 mm).</p> <p><u>Treatment Parameters</u> Spot Size: 2 or 3 mm based on the diameter of the hemangioma Power: Between 800 – 1200 mW Exposure time: 2 to 6 minutes Mean number of treatment sessions per eye: 2 No retrobulbar injections were needed because patients reported only mild discomfort.</p> <p>Results: In all 8 cases, total reabsorption of the serous retinal detachment was achieved after one or repeated applications of TTT. Mild choroidal atrophy and minimal hyperpigmentation of the RPE were observed in the treated eyes. At the 6 month follow-up exam, the tumor thickness regressed by a mean of 31%, which increased to 42 % at the 12 month follow-up visit. VA at 12 months follow-up ranged from counting fingers at 50 cm to 20/50 (mean, 20/80). The resolution of the subretinal fluid accounted for the improved VA. Treatment through the foveola of subfoveal tumor and chronicity of sub-retinal fluid were the primary reasons for less improvement of VA. Conclusions: TTT can be considered an acceptable therapeutic option for choroidal hemangiomas and serous retinal detachment, and the authors believe that the role of TTT will expand in the management of their patients. The cell necrosis observed after laser hyperthermia does not appear to be the result of a direct coagulative effect, but rather appears to be secondary to the denaturation of proteins, cell-membrane damage, chromosomal effects, and the disruption of biochemical pathways.</p>

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<p>OCU-TTT28 Indocyanine Green Enhanced Transpupillary Thermotherapy of Circumscribed Choroidal Haemangioma Kamal A, Watts AR, Rennie IG. Eye 14:701-705, 2000</p>	<p>To investigate the effect of ICG in enhancing the effect of 810 nm diode laser for treatment of circumscribed choroidal hemangiomas, 6 patients received TTT for the treatment of circumscribed choroidal haemangioma using the OcuLight SLx infrared photocoagulator with slit lamp delivery and a Volk Area Centralis Laser Plus or Volk Plus Super Quad 160 lens. The mean tumor thickness was 2.5 mm (range 2.0 – 4.5 mm); the mean tumor diameter was 7.75 mm (range 6.5 – 9 mm). The aim of the treatment was either obliteration of the tumor or resolution of sub-retinal fluid to treat tumor enlargement or visual impairments.</p> <p><u>Treatment Parameters</u> ICG was injected intravenously 20 seconds prior to the treatment. Power: 720 - 1250 mW Spot Size: 3 mm Duration: 1 minute Number of Applications: 8 – 14 burns.</p> <p>Results: Patients were followed-up for a mean period of 6 months (range 3 – 12 months). All eyes showed tumor regression. All patients retained the same or better VA after treatment, and 67% of eyes improved VA by more than 2 lines on Snellen testing. Minimal and transient complications due to treatment were observed in only 33% of cases. Conclusions: The use of ICG as a contrast medium during TTT allows consistent uptake of diode laser energy, shortens the duration of laser burn required, and results in fewer sessions of therapy. The use of ICG allowed treatment to involve burns of 1 minute duration rather than the 3 – 6 minute duration used without ICG. It is a cost-effective, easily performed outpatient procedure, with lower morbidity than other treatment modalities. Its longer-term effects will be evaluated in larger prospective trials.</p>
<p>OCU-TTT29 Intravitreal Pigment Dispersion as a Complication of Transpupillary Thermotherapy of Choroidal Melanoma Kiratli H, Bilgiç S, Çal P. Retina 20:408-409, 2000</p>	<p>The authors describe an unusual complication consisting of considerable intravitreal and subretinal pigment dispersion shortly after TTT for a non-pigmented choroidal melanoma in a patient initially treated with plaque brachytherapy. A 55-year-old patient presented with a non-pigmented choroidal mass in his right eye. The tumor measured 14 x 14 mm in basal dimensions and 12 mm in thickness. There were no signs of retinal invasion of the tumor. His best-corrected visual acuity (BCVA) in his right eye was counting fingers and his left eye was 20/20.</p> <p><u>Treatment Parameters</u> Spot Size: 3 mm - 31 overlapping spots were produced over the tumor and its margins Power: 750 mW producing gradual surface blanching in 1 min. Total treatment time: 31 minutes</p> <p>The patient received brachytherapy and the tumor steadily shrank to 8 mm in thickness during the following year but did not regress further. The tumor was managed by TTT (with a laser indirect and +20-diopter lens) with the aim of causing further shrinkage. There were no intraoperative complications. Two weeks later, the patient returned with significant pigment dispersion in the vitreous and subretinal space. Two months</p>

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	<p>later, the tumor measured 6.0 mm in thickness. Within the following year, his intraocular pressure increased to 28 mm Hg but was managed with topical b-blockers. In the following 18 months, no new tumor growth or satellite lesion formation was observed. The tumor further regressed to a thickness of 5 mm. Conclusions: Massive pigment dispersion into the vitreous and subretinal space should be added to the list of complications that can be encountered after performing TTT in an eye that had previously undergone brachytherapy. Despite a relatively short follow-up period, the clinical course of this patient suggests that this rare and alarming complication does not necessarily indicate an immediate and aggressive therapeutic intervention.</p>
<p>OCU-TTT30 Transpupillary Thermotherapy for Retinal Capillary Hemangioma in Von Hippel-Lindau Disease Parmar KN, Mireskandari K, McHugh D. Ophthalmic Surg Lasers 31:334-336, 2000</p>	<p>The authors report on a case study of a 30-year old woman who received TTT treatment for peripapillary retinal capillary hemangioma, which is a common manifestation of von Hippel-Lindau disease. TTT was delivered over 3 sessions during a period of 22 weeks, resulting in an improvement in VA from counting fingers to 6/24 and a marked decrease in exudates surrounding the hemangioma. Doppler ultrasonography demonstrated a decreased in intralesional blood flow from 7 cm per second to less than 3 cm per second, together with a decrease in the size of the lesion.</p> <p><u>Treatment Parameters</u> Power: 500 mW Duration: 1 minute, delivering 4 pulses at 1 mm spot size and one at 3 mm. A light graying of the lesion was used as an endpoint.</p> <p>Conclusion: TTT provides a useful modality in the treatment of retinal capillary hemangiomas, and may be particularly favorable for peripapillary lesions because of its relatively nondestructive characteristics.</p>
<p>OCU-TTT31 Transpupillary Thermotherapy for Recurrent Choroidal Melanoma De Potter P, Disneur D, Beauduin P. AAO Poster nr 248, Dallas, TX, 2000</p>	<p>The effectiveness of TTT for choroidal melanoma was assessed on six patients with recurrent choroidal melanoma whose other therapeutic modalities, particularly plaque radiotherapy, had failed to achieve tumor control and enucleation was not an option. No patients had recognizable metastatic disease at the time of initial TTT. TTT treatment was delivered for 60 seconds at 300 mW with a 3.0 mm spot size. The energy was raised stepwise by 50 to 100 mW until the surface of the tumor developed a light grayish discoloration. Spots were delivered in overlapping confluency including 0.5 mm of clinically normal tissue around the tumor margins and in avoiding vascular spasm. The TTT sessions were delivered at 3-month intervals. A treated tumor was judged as completely regressed when it presented with an ophthalmoscopically flat appearance and a residual thickness including overlying retina and choroids of 1.5 mm (measured by B-scan ultrasonography). If the tumor were judged partially regressed, then further treatments were performed to reach a completely regressed chorioretinal scar. The mean initial tumor basal diameter was 9 mm (range 4.5 to 12 mm) and tumor thickness was 3.7 mm (range 2.5 to 5.4 mm). Five tumors (84%) touched the optic disc margins without overhanging it and 3 tumors (50%) had a subfoveal location.</p>

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	<p>Results: All tumors showed response to TTT and no tumor recurrence was documented during the mean follow-up of 24 months. During a mean follow-up of 24 months (range 6 to 34 months), the mean tumor thickness gradually decreased to 2.5 mm at month 3, and 2 mm at month 6 after the initial TTT session. The percent reduction of tumor thickness was 33% at month 3 and 43% at month 6. The final VA was the same as the pretreatment VA in 3 patients and worse in 3 patients (33%) (retinal traction in 1 patient, tumor scar involving the fovea in 1 patient, and vitreous hemorrhage in 1 patient). One patient (#5) developed liver metastasis after his second TTT and underwent partial hepatectomy with adjuvant chemoembolization. He is currently alive with no evidence of metastatic disease progression. Conclusion: This series suggests that TTT may arrest the growth of choroidal melanoma after failure of other conservative treatments and remains a potential option versus enucleation for the management of selected posterior pole recurrent choroidal melanomas. Although the eligibility criteria for TTT ideally includes patients with choroidal melanoma measuring less than 4.0 mm in thickness, TTT may still be an effective treatment in special circumstances when recurrent choroidal melanoma presents with greater tumor thickness.</p>
<p>OCU-TTT32 Thermochemotherapy in the Management of Retinoblastoma Lumbroso LR, Urbietta M, Levy C, Bouirs D, Asselain B, Zucker JM, Doz F, Desjar'dins L. AAO Scientific Poster 83. Dallas, TX, 2000</p>	<p>The combination of thermotherapy and chemotherapy for retinoblastoma was evaluated in a retrospective, non-randomized analysis. One-hundred-three tumors were treated (diameter 0.5 mm-12 mm) with intravenous carboplatin followed by thermotherapy with a diode laser. The median follow-up was 30 months. Complete remission was observed in 96% of cases, persistence of the lesion or relapse in 10.7%. Final control of the tumor was possible in 89.3%. Conservative management of relapses was possible for nine out of 11 cases. Conclusions: Thermo-chemotherapy is an effective treatment of retinoblastoma.</p>
<p> OCU-TTT33 Solitary Choroidal Metastasis Managed by Transpupillary Thermotherapy Kiratli H. Eye 14(5):799-800, 2000</p>	<p>A 46 year old woman with a clinically solitary choroidal metastatic tumor was treated with TTT. She had complained of rapidly decreased vision in her right eye within a month. Two years previously she had undergone radical mastectomy followed by systemic chemotherapy and radiotherapy for ductal breast carcinoma. Her VA was 20/40 OD and 20/20 OS. A single session of 810 nm diode laser TTT using the OcuLight infrared system was performed. Treatment parameters included a power of 500 mW with 18 overlapping 3 mm spots each for 1 minute. At the end of the treatment, the lesion became grayish opaque. Three months later, the patient's right VA was 20/20 and the lesion became flat. The subretinal fluid resolved completely. Six months later, she maintained the same level of VA with no evidence of recurrence. Experience with this patient suggests that TTT can be a safe option in the management of symptomatic choroidal metastatic tumors of moderate thickness and a minimal amount of subretinal fluid. This technique may positively affect the quality of life of the patient by avoiding surgery and hospitalization for brachytherapy and frequent hospital visits for fractionated external beam radiotherapy and its inherent side effects. Further studies with a large number of patients are needed to define the exact niche and indications of TTT in the setting of choroidal metastasis.</p>

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<p>OCU-TTT34 Transpupillary Thermotherapy (TTT) of Choroidal Hemangioma Johnson RN, McDonald HR, Ai E. Abstract. The Macula Society. Scottsdale, AZ. February 28, 2001</p>	<p>To determine the efficacy of TTT for serous retinal detachment secondary to choroidal hemangioma, 3 patients who were previously treated with thermal laser photocoagulation (argon green and dye yellow) underwent TTT. In two cases, one treatment had previously been done and, in the third case, three prior treatments had been done. Preoperative and postoperative evaluation included VA testing using an ETDRS chart, slit lamp and indirect ophthalmoscopy, color photography and ultrasonography. Follow-up ranged from 4 to 24 months. Following treatment, complete atrophy of the hemangioma occurred in 2 cases. The third case (associated with a substantial sensory detachment) require a second TTT treatment.</p> <p><u>Treatment Parameters</u> Power: 450 – 1100 mW Spot Size: 3 mm Duration: 60 seconds</p> <p>Conclusion: TTT appears to be an effective treatment for sensory detachment associated with choroidal hemangioma. The substantial atrophy that occurs probably makes recurrent detachments less likely than with thermal laser photocoagulation.</p>
<p>OCU-TTT35 Five Year Follow-Up of 50 Patients with Choroidal Melanoma after Combined Treatment with Brachytherapy and Transpupillary Thermotherapy Keunen JE, Bartlema YM, Journe- de Korver JG, Oosterhuis JA. Eye Clinic, Academic Hospital, Leiden, Netherlands [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S109. Abstract nr 594, 2001</p>	<p>Fifty patients with choroidal melanoma with tumor heights from 1.5 to 8.4 mm and tumor diameters from 5.8 to 15.0 mm were treated with a combination of TTT and brachytherapy. Brachytherapy was performed with a Ru-106 applicator at a scleral contact dose of 600 or 800 Gy. TTT was performed with an 810 nm infrared diode laser. The beam diameter was 3 mm and the exposure time was 1 minute per application. TTT was performed once in 33 patients, twice in 13 patients and three times in 4 patients. The mean follow-up was 63 months (range 60-92 months). Results were evaluated with ophthalmoscopy, ultrasonography and FA. Results: Tumor height regressed in all patients; complete tumor flattening was found in 39 (78%) patients after two years, and in 45 (90%) patients after 5 years. Tumor recurrence was observed in two patients; in one patient after complete flattening, in the other patient after partial regression of the tumor. Five patients developed metastasis, 4 to 72 months after treatment. Five eyes were enucleated: one eye with tumor recurrence after complete flattening, one eye with incomplete regression and three eyes after development of a total retinal detachment. Radiation retinopathy was the main cause for the loss of central visual acuity. 32 (64%) Patients had a visual acuity of 20/200 or less at the end of the follow-up period; 8 (16%) patients had a visual acuity of 20/40 or better. Conclusion: Long-term results of brachytherapy combined with TTT for treating choroidal melanoma are favorable with regard to tumor regression and survival. However, a considerable loss of central vision was observed primarily due to radiation retinopathy.</p>

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<p>OCU-TTT36 Indocyanine Green Enhanced Diode Laser for the Treatment of Choroidal Melanoma Liggett PE,¹ Quiroz-Mercado H,² Alfaro V,³ Mieler W.⁴ ¹Ophthalmology, Cornell Univ/New York Hospital, Hamden, CT; ²Retina, Asociacion Para Evitar La Ceguera, Mexico City, Mexico; ³Ophthalmology, University of South Carolina, Charleston, SC; ⁴Ophthalmology, Baylor University, Dallas Texas [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S220. Abstract nr 1183, 2001</p>	<p>Eighteen eyes with choroidal melanoma were treated using ICG assisted TTT delivered in 1 to 4 sessions to evaluate the effectiveness in local control of the tumor. The mean tumor size prior to treatment was a 6.8 mm base and 3.6 mm in thickness. Clinical features, treatment results, and complications were reviewed for at least an 8-month follow-up. An average of 3 treatment sessions were required. The tumor responded to treatment in all patients with a decrease in tumor size and resolution of any associated subretinal fluid. At a minimum of 8 months, the mean tumor thickness was < 1.5 mm with visibility of bare sclera in all patients. Vision was maintained in 12 of 18 eyes; 5 eyes lost vision, and 1 eye improved. Complications: inflammation, focal cataract, field defects, vascular occlusion and vitreous hemorrhage. Conclusions: This preliminary study demonstrates that ICG-enhanced TTT appears to be an effective treatment for selected cases of small-and medium-sized melanomas. Controlled trials and longer follow-up are needed to compare this combined modality treatment to other alternative treatment modalities.</p>
<p>OCU-TTT37 Choroidal Vascular Patterns after Transpupillary Thermotherapy of Choroidal Melanoma Midena E, de Belvis V, Zaltron S, Caretti L, Doro D, Piermarocchi S, Pilotto E. Department of Ophthalmology, University of Padova, Padova, Italy [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S444. Abstract nr 2394, 2001</p>	<p>To report the choroidal angiographic patterns observed after TTT of choroidal melanoma, 42 consecutive eyes affected by small or medium choroidal melanoma (located posterior to the equator) were treated with TTT alone. All eyes were followed with serial ophthalmoscopy, ultrasonography and photography. FA and ICGA were performed at baseline, and 1 day, 1 and 3 months, and every 6 months after TTT. Mean follow-up after TTT was 28.5 months (range: 12 - 48 months). Results: All but one tumor regressed after TTT. The alterations of choroidal circulation were always limited to the treated area. In the treated area, occlusion of choriocapillaris in all cases, choroidal vascular re-modelling in 13 eyes (31%), patent medium and/or large choroidal vessels in 32 eyes (76%) and retino-choroidal anastomosis in 4 cases (10%) were observed. Choroidal vascular remodeling progressed during follow-up. Conclusions: TTT is a new and probably effective method to treat selected small and medium choroidal melanomas as sole treatment modality. This study shows TTT obliterates choriocapillaris and stimulates choroidal vascular remodeling in the treated area. In the same area, medium and large choroidal vessels remain patent in most of the examined eyes. The influence of patent choroidal circulation and vascular remodeling in the treated neoplastic area should be carefully considered when assessing ultimate choroidal melanoma control after TTT.</p>
<p>OCT-TTT38 Thermochemotherapy in Hereditary Retinoblastoma Schueler O, Havers W, Bornfeld N Abstract. Xth International Congress of Ocular Oncology. Amsterdam, the Netherlands. June 17 – 21, 2001</p>	<p>Thermochemotherapy (TCT) for retinoblastoma was used for the treatment of 55 tumors in 35 eyes of 26 children with hereditary retinoblastoma. Tumors were treated by infrared diode laser hyperthermia with an indirect ophthalmoscope during chemotherapy consisting of carboplatin, etoposide and vincristine. Mean tumor height was 3.5 ± 2.3 mm with a mean diameter of 6.1 ± 4.1 mm.</p> <p><u>Treatment Parameters</u> Thermochemotherapy sessions: 4.3 ± 1.6 (median, 5) thermochemotherapy Energy: 539 mW ± 211 mW (mean) Total Duration: 51 ± 31 minutes (mean)</p>

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	<p>Results: All tumors showed regression at the end of the treatment period. Local recurrence during the follow-up period (1.25 ± 0.6 years) occurred in 21 tumors (38%) with a mean onset of 3.2 ± 2.9 months after TCT. The recurrence rate was 17% for tumors with a height less than 2 mm, 37% for tumors with a height between 2 and 4 mm and 63% for larger retinoblastomas. Tumors with recurrence showed a significantly larger tumor height (4.5 mm vs. 2.9 mm, $p < 0.0001$) and diameter (7.9 mm vs. 5.4 mm, $p < 0.0001$), and were treated with a significantly greater total energy (2340 vs. 1677 Joule, $p = 0.001$). Multivariate analysis identified type II or type III regression after TCT as the most important risk factor for tumor recurrence besides initial tumor height. TCT dependent complications included transient corneal opacification in 2 eyes (6%), focal iris atrophy (3 eyes, 8.5%), peripheral lens opacity (2 eyes, 6%), circumscribed transient retinal detachment (1 eye, 3%), and diffuse choroidal atrophy (1 case, 3%). Conclusion: TCT was efficient for retinoblastoma with a tumor height less than 4 mm. In larger tumors, the recurrence rate was unacceptable high. Treatment should result in a type 1 or type 0 regression. The complication rate of TCT with an indirect LIO appears to be low.</p>
<p>OCU-TTT39 Transpupillary Thermotherapy as an Adjunct to Ruthenium Plaque Radiotherapy for Choroidal Melanoma Landau I, Seregard S. St. Eriks Eye Hospital and Karolinska Institute, Stockholm, Sweden Abstract. Xth International Congress of Ocular Oncology. Amsterdam, the Netherlands. June 17 – 21, 2001</p>	<p>Thirty-four patients received TTT zero to 84 months (median 6.5 months) after the primary ruthenium brachytherapy. Ten juxtapapillary, 7 juxtafoveolar, and 17 progressive tumors were selected for TTT.</p> <p><u>Treatment Parameters</u> TTT sessions: 1 to 4 Power: 300 – 1200 mW Spot size: 1 – 3 mm Duration: 1 to 25 effects of 1-minute duration</p> <p>Results: The tumor regressed in 21 cases, remained unchanged in 6 and progressed in 8 eyes that later had to be enucleated. Complications included focal lens opacity with or without posterior synechiae (n=3), retinal hemorrhage (n=4), retinal vein occlusion (n=1). Conclusion: A large number of eyes with choroidal melanoma that in the past would have been enucleated because of the juxta-papillary or -foveolar growth can be saved today by TTT.</p>
<p>OCU-TTT40 Tumor Recurrence After Transpupillary Thermotherapy (TTT) of Choroidal Melanoma Stoffelns BM. Johannes Gutenberg-University of Mainz Mainz, Germany Abstract. Xth International Congress of Ocular Oncology. Amsterdam, the Netherlands. June 17 – 21, 2001</p>	<p>The authors present a case of tumor regrowth after initially successful treatment with TTT. A 64-year-old male complained of blurred vision in his right eye. Examination revealed a choroidal melanoma in juxtafoveal location (thickness 1.8 mm, base 7 x 5 mm, VA 1.0p). The tumor was treated with TTT (diode laser at 810 nm, beam diameter 2 - 3 mm, power setting 0.3 - 0.7 W, exposure time 36 (32) minutes) delivered over two sessions. Results: Three months after the last treatment, the tumor was completely flattened and vision stabilized at 0.6. Fluorescein and ICG angiography showed occlusion of choriocapillaris, but here and there persistence of larger choroidal vessels in the heat-treated area. Four months after treatment at the posterior border of the treatment zone a melanocytic lesion, which touched the fovea without visual loss, was noticed. During the next 11 months this lesion increased in size and the posterior pole was involved. The</p>

	<p>patient did not complain of visual symptoms; visual acuity remained stable at 0.6. Ultrasonography revealed the higher reflectivity of the flattened scar in the heat treated area, but no tumor thickness, and fluorescein as well as ICG angiography showed no regrowth of tumor vessels. Nevertheless, we judged this expanding melanocytic lesion as regrowth of melanoma cells. Tumor regression was achieved with one additional session of TTT. The authors speculate that the initial treatment along the posterior tumor margin near the fovea was lighter and margins tighter to preserve vision. But for prevention of tumor regrowth it is essential to deliver the thermotherapy to the exact edges of a choroidal melanoma with at least 0.5 mm of normal surrounding choroid, whether the fovea is touched by the treatment zone or not.</p>
<p>OCU-TTT41 Transpupillary Thermotherapy for Small Choroidal Melanoma: Results in 25 Patients Primavera V, Russo V, Iaculli C, Delle Noci N. Institute of Ophthalmology, University of Foggia, Italy Abstract. Xth International Congress of Ocular Oncology. Amsterdam, the Netherlands. June 17 – 21, 2001</p>	<p>To report the short-term follow-up results of TTT for small choroidal melanoma, 810 nm diode laser with a beam diameter of 3 mm and 1 minute exposure was used to treat 25 patients with choroidal melanoma. The mean age of the patients was 56 years (from 31 to 77 years) with a primary choroidal melanoma located posterior to the equator. The mean basal diameter measured ophthalmoscopically was 6.5 mm and thickness measured by ultrasonography was 2.6 mm. The follow-up ranged from 3 to 12 months. After 1 – 3 treatments, the mean thickness was 1.0 mm. In 23 eyes we observed a complete tumor regression (92%), in one eye a partial regression (4%) and one eye an absent response to TTT. Complications included intraretinal hemorrhages (3 eyes), focal iris atrophy (1 eye), branch retinal vein occlusion (1 eye), macular traction (2 eyes). Conclusions: Transpupillary thermotherapy may be useful for the treatment of small choroidal melanoma, but long-term results are necessary to evaluate the tumor recurrence.</p>
<p>OCU-TTT42 Transpupillary Thermotherapy for Choroidal Melanoma in Asian Indian Population Shanmugam MP, Raman R. Insight. Scientific Journal of Medical & Vision Research Foundations 19(3);100-103, 2001</p>	<p>A retrospective analysis of 6 Asian Indian patients with small choroidal melanoma, who were treated with TTT, was conducted. The mean pretreatment height of the tumor was 2.9 ± 0.78 mm and the basal diameter 9 ± 2.3 mm. TTT was performed using an 810 nm OcuLight SL and operating microscope adapter. The power was titrated to achieve a mild graying of the tumor at the end of 1 minute. Mean laser power used was 885 ± 230.98 mW. A 2.0 mm spot size was used. The entire surface of tumor including 1 – 1.5 mm of clinically normal chorioretina around the margins of the tumor was treated by overlapping spots. Mean follow-up was 11.5 ± 5 months (range: 2 – 22 months). Five of 6 (83.3%) tumors showed signs of regression after TTT. The average time to achieve a flat scar was 17 months. There was no evidence of metastatic disease in any of the patients to date. The patient who did not respond to TTT had an amelanotic tumor, lacking adequate pigment to absorb laser energy. Three patients had decreased vision after TTT because of the proximity of the tumor to the optic nerve or macula. Conclusion: This is the first report to evaluate the role of TTT for choroidal melanoma in Asian Indian patients. This report also assumes significance as ¹²⁵I brachytherapy for treating melanomas is as yet not available in India and some of the tumors that may need brachytherapy may alternatively be managed with TTT.</p>


New



OCU-TTT43

Calcification in Choroidal Melanoma after Transpupillary Thermotherapy
Kiratli H, Bilgiç S.
Am J Ophthalmol 132(6):939-941, 2001

A 66-year-old male with a posterior uveal melanoma measuring 10 x 8 x 4.4 mm, with a small nodular portion overhanging the optic disc, underwent infrared diode laser TTT three times, each 12 weeks apart. For each treatment, a 3-mm spot size of 1-minute duration was used, and the power setting was 500 mW for the first session, 450 mW for the second, and 500 mW for the third. Two months after the last TTT session, A- and B-mode echographic patterns strongly suggestive of intratumor calcification were observed. The tumor regressed to 2.8 mm in thickness, but calcification persisted. Local recurrence or distant metastasis was not detected during a follow-up of 14 months. His vision went from 20/40 pretreatment to 20/200. Conclusion: Clinically detectable calcification is extremely rare in choroidal melanomas. Tumor regression with slowly progressive calcification may occur after TTT.



OCU-TTT44

Primary Transpupillary Thermotherapy for Small Choroidal Melanoma in 256 Consecutive Cases
Shields CL, Shields JA, Perez N, Singh AD, Cater J.
Ophthalmology 109: 225-234, 2002

Two-hundred-fifty-six patients with newly diagnosed choroidal melanoma were treated with primary TTT. In the affected eye, the VA was 20/20 to 20/50 in 209 cases (82%), 20/60 to 20/100 in 28 cases (11%) and 20/200 or worse in 10 cases (7%). The tumor was a mean of 2.4 mm to the optic disc (median 2.0 mm; range 0-8.0 mm) and a mean of 2.4 mm to the foveola (median, 2.0 mm; range, 0-9.0 mm), The tumor base was a mean of 7.0 mm (median, 6.5 mm; range, 2.0-14.0 mm), and the tumor thickness was a mean of 2.7 mm (median, 2.7 mm; range, 1.0-5.2 mm).

Treatment Parameters (mean)

Session I: 11 spots of 815 mW for a gray or white endpoint at completion in 242 patients (95%).

Session II: 11 spots of 832 mW with an endpoint of gray or white in 98%.

Session III: 9 spots of 903 mW with an endpoint of gray or white in 96%.

A beam width of 3.0 mm was used in all cases. In few cases, additional smaller spot sizes were used to treat near visually vital areas to minimize damage to adjacent tissue.

It is important to treat each tumor completely with overlapping spots so that the entire tumor surface is treated and broad tumor-free margins are achieved with a gray uptake clearly visible. Unlike TTT for choroidal neovascularization, where “no visible uptake” is the endpoint, TTT for choroidal melanoma should have “light to moderate uptake” as the endpoint. Adjustment of the power parameter on the OcuLight provides a stepwise elevation in tumor temperature until the visible endpoint is achieved.

Results: After a mean of 3 treatment sessions, complete tumor control without recurrence was documented in 232 cases (91%) and tumor recurrence in 24 cases (9%). The mean duration of follow-up was 19 months. After treatment, the final VA was 20/20 to 20/50 in 128 cases (50%), 20/50 to 20/100 in 47 cases (18%) and 20/200 or worse in 81 cases (32%). Complications included branch retinal vein obstruction in a vessel overlying the treated tumor in 104 eyes (41%), branch retinal artery obstruction in 31 (12%), retinal traction in 112 (44%), macular edema in 24 (9%), optic disc edema in

Infrared Diode Laser Applications

	<p>2 (< 1%), neovascularization of the retina in 16 (6%), neovascularization of the optic disc in 0 (0%), and cataract in 2 (< 1%). The advantages of TTT over methods of radiotherapy for choroidal melanoma include the precision of treatment, immediate necrosis of tumor with clinically visible regression within weeks, and facility of treatment for the patient on an outpatient basis using local anesthesia without intravenous sedation.</p> <p>Conclusions: Tumor control after properly applied primary thermotherapy for carefully selected choroidal melanomas is satisfactory at nearly 80% at 3-year follow-up. It is important to be extremely selective when identifying choroidal melanomas suitable for this treatment, (i.e. deeply pigmented tumors in the posterior pole of the fundus, 3.5 mm or less in thickness, with small base under 10.0 mm in diameter, with distinct margins, and with minimal or no contact with the optic disc). TTT can cause damaging effects to the retina, leading to visual loss shortly after treatment. Longer-term follow-up is needed to further define the role of this treatment modality.</p>
<p> OCU-TTT45 Transpupillary Thermotherapy (TTT) in Circumscribed Choroidal Hemangioma Fuchs AV, Mueller AJ, Grueterich M, Ulbig MW. Graefe's Arch Clin Exp Ophthalmol 240: 7-11, 2002</p>	<p>In this study the authors sought to determine whether TTT is suitable for treatment of choroidal hemangioma at the posterior pole. Ten patients with choroidal hemangioma were treated with TTT. Four of these were found superotemporally, 1 subfoveally, 2 temporally to the fovea, and 3 superotemporally to the optic disc. Mean tumor thickness before treatment was 2.96 mm (1.2-5.1 mm). TTT was delivered via a slit lamp microscope with the 810 nm OcuLight system.</p> <p><u>Treatment Parameters</u> Power: 300 to 1100 mW Duration: 0.5-1 minute Spot Size: 3 mm</p> <p>Each hemangioma was covered with confluent laser spots until the exposed area appeared grayish.</p> <p>Results: The mean follow-up period was 13.3 months (3-21 months). At 3 months after treatment, reduction in tumor prominence was observed in 8 patients by a scan sonography. VA improved by more than 3 lines in 4 (40%) patients, and remained unchanged in all other patients. Two patients were retreated to achieve complete absorption of fluid. Serous retinal detachment persisted in 3 patients because the hemangioma could not be treated completely due to proximity of the fovea. By 3 months after treatment the mean prominence was 2.1 mm (1.2-3.0 mm).</p> <p>Conclusions: Theoretically, TTT seems to be advantageous for the treatment of choroidal hemangioma for the following reasons: Diode laser radiation can penetrate the pigmented epithelium producing a burn confined to the outer retina and choroid; it induces mitochondrial breakdown followed by ischemic necrosis and finally leads to obliteration of the tumor; and transpupillary application via a slit lamp microscope is ideal for exact placement of laser exposures in the parafoveal region. TTT is minimally invasive and is easy to administer using a slit lamp microscope attached to a diode laser. It leads to a circumscribed diminution</p>

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of the hemangioma while sparing surrounding structures and is therefore suitable for treating peri and subfoveal lesions. If fluid leakage recurs retreatment is possible. Preliminary results suggest that TTT may be used effectively to treat some choroidal hemangiomas in the first instance and prevent fluid leakage provided the lesion does not involve the fovea. However, long-term follow-up and more cases are needed to evaluate the long-term visual outcome and potential risks.

OCULAR TUMORS

Transscleral Thermotherapy (TSTT) Photocoagulation

<p>OCU-TS1 Turning Up the Heat on Retinoblastoma Shields C. Review of Ophthalmology 4(3):116-118, 1997</p> <p><i>Also listed as OCU-CH5, pg. 146 and OCU-TTT8, pg. 156</i></p>	<p>This article summarizes three relatively new retinoblastoma treatment options. Two of the options* use the 810 nm OcuLight system.</p> <p>*Thermotherapy Thermotherapy involves applying infrared (810 nm) radiation to heat the cancerous cells to around 50° or 60° C, killing them. It's used to treat small tumors 8 mm or smaller in base, and 4 mm or less in thickness. Thermotherapy can be delivered two ways: 1) Transpupillary Thermotherapy (TTT) is used to treat tumors in the post-equatorial region. TTT takes patience, since treatment is "slow cooking" the tumor over 20 to 40 minutes. TTT offers benefits over traditional laser photocoagulation: Doctors can treat tumors in the macula or papillomacular bundle and still spare some vision, something almost impossible to accomplish with photocoagulation. 2) Transscleral Thermotherapy (TSTT) is used to treat tumors anterior to the equator and is replacing cryotherapy for small, peripheral tumors. Using indirect ophthalmoscopy with a 20 D lens to visualize the tumor, the surgeon places a DioPexy Probe (810 nm) probe on the outside of the eye in the area of the tumor and begins heating it. In 2 to 5 minutes, the tumor will turn white and begin to scar down (smaller than what can be achieved with cryotherapy). Transscleral thermotherapy destroys tumors more quickly than transpupillary thermotherapy because the direct infrared energy quickly heats the choroid and RPE.</p> <p>Chemotherapy Chemoreduction involves introducing an initial jolt of medication that can shrink large tumors to half their thicknesses and 30% of their base sizes. Chemotherapy is given intravenously in 2 to 6 cycles, delivered over 2 days, with each cycle spaced 3 to 4 weeks apart. Chemotherapy can flatten retinas in three-quarters of eyes with retinoblastoma and total detachments. Chemotherapy may induce secondary tumors in children with bilateral tumors. Because of the IV delivery, patients lose their hair, and experience bone marrow suppression and possible infections; however, these side effects are not permanent.</p> <p>*Chemothermotherapy Tumors flattened by chemotherapy (to 4 mm or less in thickness) can then be treated with TTT or other focal methods. For larger tumors, giving chemotherapy immediately prior to thermotherapy can be effective. The author has had no recurrences using this on appropriately sized tumors.</p>
<p>OCU-TS2 Feasibility of Infrared Lasers (810, 1064 NM) for Transscleral Thermotherapy of Intraocular Tumors Rem AI, Journée-De Korver JG, Oosterhuis JA, Keunen JEE, Van Den Berg TJTP. Department of Ophthalmology, Leiden</p>	<p>In this study, the authors' aim was to use TSTT to reach a temperature of at least 50° C in the sclera, below the threshold for scleral damage, to ensure the destruction of tumor cells that may have infiltrated into the sclera. Hamster Greene melanoma was subcutaneously implanted in hamsters. The pigmented tumor covered by a piece of human sclera served as an experi-</p>

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<p>Univ. Medical Center; Laboratory of Medical Physics and Informatics, Academic Medical Center Amsterdam, The Netherlands [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S289. Abstract nr 1325, 1998</p>	<p>mental model. Infrared lasers, 810 and 1064 nm, were used combined with cooling of scleral surface. Histologic and electron microscopic examination were performed. Polarized light microscopy was used to reveal thermally induced changes to birefringence of scleral collagen fibers. Results: Treatment power settings were found and histopathology showed a depth of tumor necrosis of 5-8 mm for both lasers. Minimal scleral damage was detected at surface temperatures of 50° C. Infrared radiation from both lasers induced effective tumor necrosis.</p>
<p>OCU-TS3 Treatment of Retinoblastoma with the Transscleral Diode Laser Abramson D, Servodidio C, Nissen M. Am J Ophthalmol 126:733-735, 1998</p>	<p>The authors successfully treated a small (6.6 x 4.3 x 3.2 mm) retinoblastoma in an 18 month old girl by using contact transscleral photocoagulation with the OcuLight infrared photocoagulator and DioPexy Probe. The tumor was located just anterior to the superotemporal arcade in the right eye. With the patient under general anesthesia, a peripheral opening in the conjunctiva in the meridian of the tumor was made and transscleral photocoagulation performed. The probe created a spot size of 1.0 mm at 0.5 mm from the prism face. Treatment parameters – power: .350 W; duration: titrated to achieve whitening of the mass and the surrounding retina. The treated area included the tumor and a 1.0 mm border (of uninvolved retina) surrounding the tumor. Overlapping burns were placed with the help of a red transscleral aiming beam and were monitored with indirect ophthalmoscopy. The tumor regressed after photocoagulation, leaving a pigmented chorioretinal scar. There was no regrowth of the tumor 12 months after photocoagulation. The advantages of transscleral over transpupillary delivery include the ability to treat tumors in the presence of media opacities; the larger available spot size; and the avoidance of transmitting laser through the pupil, which eliminates the risks of cataract and synechiae. Conclusion: Contact diode transscleral photocoagulation may be a viable new treatment for small retinoblastoma.</p>
<p>OCU-TS4 Thermotherapy for Retinoblastoma Shields CL, Santos MCM, Diniz W, Gündüz K, Mercado G, Cater JR, Shields JA. Arch Ophthalmol 117:885-893, 1999 <i>Also listed as OCU-TTT20, pg. 162</i></p>	<p>The goals of this study were to assess tumor control provided by thermotherapy and its associated ocular complications. The authors treated 188 retinoblastomas in 80 eyes of 58 patients using either the OcuLight SLx and large spot operating microscope adapter (OMA) and a wide-angle contact lens, a laser indirect ophthalmoscope (LIO) and 20 diopter lens, or the transscleral DioPexy Probe. Mean tumor base was 3.0 mm and tumor thickness was 2.0 mm. Thermotherapy was coupled with chemotherapy in 108 cases (57.4%) Results: Complete tumor regression was achieved in 161 tumors (85.6%), and 27 tumors (14.4%) developed recurrence. Conclusion: Thermotherapy provides satisfactory control for selected retinoblastomas, however these results are preliminary with a maximum of only 4 years of follow-up. Longer follow-up may reveal a greater incidence of tumor recurrence or ocular complications. Treatment parameters: The endpoint of all methods was a gentle, light gray color change (“take”) within the tumor during a 1- to 5-minute period without causing vascular spasm or rapid tumor whitening. Mean thermotherapy power was 437 mW. Mean number of sessions per tumor was 3. Mean total cumulated thermotherapy time for each individual tumor was 27 minutes.</p>

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	<u>Tumor Location</u>	<u>Delivery Device</u>	<u>Contact Lens</u>	<u>Spot Sizes</u>	<u># of Eyes Treated</u>
	Nearest the optic disc and fovea; and large in size (>6mm)	OMA	Wide-Angle	0.8, 1.2, 2.0 mm	72 (38.3%)
	Peripheral to the macula and smaller in size	LIO	20 D	1.2 mm	109 (58%)
	At the ora serrata	DioPexy Probe		1.0 mm	7 (3.7%)
	Thermotherapy Variables as a Function of Tumor Thickness in 180 Retinoblastomas				
	<u>Variable</u>	<u>≤ 2mm (n=106)</u>	<u>2-4mm (n=56)</u>	<u>≥ 4 mm (n=18)</u>	<u>P*</u>
	Sessions (mean #)	2.3	3.3	3.3	<.001
	Spot Size (mean mm)	1.4	1.6	1.8	<.001
	Power (mean mW)	380	490	630	<.001
	Duration (mean min)	14	42	68	<.001
	Chemotherapy coupled with thermotherapy				
	No	57	13	2	
	Yes, same day	35	31	13	
	Yes, within 1 – 2 day	14	12	3	
	Thermotherapy Variables as a Function of Tumor Base in 180 Retinoblastomas				
	<u>Variable</u>	<u>< 3mm Diameter (n=110)</u>	<u>≥ 3mm Diameter (n=70)</u>	<u>P*</u>	
	Sessions (mean #)	2.3	3.3	<.001	
	Spot Size (mean mm)	1.3	1.7	<.001	
	Power (mean mW)	370	540	<.001	
	Duration (mean min)	14	49	<.001	
	Chemotherapy coupled with thermotherapy				
	No	57	15		
	Yes, same day	38	42		
	Yes, within 1 – 2 day	15	14		
	*P - Continuous variables were analyzed by unpaired t test; discrete variables were analyzed by Fisher exact test.				
<div style="display: flex; align-items: center;"> <div style="margin-right: 10px; color: green; font-weight: bold;">New</div> <div> <p>OCU-TS5 Transscleral Laser Thermotherapy of Hamster Greene Melanoma: Inducing Tumour Necrosis without Scleral Damage</p> <p>Rem AI, Oosterhuis JA, Journée-de Korver JG, van den Berg TJTP. Melanoma Research 11:503-509, 2001</p> <p><i>Also listed as HIST23, pg. 241</i></p> </div> </div>	<p>The feasibility of using TSTT to induce necrosis of choroidal melanoma without causing damage to the sclera was investigated. Fifty-two subcutaneously implanted hamster melanomas covered by human donor sclera were irradiated for 1 minute with an 810 laser using a 3 mm spot diameter, with and without cooling of the scleral surface by water at a temperature of 18 – 20°. Immediately after irradiation, the temperature of the scleral surface was measured with an infrared camera. Irradiation at 2000 mW, without cooling of the sclera, resulted in tumor necrosis to a mean depth of 4.4 mm and a mean diameter of 5.5 mm, without causing damage to the scleral collagen. The surface temperature of the sclera was 44.5°C, and the estimated temperature at the sclera-tumor interface was 60.1°C. There was a sharp demarcation between the viable and the necrotic part of</p>				

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	<p>the tumor. TSTT at 2500 mW, without cooling of the sclera, caused maximal tumor necrosis to a mean depth of 5.2 mm and a mean diameter of 5.9 mm; the scleral layers adjacent to the tumor had an estimated temperature of 67.6°C and showed signs of damage in 14% of the experiments. Cooling of the sclera resulted in less thermal damage to the sclera but also less tumor necrosis. Results indicate that TSTT can induce tumor cell necrosis in pigmented melanoma to a depth of several millimeters without causing damage to the sclera. This means that in the combined treatment of brachytherapy and TTT, TSTT has potential as a new modality for treating choroidal melanoma, where it may be an alternative to brachytherapy in order to avoid radiation-induced complications.</p>
<p>OCU-TS6 Temperature Dependence of Thermal Damage to the Sclera: Exploring the Heat Tolerance of the Sclera for Transscleral Thermotherapy Rem AI, Oosterhuis JA, Journée-de Korver H, van den Berg TJTP, Keunen JEE. Exp Eye Res 72, 153-162, 2001 <i>Also listed as HIST22, pg 240</i></p>	<p>Thermal damage to the human sclera in relation to temperature and duration of exposure was studied in order to determine the heat tolerance of the sclera with respect to TSTT of choroidal melanoma. Samples of human sclera were submerged in saline for 10 seconds to 10 minutes at temperatures of 37 – 100°C. The effects of heat on the shape, weight and size of the samples were studied. Thermal damage of scleral collagen was examined by polarized light microscopy and electron microscopy (EM). The sclera was embedded in epoxy resin and stained with toluidine blue for LM and with uranyl acetate and lead citrate for EM. Thermal damage of scleral collagen on polarized LM was graded on a 5 point scale. Scleral damage was visible on macroscopic examination and on LM and EM in sclera heated at 65°C for 20 seconds or longer, at 70°C for 10 seconds or longer, and at higher temperatures. A sigmoidal function was used to define the relation between temperature and changes in diameter, thickness, and weight of scleral samples. Using fitted functions, the threshold temperature for thermal damage was estimated to be 59 – 61°C when samples were heated for 10 minutes, 62-63°C when heated for 1 minute, and 66 – 67°C when heated for 10 seconds. The threshold exposure time at 60°C was estimated to be 7 – 12 minutes. Conclusion: These results indicate a temperature of 60°C for 1 minute is well tolerated by human donor sclera; information of in vivo studies is required to validate whether this setting can be used in TSTT for choroidal melanoma.</p>
<p>OCU-TS7 Pre-Enucleation Transscleral Thermotherapy in Human Uveal Melanoma Keunen JEE, Oosterhuis JA, Rem Ai, Bleeker JC, Journée-de Korver. Poster P10. Meeting of the Club Jules Gonin. Montreux, Switzerland. August 31 – Sept. 4, 2002 <i>Also listed as HIST29, pg. 244</i></p>	<p>This study was conducted to determine the feasibility of TSTT for the treatment of uveal melanoma by exploring the range in temperature where heat exerts a necrosis in melanoma cells but does not harm the sclera. Experimental TSTT was performed in eyes with large uveal melanomas prior to enucleation. A custom-made scleral applicator was used with diode laser output and/or hot water at temperatures of 60 to 65°centigrade for conductive transscleral heating. The diameter of the applicator on the sclera was 7 mm and the exposure time was 1 minute per application. In general, 2 applications were given onto each eye. Histopathologic examination showed varying degrees of tumor necrosis in all treated areas, with incomplete occlusion of the blood vessels. A steep border in tumor necrosis between treated and non-treated areas was only noticed after diode laser TSTT and not after TSTT with hot water. Slight or no visible microscopic changes of the scleral collagen were noticed in the treated areas at temperatures between 60 to 65°centigrades. Conclusion: TSTT in the range of 60 to 65° centigrade may have potential as a new treatment modality for uveal melanoma.</p>

New

New

Additional Education Material Available on:

Ocular Tumors

OCU-P Patient Education Brochure

A Parent's Guide to Understanding Retinoblastoma

A 21 page brochure created to help the parent understand the eye and the diagnosis and treatment of retinoblastoma.

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RETINAL TEARS AND DETACHMENTS

<i>Endophotocoagulation</i>	
 <p>RTD-E1 Diode Endolaser Photocoagulation Smiddy W. Arch Ophthalmol 110:1172-1174, 1992</p> <p><i>Also listed as PDR-E1, pg. 79</i></p>	<p>Endolaser photocoagulation was applied using an 810 nm diode laser in 25 patients. Indications were for treatment of complications of proliferative diabetic retinopathy, proliferative vitreoretinopathy, complex retinal detachments, and a retinal break. Predictable clinical results and no adverse effects have been observed.</p>
<p>RTD-E2 Retinal Diode Laser Photocoagulation Smiddy W. Bascom Palmer Eye Institute Miami, FL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1310. Abstract nr 3089, 1992</p> <p><i>Also listed as PDR-E3, pg. 79</i></p>	<p>Diode (805 nm) endolaser photocoagulation was applied in 50 patients with proliferative diabetic retinopathy, proliferative vitreoretinopathy, complicated retinal detachments, and posterior tears. Treatment was found to be effective using an average of 505 spots, 0.5s duration, and 800 mW. The clinical effects of diode laser photocoagulation were similar to that achieved with argon.</p>
 <p>RTD-E3 Diode Laser Endophotocoagulation Sasho M, Smiddy W. Retina 15:388-393, 1995</p> <p><i>Also listed as PDR-E5, pg. 79</i></p>	<p>Two hundred twenty-six consecutive eyes underwent 810 nm endolaser photocoagulation during vitrectomy for proliferative diabetic retinopathy (134 eyes), proliferative vitreoretinopathy (27 eyes), complicated retinal detachment (50 eyes), and miscellaneous indications (15 eyes). A retrospective comparison group of 67 consecutive eyes undergoing vitrectomy with argon endolaser photocoagulation was also studied. Visual acuity was improved in 159 eyes (71%) and was 5/200 or better in 157 eyes (70%) with diode endophotocoagulation. In comparison, final visual acuity was improved in 48 eyes (73%) and was 5/200 or better in 45 eyes (68%) for argon endophotocoagulation. No statistically significant difference was found between the two groups regarding rate of visual improvement or final visual results. The desired intraoperative effect was obtained in 99.6% of the cases without complication. Diode laser is a safe, reliable, and effective mode of endophotocoagulation.</p>

RETINAL TEARS AND DETACHMENTS

<i>Laser Indirect Photocoagulation</i>	
 <p>RTD-LI1 Indirect Diode Laser Retinopexy Disperses Fewer Viable Pigment Epithelial Cells Than Cryopexy Nissen M, Rosen R, Hu D, McCormick S. The New York Eye and Ear Infirmary [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1055. Abstract nr 1817, 1992</p>	<p>Fresh bovine eyes were used to study the effect of the diode laser on RPE dispersion when delivered with the indirect ophthalmoscope to the retinal periphery. A 4 mm retinotomy was performed in all eyes which were randomly selected to receive either no treatment, cryopexy or indirect diode laser treatment surrounding the retinotomy site. While cryopexy released significant numbers of RPE cells compared to the controls, there were no significant differences in cell counts between the diode laser and control groups. After 4 days, no RPE cells proliferated in culture in the diode laser group, although significant proliferation was noticed in the cryopexy group ($p = 0.01$). Conclusion: Indirect diode laser therapy, while clinically effective in producing chorioretinal adhesions, may not lead to RPE cell dispersion and proliferation, which may be a risk factor for development of pre-retinal membranes and potential failure of detachment repairs.</p>
<p>RTD-LI2 Diode Laser Indirect Ophthalmoscope versus Cryotherapy in Retinal Detachment “AB Externo” Treatment Reibaldi A, Avitabile T, Marano F, Uva M. Institute of Ophthalmology, Univ of Catania, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1536. Abstract nr 1315, 1994</p>	<p>To determine the clinical validity and complications of 810 nm diode laser retinopexy instead of cryotherapy, the authors studied 90 patients treated with “scleral buckling” retinal detachment surgery. Either conventional cryotherapy (<i>Group I</i>: 45 eyes) or diode laser treatment was performed (<i>Group II</i>: 45 eyes) using a laser indirect ophthalmoscope, to obtain retinopexy. In <i>Group I</i> the complications were: 10 (22.2%) PVR cases, 4 (8.8%) endovitreal hemorrhages, 1 (2.2%) relapse, 1 (2.2%) choroidal detachment. In <i>Group II</i> they were 2 (4.4%) PVR cases, 2 (4.4%) relapses, 1 (2.2%) choroidal detachment. Conclusions: Diode laser retinopexy is considered safer for the patients because of the smaller amount of proliferative vitreoretinopathy ($p = 0.03$), endovitreal hemorrhages ($p = 0.125$) and less eye congestion.</p>
<p>RTD-LI3 Retinal Detachment Surgery with the Diode Laser Cedillo B, Yee RI, Graue F, Pombo P, Quiroz MA, González J, Lozano D, Durán F, De la Fuente MA, Solano E. Instituto de Oftalmología, Universidad Nacional Autónoma de México, Mexico City [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S402. Abstract nr 1865, 1996</p>	<p>Fifteen patients with uncomplicated rhegmatogenous retinal detachment received photocoagulation with the IRIS Medical diode laser using scleral depression and the indirect ophthalmoscope delivery system. A silicon implant was placed at the site of the lesions and drainage of subretinal liquid was performed when needed. Laser spots were applied surrounding the lesions. Follow-up was done the first day, 15 days, 1, 3, and 6 months. Drainage of subretinal fluid was performed in 73.3% of the cases. All but one eye obtained successful reattachment at the first operation, except one that developed a new hole at the site of an intensive laser application, requiring an injection of air and a few more laser spots, preserving a visual acuity of 20/30. At 9 months no patient developed proliferative vitreo-retinopathy; 53% obtained a 20/100 VA or better. This study suggests that treatment with the diode laser in primary uncomplicated rhegmatogenous retinal detachments can be successfully achieved; however, a longer follow-up will determine its long-term efficacy.</p>

RETINAL TEARS AND DETACHMENTS

<i>Transscleral Retinal Photocoagulation (TSRPC)</i>	
<p>RTD-TS1 Transscleral Contact Retinal Photocoagulation With an 810 nm Semiconductor Diode Laser Jennings T, Fuller T, Vukich J, Lam T, Joondeph B, Ticho B, Blair N, Edward D. Ophthalmic Surg 21:492-496, 1990</p>	<p>Experiments were performed to determine if consistent transscleral chorioretinal lesions could be produced in six Dutch-belted pigmented rabbits using the 810 nm laser, and if this modality caused less blood-retinal barrier disruption than retinal cryopexy of clinically equivalent treatment areas. The laser applications produced whitish to grayish-white retinal lesions when the surgeon used low powers and long durations, and controlled the treatment duration. Histopathologic evaluation of a lesion demonstrated an intact sclera overlying the chorioretinal lesion. Vitreous protein concentration, which was measured to assess blood-retinal barrier disruption, was significantly less in eyes treated with transscleral photocoagulation than in eyes treated with cryopexy. Conclusion: Transscleral 810 nm laser treatment may be a viable clinical alternative to retinal cryopexy.</p>
<p>RTD-TS2 Transscleral Diode Laser Retinopexy Muldoon T, Rosen R, Walsh J, McCormick S. The New York Eye and Ear Infirmary Abstract. Vitreous Society Meeting, Paris, France. September 22-27, 1991</p>	<p>A transscleral diode retinopexy probe (200-600 mW for 1.0-2.0 sec) was used to produce chorioretinal lesions in six pigmented rabbits. The lesions were comparable clinically and histopathologically to those created with transpupillary photocoagulation (200-400 mW for 0.2 - 0.3 sec). Treatment through solid silicon implant materials yielded similarly favorable results at energy levels slightly higher (700-1000 mW for 1.0-2.0 sec). Transscleral diode laser retinopexy offers a significant new approach to the problem of adhesion in retinal surgery, and the 810 nm wavelength allows transscleral photocoagulation of the choroid and retina while sparing the overlying sclera and conjunctiva.</p>
<p>RTD-TS3 A Cryo-like, Semiconductor Diode Laser Probe for Transscleral Retinopexy. Evaluation in a Rabbit Model Rosen R, Muldoon T, Walsh J, McCormick S. The New York Eye and Ear Infirmary [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1311. Abstract nr 3090, 1992</p>	<p>A new specially engineered contact probe (DioPexy Probe) used with an 810 nm semiconductor diode laser was used to create chorioretinal lesions in 12 eyes from 12 Dutch-belted rabbits. This study compared chorioretinal lesions produced in fellow eyes using transpupillary delivery of the diode laser via an indirect ophthalmoscopic delivery system. Transscleral applications required energies of 200-600 mW for 1.0-2.0 seconds while comparable transpupillary lesions were achieved with 200-400 mW for 0.2-0.3 seconds. Early lesions revealed RPE necrosis with melanophagic activity in the sub-retinal space. By 1 week, scar proliferation at the chorioretinal interface had begun. By 1 month, these had developed firm adhesions with only a scant remaining inflammatory infiltrate. The overlying retina showed varying degrees of atrophy. In no instance was scleral necrosis observed, and scleral cellularity remained comparable to adjacent, non-treatment areas. Transscleral diode laser therapy proved to be an effective technique for the production of chorioretinal adhesions without damaging the sclera. The cryo-like design of the DioPexy Probe gives the surgeon more ergonomic control over the probe while simultaneously controlling the progress of the application by indirect ophthalmoscopy.</p>

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<p>RTD-TS4 The Effect of Transscleral 810 nm Laser Retinal Photocoagulation on the Ciliary Nerves Packo K¹, Torczynski E¹, Jennings T². ¹Rush-Prebysterian-St. Luke's Medical Center, Chicago, IL, ²Univ. of IL, Chicago, IL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1311. Abstract nr 3092, 1992</p>	<p>In one eye of a cynomolgus monkey, transscleral diode photo-coagulation burns were placed over the 3:00 and 9:00 meridians overlying the anterior ciliary nerves with an additional 100 burns in each quadrant over the posterior ciliary nerves using the DioPexy Probe. Powers ranged from 80-150 mW, with durations 0.2-0.5 seconds. The initial treatment produced a mid-dilated, poorly reactive pupil. The pupil size and reaction to direct light stimulation slowly improved over the next 14 days and was normal at 30 days. Transscleral diode retinal photocoagulation has the ability to disrupt the function of both the long and short ciliary nerves, but this damage is rather mild and shows evidence of regeneration at 1 month.</p>
<p>RTD-TS5 Transscleral Retinal Photocoagulation with the Diode Laser Kletzky D, Cupples H, Gaasterland D. Worthen Center for Eye Care Research, Center for Sight, Georgetown Univ., Washington, D.C. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 33(4): 1311. Abstract nr 3093, 1992</p>	<p>Twenty human autopsy eyes were used to study power-duration thresholds for chorioretinal burns with an 810 nm diode laser and a 600 µm fiberoptic probe for TSRPC. Each eye received a power of 1 or 2 Watts with durations of 0.5, 1, 2, and 3 seconds. At 1 Watt, 2 second exposures were near threshold, causing small, opalescent retinal burns in 7/20 eyes. At 2 Watts the threshold was lower: 0.5 second exposures caused lesions in 6/20 eyes; 2 second exposures caused lesions in 18/20 eyes; 3 second exposures caused lesions in all 20 eyes. The threshold for retinal burns was lower in eyes with brown irides than in eyes with blue irides. The eyes were examined with a dissecting microscope, and histologically, no scleral damage occurred. This study indicates diode laser TSRPC may be effective and safe.</p>
<p>RTD-TS6 Effect of Transscleral Diode Laser Photocoagulation Applied Through Buckling Elements. Evaluation in a Rabbit Model Colín A, García-Arumí J, Mateo C, Corcóstegui B. Hospital Valle de Kebrón, Barcelona, Spain [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 958. Abstract nr 1260, 1993</p>	<p>A DioPexy Probe connected to an 810 nm diode laser was used to produce chorioretinal lesions, with and without a scleral buckling element, in 20 live pigmented rabbit eyes. Histopathologic study of the eyes was performed at 24 hours, 1 week and 2 months. Early lesions revealed RPE necrosis and the choroidal pigmented areas showed marked disorganization. By 2 months, the laser lesions demonstrated a marked thinning and atrophy at the center of the lesions and the choroid displayed marked hyperpigmentation, developing firm adhesions. No scleral damage was observed. Results demonstrate that diode laser photocoagulation applied through a scleral buckle can produce chorioretinal scars without damaging the scleral tissue nor the buckling elements employed.</p>
<p>RTD-TS7 Transscleral Diode Laser Photocoagulation of Choroidal Vessels Kaplan H, Awh C. The Krieger Eye Institute, Sinai Hospital of Baltimore, Baltimore, MD [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 961. Abstract nr 1275, 1993</p>	<p>The authors used an 810 nm OcuLight diode laser and DioPexy Probe for TSRPC of four pigmented New Zealand rabbit eyes. The endpoint of retinal whitening was reliably achieved at 200 mW, 9 sec. duration, with slow probe movement to "paint" an area of retinal whitening. A 20 gauge needle stabbed through six treated areas produced no visible hemorrhage. In untreated areas, punctures resulted in immediate intraocular hemorrhage. TSRPC can create discrete areas of choroidal hemostasis, and may prove useful in the treatment of choroidal melanoma, choroidal neovascularization, and other entities dependent upon choroidal circulation.</p>
<p>RTD-TS8 Pilot Trial of Transscleral Diode Laser Retinopexy in Retinal Detachment Surgery Haller J, Lim J, Goldberg M. Arch Ophthalmol. 111:952-956, 1993 See RTD-TS15, pg. 190 for Pilot Update See RTD-TS34, pg. 197 for Phase II</p>	<p>Ten patients with primary rhegmatogenous retinal detachments underwent scleral buckling surgery using the DioPexy Probe to perform transscleral diode infrared laser retinopexy. By 6 months, 9 of 10 retinas were successfully repaired following only one operation. Transscleral diode retinopexy served as a safe and effective means of obtaining chorioretinal adhesion in retinal detachment surgery.</p>



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<p>RTD-TS9 Comparison of Transscleral Diode Photocoagulation and Transscleral Cryotherapy Kaplan H, Levine E, Awh C. The Kreiger Eye Institute, Sinai Hospital of Baltimore, MD [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1538. Abstract nr 1331, 1994</p>	<p>This study shows that DioPexy treatment in a continuous annular pattern can create a central area with no choroidal perfusion (within the area encircled by diode infrared burns). After 30 days, this central untreated area developed a full-thickness chorioretinal scar which is clinically and histologically indistinguishable from scars created by direct diode photocoagulation or by cryotherapy. This encircling delivery pattern may simplify treatment and further minimize disruption of the blood-retinal barrier.</p>
<p>RTD-TS10 Tensile Strength Comparison of Chorioretinal Adhesions Produced by Diode, Argon Laser, and Cryopexy Cordeiro M, Pollack W, Woon H, Marshall J, Chignell A. St. Thomas Hospital, London Abstract. The Royal College of Ophthalmologists. Annual Congress. Guernsey. April 19-22, 1994</p>	<p>Ten rabbit eyes were treated with cryopexy, argon laser photocoagulation and 810 nm diode laser therapy, each applied to separate and distinct areas of the retina. The rabbits were sacrificed at 2, 7, 14, 21, and 35 days after treatment. Comparison of the three different therapies and their respective degrees of chorioretinal tensile strength against time showed a favorable response of chorioretinal tissue to diode laser. The authors suggest diode laser as an alternative and effective therapy in retinopexy for vitreo-retinal disease.</p>
<p> RTD-TS11 Diode Laser Contact Transscleral Retinal Photocoagulation. A Clinical Study McHugh D, Schwartz S, Blach R, Gregor Z, Ulbig M. AAO Scientific Sessions. Ophthalmology 101 (9A, suppl):68, 1994</p>	<p>A clinical study of contact diode laser transscleral retinal photocoagulation was performed. Conditions treated were giant retinal tears (6 eyes) and other peripheral retinal breaks (15 eyes). This technique was also used to effect choroidal vascular closure prior to suture needle drainage of subretinal fluid to reduce the risk of hemorrhage (20 eyes). Lesions were produced with energies of 1-2 J. This technique has advantages over laser indirect ophthalmoscopy in the presence of small pupils or media opacities, over endophotocoagulation for treating peripheral lesions, and over cryotherapy in reduced postoperative inflammation.</p>
<p> RTD-TS12 Pilot Trial of Transscleral Diode Laser Photocoagulation of Retinal Breaks Bonnet M, Mouries O. J Fr Ophthalmol 17:739-745, 1994</p> <p>Abstract - English/French Article - French</p>	<p>Fourteen patients (14 eyes) were enrolled in a pilot trial to evaluate the efficacy and safety of transscleral diode (810 nm) laser photocoagulation in the management of retinal breaks. Twelve patients showed opaque media which prevented transpupillary argon laser photocoagulation (10 eyes) and/or a retinal detachment after previous failed surgery (3 eyes), and/or retinal tears with a curled and fixed posterior edge (6 eyes). Twenty-five retinal breaks were treated in the 14 eyes (7 breaks in attached retina and 18 in detached retina). A satisfactory retinochoroidal scar with permanent sealing of the retinal breaks was achieved in all eyes. The retina was attached in all eyes. The follow-up ranged from 2 to 12 months. Ten patients had a minimum 6 month follow-up. Overtreatment attributed to technical mistake occurred in two eyes; however, it had no adverse effect on the final result. Conclusion: Transscleral diode laser photocoagulation of retinal breaks is efficacious and safe. It is a valuable alternative to cryo treatment in eyes at high risk of postoperative PVR and/or when argon laser photocoagulation cannot be used, and/or in retinal detachments after previous failed surgery.</p>

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<p>RTD-TS13 Diode Laser Indirect Ophthalmoscope versus Cryotherapy in Retinal Detachment "AB Externo" Treatment Reibaldi A, Avitabile T, Marano F, Uva M. Institute of Ophthalmology, Univ of Catania, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1536. Abstract nr 1315, 1994</p>	<p>To determine the clinical validity and complications of 810 nm diode laser retinopexy instead of cryotherapy, the authors studied 90 patients treated with "scleral buckling" retinal detachment surgery. Either conventional cryotherapy (<i>Group I</i>: 45 eyes) or diode laser treatment was performed (<i>Group II</i>: 45 eyes) using a laser indirect ophthalmoscope, to obtain retinopexy. In <i>Group I</i> the complications were: 10 (22.2%) PVR cases, 4 (8.8%) endovitreous hemorrhages, 1 (2.2%) relapse, 1 (2.2%) choroidal detachment. In <i>Group II</i> they were 2 (4.4%) PVR cases, 2 (4.4%) relapses, 1 (2.2%) choroidal detachment. Conclusions: Diode laser retinopexy is considered safer for the patients because of the lesser amount of proliferative vitreoretinopathy ($p=0.03$), endovitreous hemorrhages ($p=0.125$) and eye congestion.</p>
<p>RTD-TS14 Collaborative Trial of Diode Laser Retinopexy in Retinal Detachment Surgery Haller J, Packo K, Goldberg M, Blair N, de Bustros S. Scientific Poster. XXVIIth ICO. Toronto, Canada. June 26-30, 1994</p>	<p>Fifty patients were enrolled in a collaborative trial to evaluate the safety and efficacy of diode laser retinopexy in retinal detachment surgery. Forty-seven detachments were successfully repaired with one scleral buckling procedure. Three cases required subsequent vitrectomy. Complications included subretinal hemorrhage (in one case) and scleral dehiscence (in one case) and scleral thermal effect (in four cases). This new approach to transscleral retinopexy may provide an effective, potentially safer alternative to cryopexy and diathermy.</p>
<p>RTD-TS15 Update on the Multicenter Trial of Transscleral Diode Retinopexy in Retinal Detachment Surgery Haller J, Blair N, de Bustros S, de Juan Jr. E, Goldberg M, Muldoon T, Packo K, Resnik K, Rosen R, Shapiro M, Smiddy W. Abstract. Vitreous Society Meeting Aspen, CO August 14-18, 1994 <i>See RTD-TS8, pg. 188 for Pilot Study</i> <i>See RTD-TS34, pg. 197 for Phase II</i></p>	<p>Sixty-five eyes with rhegmatogenous retinal detachments less than 3 months in duration were treated with an average of 137 transscleral diode applications, with a mean power of 1099 mW, mean duration of 2107 ms, and total energy averaging 301 J. The retina was successfully reattached in 90% of eyes with one operation. Further surgery was required in five eyes which developed PVR and two eyes which developed new inferior breaks. Preliminary results from this study suggest that transscleral diode retinopexy is comparable to cryotherapy in terms of anatomic and visual success.</p>
<p>RTD-TS16 Comparison of Techniques for Transscleral Diode Photocoagulation in the Rabbit Benner JD, Galustian JC, Lim M, Hjelmeland L, Landers MB, Morse LS. Retina 15:253-260, 1995</p>	<p>Transscleral diode photocoagulation was performed on the eyes of 13 Dutch-belted rabbits using a straight, 400 μm diameter probe; a prism-tipped, 400 μm diameter probe; and a prism-tipped, 900 μm diameter probe. Both the burn diameter and the mean radiant output energy requirement increased as the burn duration and probe aperture diameter was increased. Explosive retinal holes were encountered in 12% of the burns created with the straight probe. The use of the prism-tipped probes significantly reduced the incidence of retinal holes to <4% ($P<0.005$), and with long duration burns, resulted in the fewest adverse reactions. Conclusion: Transscleral diode photocoagulation with all three probe types was an effective method of ablating the retina and creating chorioretinal adhesions.</p>
<p>RTD-TS17 High-Resolution Magnetic Resonance Imaging Evaluation of Blood-Retinal Barrier Integrity Following Transscleral Diode Laser Treatment Arrindell E, Wu J, Wolf M, Nanda S, Han D, Wong D, Abrams G, Mieler W, Hyde J. Arch Ophthalmol 113:96-102,1995</p>	<p>In this study, continuous Gd-DTPA (gadolinium-diethylene-triaminepentaacetic acid) infusions to quantitate disruption of the blood-retinal barrier was used to compare the effect of transconjunctival diode laser photocoagulation and retinal cryotherapy on equivalent areas of the inferior retinal periphery of pigmented rabbits. Conclusion: Transconjunctival diode laser retinal photocoagulation induces less disruption of the BRB than cryotherapy commonly used in vitreoretinal procedures.</p>

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 <p>RTD-TS18 Experimental Transconjunctival Diode Laser Retinal Photocoagulation through Silicone Scleral Explants Nanda S, Han D. Arch Ophthalmol 113:926-931, 1995</p>	<p>The authors studied the feasibility of inducing chorioretinal lesions in pigmented rabbit eyes under hard silicone elements by transconjunctival diode laser photocoagulation and compared these results to lesions produced without these elements. Intensity burns were also compared - grade 1 (faint, grayish white), grade 2 (whitish center with grayish periphery), and grade 3 (distinct white center). Four rabbits were sacrificed at 1 day and three at 1 week. Results showed that similar chorioretinal lesions could be reproducibly produced both through and without the hard silicone elements. Attenuation through the element was about 20%. Histological findings were likewise similar. No acute histopathologic change in the underlying sclera was observed in burns of intensity grades 1 and 2. After 7 days, hypercellularity and loss of the normal architecture of the inner scleral collagen lamellae underlying the chorioretinal adhesions were noted in lesions of all intensity grades. The authors suggested that despite initial passage of diode laser energy through the sclera, scleral damage may have occurred from secondary conduction of thermal energy from the RPE/choroid to the sclera.</p>
<p>RTD-TS19 Comparison of Scleral Tensile Strength After Transscleral Retinal Cryopexy, Diathermy, and Diode Laser Photocoagulation Han D, Nash R, Blair J, O'Brien W, Medina R. Arch Ophthalmol 113:1195-1199, 1995</p>	<p>The authors compared the tensile strength of sclera following application of transscleral 810 nm diode laser photocoagulation (IRIS Medical OcuLight and DioPexy probe), transscleral cryotherapy, and transscleral diathermy. Twenty-four Dutch-belted rabbits received one of the three treatment modalities. The opposite eye served as a paired, untreated control. Tensile strength measurements of scleral strips excised from areas of treatment were obtained 6 weeks later. No statistically significant difference in mean tensile strength was observed between eyes receiving transscleral cryopexy (n=7) or transscleral diode photocoagulation (n=8) and their corresponding, paired, control eyes. In contrast, transscleral diathermy reduced mean scleral tensile strength to 26% of that of the paired control eyes (n=8, p=.0001). Conclusion: In this rabbit model, scleral weakening is significant following transscleral diathermy while transscleral cryopexy or transscleral diode photocoagulation produces no significant weakening relative to paired, untreated controls.</p>
 <p>RTD-TS20 Transscleral Diode Laser Retinopexy for Treatment of Peripheral Retinal Tears. A Pilot Study Rosen R, Walsh J, Muldoon T, Rosenthal J, Clewner L, Gentile R. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S849. Abstract nr 3899, 1995</p>	<p>Retinopexy was performed on 10 eyes of 10 patients with newly diagnosed peripheral retinal tears using a specially designed fiberoptic transscleral DioPexy Probe. Anesthesia was achieved using either light neuroleptic sedation or local subconjunctival injection of 1% lidocaine. Treatment was administered under direct visualization using indirect ophthalmoscopy. A red diode laser aiming beam emanating from the tip of the DioPexy Probe was visualized through the eye wall at the site of intended laser delivery, facilitating accurate placement of 810 nm treatment laser spots. Retinal lesions were then surrounded with overlapping rows of burns to create a good retinopexy seal. Patients were evaluated at 72 hours, 1 week, 3 weeks, 6 weeks, 3 months, and 6 months after treatment. Result: Nine (90%) of the 10 patients developed well-pigmented chorioretinal adhesions. None of the eyes developed subsequent retinal detachment or evidence of PVR after 3 months of follow-up. No patient reported post-treatment discomfort as is often experienced following cryopexy. Conclusion: Transscleral diode laser retinopexy is effective in the treatment of peripheral retinal tears.</p>

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<p>RTD-TS21 Human Scleral Permeability. Effects of Age, Cryotherapy, Transscleral Diode Laser, and Surgical Thinning Olsen T, Edelhauser H, Lim J, Geroski D. Invest Ophthalmol Vis Sci 36:1893-1903, 1995</p>	<p>To study the effects of transscleral diode laser treatment on human scleral permeability, 15 scleral specimens from human eye bank eyes were treated with a diode laser at 1 Watt for a 2 second duration. None of the specimens were thinned or displayed bluish discoloration from visible uveal tissue. The diode laser's energy is absorbed in pigmented tissue, such as the choroid and the RPE, but is not absorbed in nonpigmented tissues such as the sclera. Diode laser treatment does not alter the permeability or ultrastructure of the sclera.</p>
<p>RTD-TS22 Diode Laser Contact Transscleral Retinal Photocoagulation: A Clinical Study McHugh D, Schwartz S, Dowler J, Ulbig M, Blach R, Hamilton P. Br J Ophthalmol 79:1083-1087, 1995</p>	<p>Thirty-six eyes in 36 patients underwent diode laser transscleral retinopexy with the IRIS Medical DioPexy Probe. Mean age: 47; mean period of review: 8 months. Retinal reattachment was achieved in 100% of eyes. Indications for transscleral retinopexy for this study included retinal detachments with scleral buckle (2 clock hours or more), irradiation of the site of drainage of subretinal fluid, and giant retinal tears (3 clock hours or more). All procedures were performed subconjunctivally under peribulbar or general anesthesia. Power was set at 500 mW. The target area was irradiated until a reaction was observed. If a lesion was not observed after an exposure of up to 2 to 3 seconds, then power was increased in 250 mW increments. If an intense blanching reaction, an audible popcorn effect, or a hemorrhagic lesion was observed, power was decreased until "pops" did not occur. Higher powers were required in the presence of subretinal fluid or hemorrhage. Complications during this study only included punctate choroidal hemorrhages in three eyes, and drainage related choroidal hemorrhage following earlier photocoagulation in two eyes. Visualization of choroidal lesions in the presence of deep or turbid subretinal fluid may be a potential difficulty. The 810 nm wavelength offers high scleral transmission and significant absorption within melanin of the retinal pigment epithelium. Compared to cryotherapy, the 810 nm diode laser induces less pigment epithelial cell dispersion and reduces the risk of over treatment because the diode lesions remain clearly visible. When using the DioPexy Probe for diode retinopexy, it's important to maintain the probe tip perpendicular to the sclera while indenting to maximize scleral transmission. It's also important to make sure the aiming beam is in sharp focus on the retina.</p>
<p>RTD-TS23 Histopathologic and Immunohistochemical Findings of Transscleral Diode Retinopexy: Comparative Studies with Cryoretinopexy Kim JH¹, Oum BS², Lee SH³. ¹Department of Ophthalmology, Pusan Veterans Hospital; ²Department of Ophthalmology Pusan National Univ. Hospital; ³Lee's Eye Clinic, Pusan, Korea [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S403. Abstract nr 1874, 1996</p> <p><i>Also listed as HIST10, pg. 235</i></p>	<p>The authors performed transscleral diode laser retinopexy or cryoretinopexy in 25 pigmented rabbits to compare clinical, histopathologic, and immunohistochemical features of chorioretinal lesions. The eyes were enucleated at 2 hours, 1 week, 1 month, and 3 months after retinopexy. Tissues were sectioned and light and electromicroscopic stains were made. Immunohistochemical studies by the avidin biotin peroxidase complex method with antibodies for Muller cell, astrocyte, retinal pigment epithelium and macrophage (5 immunological markers - GFAP, vimentin, S-100, Cytokeratins, and anti-macrophage) were done. Lesions produced by cryotherapy showed full-thickness overlying retinal destruction compared with those produced by transscleral diode which showed reaction primarily at the outer retina and choroid. Remarkable expressions of GFAP, vimentin and S-100 epitopes were seen in chorioretinal scar tissues made with cryo and with less</p>

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	<p>intensity in diode induced retinopathy. This study indicates that both diode laser retinopathy and cryoretinopathy lesions showed similar deep retinal Muller cell reaction as demonstrated by the immunohistochemical studies; histopathologically, less inner retinal destruction was observed using transscleral diode laser.</p>
<p>RTD-TS24 Combined Transscleral Diode Laser Cyclophotocoagulation and Transscleral Retinal Photocoagulation for Refractory Neovascular Glaucoma Tsai J, Bloom P, Franks W, Khaw P. <i>Retina</i> 16:164-166, 1996</p> <p><i>Also listed as G-TS43, pg. 104</i></p>	<p>The authors report their experience with combined transscleral diode laser ablation of the ciliary body and retina for refractory neovascular glaucoma. The OcuLight diode laser (IRIS Medical) was used with different transscleral probes for cyclophotocoagulation (IRIS Medical G-Probe) and for retinal photocoagulation (IRIS Medical DioPexy Probe). Details of two case studies are discussed. Retrobulbar anesthesia was administered using a 1:1 mixture of 0.5% bupivacaine and 2% lidocaine. For each cycloablative treatment, a total of 40 burns were placed over 360° with a power of 1.5 Watts and a duration of 1.5 seconds. Laser settings for retinal photocoagulation were 1.4 to 2.0 Watts power and 1.0 to 1.5 seconds duration. The authors were able to obtain demonstrable regression of iris neovascularization in patients with ocular media opacities, precluding effective transpupillary panretinal photocoagulation. In 25 previous eyes with NVG treated with diode cycloablative laser treatment only, the authors had not observed a marked improvement in rubeosis. Furthermore, combined transscleral diode treatment of the ciliary body and retina seems to induce only minimal inflammation and pain compared with the authors' previous experience using combined transscleral ciliary body and retinal cryotherapy. This would appear to be a major advantage of this new combined treatment. If future surgery requiring minimal conjunctival damage (e.g., trabeculectomy or drainage tube implant surgery) is necessary, a reduction in conjunctival damage may be an advantage. Therefore, combined transscleral diode laser cycloablation and retinal ablation shows promise as a treatment option in patients with refractory neovascular glaucoma with media opacities limiting adequate transpupillary retinal photocoagulation. Long-term prospective studies investigating this combined treatment modality are needed and currently are in progress at Moorfields Eye Hospital, London, England.</p>
<p>RTD-TS25 Transscleral Diode Laser Photocoagulation for Treatment of Peripheral Retinal Tears, Retinal Detachments, and Iris Neovascularization Rosen RB, Muldoon TO, Walsh JB. The New York Eye and Ear Infirmary, New York Medical College, NY Abstract. The First Jerusalem International Congress on Retinal and Vitreous Diseases. Jerusalem, Israel. June 30 - July 4, 1996</p>	<p>Transscleral photocoagulation was performed on 36 eyes of 36 patients using 810 nm diode laser energy delivered through a specially designed fiberoptic transscleral DioPexy Probe. The conditions treated included 11 peripheral retinal tears, 22 retinal detachments, and 3 cases of iris neovascularization. Subconjunctival lidocaine provided anesthesia for treating retinal tears. Retrobulbar injection or general anesthesia was preferred for scleral buckles and panretinal photocoagulation. Treatment was administered under direct visualization using indirect ophthalmoscopy. A red diode laser aiming beam emanating from the tip of the DioPexy Probe was visualized through the eye wall facilitating accurate placement of laser spots. Retinal tears were surrounded with overlapping rows of burns to create a good retinopathy seal. Panretinal treatment was performed transconjunctivally in a grid pattern. Patients were evaluated postoperatively for at least 6 months. Satisfactory chorioretinal lesions were produced in all cases using treatment parameters</p>

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	<p>(600-1500 mW for 1000-2000 ms) which varied with fundus pigmentation and amount of subretinal fluid present. At 6 months, 100% (11/11) retinal tears remained stable, 95% (21/22) eyes buckled for retinal detachment remained attached, and 100% (3/3) rubeotic eyes maintained regression of the neovascular vessels. Complications included 4 subconjunctival, 3 intraretinal, and 1 vitreous hemorrhage. Conclusion: Transscleral diode laser is effective for the treating of peripheral retinal pathology. It may be advantageous in cases where indirect laser is prevented because of significant subretinal fluid or media opacity. It is comparable to conventional cryopexy and may have theoretical advantages.</p>
<p>RTD-TS26 Management of Giant Retinal Tears with Perfluoro-N-Octane and Transscleral Diode Retinopexy Campbell W. Abstract. Vitreous Society Meeting Cancun, Mexico December 8 - 14, 1996</p>	<p>A prospective consecutive series of seven patients with recent giant retinal tears was treated with pars plana vitrectomy and the retina completely reattached by filling the vitreous cavity with perfluoro-n-octane (PFnO). The edge of the tear was then treated with transscleral 810 nm diode laser photocoagulation. The PFnO remained in the eye for a period of 5 to 7 days, when it was completely replaced with either SF₆ or C₃F₈ gas. The success of the technique was assessed by the reattachment rate and visual acuity results. All cases had follow-up for at least 6 months. In all seven cases, the retina remained fully attached after resorption of gas. In the four macula-on detachments there was no deterioration of visual acuity and in the three macula-off cases, the vision improved. No adverse effect of PFnO on the cornea, lens or retina was observed. This technique of short-term tamponade with PFnO combined with transscleral diopexy is a safe and effective means of retinal re-attachment in giant tear disease. Although it requires two surgical procedures, it prevents posterior retinal slippage and eliminates the need for lensectomy, silicone oil and scleral buckling.</p>
<p>RTD-TS27 Cryopexy in Primary Rhegmatogenous Retinal Detachment: A Risk Factor for Postoperative Proliferative Vitreoretinopathy? Bonnet M, Fleury J, Guenoun S, Yaniali A, Dumas C, Hajjar C. Graefe's Arch Clin Expo Ophthalmol 234:739-743, 1996</p>	<p>The authors conducted a prospective clinical study to evaluate the role of cryopexy and laser photocoagulation treatment (transpupillary argon laser and transscleral diode laser photocoagulation) in the stimulation of postoperative proliferative vitreoretinopathy (PVR) in primary rhegmatogenous retinal detachment. 595 eyes of 554 patients with primary rhegmatogenous retinal detachment, referred before any failed surgery, were enrolled in the study. Multivariate statistical analysis showed that the incidence of postoperative PVR in relation to the methods used for retinopexy was dependent on the types and anatomy of retinal breaks associated with retinal detachment. The incidence of postoperative PVR was nil in retinal detachment due to atrophic holes in lattice, oral dialyses, and macular holes, regardless of the retinopexy methods. Postoperative PVR occurred solely in retinal detachments due to horseshoe tears (PVR: 4.42%), paravascular tears of the postequatorial region (PVR: 18.18%), and giant tears (PVR: 24.6%), (p <0.00001). The incidence of postoperative PVR was 0.5% in eyes with horseshoe tears with mobile posterior edges, versus 9.72% in eyes with horseshoe tears with curled posterior edges, regardless of the retinopexy methods (0.00001). In retinal detachments due to horseshoe tears with mobile posterior edges, the incidence of postoperative PVR (0.5%) was not influenced by the retinopexy methods. In contrast, in retinal detachments due to horseshoe tears with curled posterior edges, the incidence of postoperative</p>



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	<p>PVR was increased in eyes managed with cryopexy (PVR: 14.77%), as compared to eyes managed with laser retinopexy (PVR: 1.78%) (p<0.02). In retinal detachments due to giant tears, the incidence of postoperative PVR was not increased at a statistically significant level in eyes managed with cryopexy (PVR: 33.3%), as compared to eyes managed with laser retinopexy (PVR: 15.6%). In tears 180° and over in size, however, the incidence of postoperative PVR was increased at a statistically significant level in eyes managed with cryopexy (PVR: 9/11 eyes), as compared to eyes managed with laser retinopexy (PVR: 5/17 eyes) (p: 0.006). The authors concluded that cryopexy is not a stimulating factor for postoperative PVR in primary rhegmatogenous retinal detachments due to atrophic holes in lattice, oral dialyses, macular holes, and horseshoe tears with mobile posterior edges. In contrast, cryopexy is probably a stimulating factor of postoperative PVR in retinal detachments due to horseshoe tears with curled posterior edges, and retinal tears 180° and over in extent.</p>
<p>RTD-TS28 Trans Scleral DioPexy in Retinal Detachment Surgery Nagpal PN, Sharma RK, Hindocha CR. Indian Ophthalmology. Proceedings 54th All India Ophth. Conf. Chandigarh, 206-209, 1996</p>	<p>Twenty patients with primary rhegmatogenous retinal detachment were treated with the IRIS Medical OcuLight and DioPexy Probe. Power settings of 500 mW and short durations (0.5-0.7 sec.) were used initially and both were gradually increased as deemed necessary. Two to three rows of laser coagulations were placed around the retinal breaks and any lattice lesions. A constant watch was kept to detect and manage any complications, such as scleral thermal damage, choroidal retinal, or vitreous hemorrhage. Follow-up was at 3 days, 1 week, 4-6 weeks, and 3 month intervals. The maximum follow up period was 1 year with an average follow up of 6 months. At 4 weeks post-op, 17 out of 20 patients had a settled retina. But of these, 6 were lost to subsequent follow-up and were not included in the final analysis. Of the remaining 11 patients, 4 had good visual recovery with no further improvement in vision during the next 5 months. Seven patients showed a slow, steady improvement in vision over the first few months postoperative which stabilized by the 6th month. The only major complication was vitreous hemorrhage in one case. The authors conclude that transscleral diode laser retinopexy is an efficient and relatively safe means of obtaining chorioretinal adhesion in retinal detachment surgery.</p>
<p>RTD-TS29 A New Treatment for Retinal Detachment Haller J. Review of Ophthalmology 1:120-122, 1997</p>	<p>This article reviews the benefits, multi-center study, treatment parameters and guidelines of the DioPexy Probe used with the OcuLight 810 nm photocoagulator. Benefits: excellent penetration through ocular structures, high transmission through conjunctiva, sclera, and solid silicone; a good alternative to argon laser delivered via indirect ophthalmoscopy; and helpful in patients who've had previous detachments and those who have glaucoma implants, since it can treat tears and detachments through existing scleral buckles and glaucoma shunts. Multi-center study: In Phase II of the DioPexy Probe's multi-center study, 89% of 65 eyes with retinal detachments were successfully repaired. (See RTD-TS15, pg. 144 for Phase I; RTD-TS32, pg. 151 for Phase II) Treatment parameters: 1. Administer either peri- or retrobulbar anesthesia; 2. Focus the red aiming beam by turning the OcuLight to "TREAT" mode, hold the probe tip</p>

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	<p>perpendicular to the sclera, indent the sclera with the probe about 0.75 mm, and adjust the probe until you see a circular, discrete red dot; 3. Press the foot switch to administer the laser treatment. This will temporarily extinguish the aiming beam, which allows you to see the developing lesion with your laser indirect ophthalmoscope. 4. Adjust the treatment parameters according to the retina's pigmentation, in areas with thin sclera, or where there is subretinal fluid. Conservative treatment parameters for first-time users:</p> <table style="margin-left: auto; margin-right: auto; border: none;"> <thead> <tr> <th style="text-align: center;"><u>Pigmentation</u></th> <th style="text-align: center;"><u>Power</u></th> <th style="text-align: center;"><u>Duration</u></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Light</td> <td style="text-align: center;">500 mW</td> <td style="text-align: center;">1,200 ms</td> </tr> <tr> <td style="text-align: center;">Moderate</td> <td style="text-align: center;">400 mW</td> <td style="text-align: center;">1,000 ms</td> </tr> <tr> <td style="text-align: center;">Heavy</td> <td style="text-align: center;">300 mW</td> <td style="text-align: center;">800 ms</td> </tr> </tbody> </table> <p>5. Treat to a light gray endpoint. If no reaction is observed after 1 or 2 seconds, increase the power in 100 mW increments. At the first sign of graying of the overlying retina, release the foot pedal. As experienced is gained, durations will become significantly shorter than the final parameters you used in your first few cases.</p> <p>Treatment Guidelines: 1. During treatment, keep the sclera moist at the point of contact and occasionally inspect the tip of the probe to make sure it's free of debris. 2. Hold the tip of the probe so that the face of the laser prism is parallel to the surface of the eye. Do not drag the probe across the sclera when moving from site to site. 3. Inspect the sclera after delivering 10 pulses to a site. As with any new technique, working with the probe gets easier with experience. Start slowly, with a patient who has a peripheral retinal tear without detachment and relatively dark pigmentation. Also, be patient. The multi-center study has shown that after two or three uses of the probe, complications decrease and then remain minimal.</p>	<u>Pigmentation</u>	<u>Power</u>	<u>Duration</u>	Light	500 mW	1,200 ms	Moderate	400 mW	1,000 ms	Heavy	300 mW	800 ms
<u>Pigmentation</u>	<u>Power</u>	<u>Duration</u>											
Light	500 mW	1,200 ms											
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<p>RTD-TS30 Peripheral Transscleral Retinal Diode Laser for Rubeosis Iridis Flaxel CJ, Larkin GB, Broadway DB, Allen PJ, Leaver PK. Retina 17:421-429, 1997</p> <p><i>Also listed as G-TS63, pg. 112</i></p>	<p>Peripheral TSRPC was performed with the OcuLight 810 nm photocoagulator and DioPexy Probe in 15 eyes of 13 patients. TSRPC was performed in an attempt to promote regression of rubeosis in which the fundal view was insufficient to allow transpupillary laser panretinal photocoagulation (PRP) or to allow viewing of the transscleral PRP delivery during treatment. Mean pre-treatment intraocular pressure (IOP) was 35 mm Hg. Nine of the 15 eyes were also treated with TSCPC with the OcuLight 810 nm photocoagulator and G-Probe. Mean pre-treatment IOP was 41 mm Hg. Mean follow-up was 14 months. All eyes showed regression of rubeosis. The best-corrected visual acuity either remained the same or improved in 11 of 15 eyes (73%). The final mean IOP was 13 mm Hg in all patients (range 0 - 27 mm Hg). Of the nine eyes treated with combination therapy, six had stabilized IOP, and three developed hypotony. None of the eyes developed a peripheral retinal detachment, and one eye lost the ability to perceive light. The final mean IOP was 9 mm Hg (range 0 - 27 mm Hg). Even when TSRPC is combined with TSCPC, the inflammatory reaction is significantly less than that which occurs with cryotherapy or intraocular surgical intervention, and no studies have shown an increased risk of retinal detachment. In the event IOP is not controlled, cyclodiode treatment can be repeated; likewise, if rubeosis continues to progress, additional transscleral retinal treatment can be given with no serious adverse effects.</p>												

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<p>RTD-TS31 Transscleral Diode Laser for Retinal Detachment Surgery: A Preliminary Report Gongalves JCM, Farah ME. Paulista School of Medicine, Sao Paulo, Brazil [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S85 Abstract nr 416, 1997</p>	<p>The authors evaluated the use of transscleral diode laser, replacing cryotherapy, in 12 cases of rhegmatogenous retinal detachment surgery. At 6 months of minimum follow-up, retina attachment was obtained in all cases; one case required a buckle revision.</p>
<p>RTD-TS32 Transscleral Diode Laser Photocoagulation In Proliferative Sickle Cell Retinopathy Seiberth V, Knorz MC. University Eye Clinic, Klinikum Mannheim, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S1121. Abstract nr 5258, 1997</p>	<p>The authors treated a 30 year old male patient with hemoglobin sickle cell disease to demonstrate the feasibility of transscleral diode laser photocoagulation for the treatment of proliferative sickle cell retinopathy in eyes with cloudy optical media (e.g., vitreous bleeding). Because of vitreous bleeding, transpupillary coagulation was not possible. After coagulation, vascular proliferation receded completely and vitreous bleeding was absorbed. There were no side effects during the 12 months of follow-up. Transscleral diode laser photocoagulation proved an effective and safe treatment method in a case of proliferative sickle cell retinopathy with vitreous bleeding.</p>
<p>RTD-TS33 The Effect of Retinal Cryoapplication on the Vitreous Dunker S, Faulborn J, Haller E, Reich M. Retina 17:338-343, 1997</p>	<p>The authors applied single cryolesions on one eye and 24 contiguous cryolesions on the other eye of 16 rabbits and examined how vitreous structure changed. A cryoprobe was applied to the sclera 3 - 6 mm from the limbus, and the application was maintained at -60° C until ophthalmoscopic whitening occurred. Two animals were killed on the first day; the third day; after 1, 2, and 4 weeks; and after 2, 3, and 6 months after surgery. The eyes were enucleated and dissected and studied by scanning and transmission electron microscopy. Results: <u>Single Cryoapplications</u> - Single cryoapplications did not have a significant effect on vitreous structure in the rabbit eye and did not lead to posterior vitreous detachment or vitreous liquefaction. <u>Multiple Contiguous Cryolesions</u> (24 cryolesions) - Contiguous cryoapplications had severe effects on the vitreous structure. The retina was detached from the RPE and choroid as a result of massive subretinal edema. The entire vitreous showed an increased density that was probably the result of protein exudation from the breakdown of the BRB and that could be referred to as "vitreous edema." Only 3 - 6 months after cryoapplication, vitreous edema subsided. There were membranes throughout the entire vitreous body composed of detached retina, vessels, fibrocellular elements, and aggregated vitreous collagen fibers. This study supports the concept that the extensive use of cryopexy in human retinal surgery could contribute to the development of PVR.</p>
<p> RTD-TS34 Transscleral Diode Laser Retinopexy in Retinal Detachment Surgery. Results of a Multicenter Trial Haller J, Blair N, De Juan, Jr. E; De Bustros S, Goldberg M, Muldoon T, Packo K, Resnick K, Rosen R, Shapiro M, Smiddy W, Walsh J. Retina 18:399-404, 1998</p> <p><i>See RTD-TS8, pg. 188 for Pilot Study See RTD-TS15, pg. 190 for Update</i></p>	<p>Patients with primary retinal detachment underwent scleral buckling surgery at 5 centers, using the OcuLight SLx and DioPexy Probe for retinopexy. Eyes with chronic retinal detachment, retinal break greater than 90°, history of uveitis or infectious retinopathy or PVR Grade C2 or greater were excluded. Average treatment parameters - laser applications: 137 ± 12; power: 200 to 2000 mW; duration 500 to 9000 ms; total energy 25-1492 J. The mean total energy was 62% higher for eyes with blue-green irides (414 ± 71 J) than for eyes with dark-brown irides (255 ± 57 J). (Average power for dark brown eyes was 800 ± 32 mW and for blue-green eyes was 1,200 ± 40 mW.) The lowest treatment settings were 200 mW/500 ms for dark brown eyes and 500 mW/</p>

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	<p>500 ms for blue-green eyes.) Sixty-five eyes were followed for 6 months or more. Retinas were reattached with a single operation in 58/65 (89%) of these eyes. Seven eyes (11%) required a second procedure, all for redetachment. Visual acuity improved (2 or more Snellen lines) or remained unchanged in 95% (55/58) of eyes with successful outcomes. Seventy-four percent of the eyes had 20/50 acuity or better at 6 months. Complications included apparent breaks in Bruch's membrane (15 eyes), some scleral thermal effect (14), limited intraretinal hemorrhage (10), and hemorrhage extending into the vitreous (3). In only one case was hemorrhage judged to adversely affect surgical outcome. <i>Complication rates significantly reduced with increased physician experience, usually by their third procedure.</i></p> <p>Advantages over cryotherapy include laser energy delivered through silicone elements such as scleral buckling hardware or glaucoma drainage devices/reservoirs; the DioPexy Probe's aiming beam provides precise localization during indirect ophthalmoscopic localization of retinal breaks, and it potentially causes less breakdown of the BRB. Transscleral diode laser retinopexy served as a safe and effective means of creating chorioretinal adhesion in retinal detachment surgery.</p>
<p>RTD-TS35 Does Transscleral Diode Laser Retinopexy Enhance Dispersion of Viable Retinal Pigment Epithelial Cells? Barnes SD,^{1,2} LoRusso FJ.^{1,2} ¹Wilford Hall Medical Center, Lackland Air Force Base, TX; ²Brooke Army Medical Center, Fort Sam Houston, TX [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S108. Abstract nr 506, 1998</p>	<p>Twelve bovine eyes were obtained within 1 hour of the animal's death. The retina was gently separated from the RPE after the anterior segment and vitreous were removed. Cryotherapy was applied to 4 eyes, diode laser was applied to 4 eyes, and 4 eyes served as controls. The eyes were then filled with Eagle's medium and, after 3.5 hours of incubation, this was transferred to petri dishes. The number of attached RPE cells were counted after 24 hours of incubation and again at 5 days of incubation to ascertain growth of viable RPE cells. Results: The eyes serving as controls had an average of 29 separate groups of attached cells which dropped to 25 at the 5 day count. The eyes with laser had 20 separate groups which increased to 21. The eyes with cryotherapy had 25 separate groups which increased to 109. The difference in growth rates between the laser and control groups was not statistically significant ($p=0.5$), while the 400% increase in RPE cell groups for the eyes treated with cryotherapy represents a statistically significant difference ($p=0.07$). Conclusions: The use of transscleral diode laser does not appear to be associated with the dispersion of viable RPE cells and is an alternative for treating retinal detachments which may decrease the incidence of PVR.</p>
<p>RTD-TS36 Performance Characteristics of Infrared Diode Laser Probe for Transbuckle Photocoagulation Tsilou E, Steidl S, Choe HS. Maryland Center for Eye Care, Univ of Maryland, Baltimore, MD [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S1001. Abstract nr 4628, 1998</p>	<p>The DioPexy Probe was used for transbuckle photocoagulation on New Zealand pigmented rabbits. Optimal power settings to achieve a moderate burn 6 mm and 4 mm from the limbus were determined for three buckle sizes (0.75, 1.2, and 1.9 mm thickness). Using these settings 32 treatments were placed through each buckle element with and without conjunctiva. The optional power settings to achieve a moderate intensity burn at 4 mm from the limbus were 600, 650 and 1000 mW for buckles with thickness 0.75, 1.2, 1.9 mm respectively. The power settings were 600, 900 and 1300 for the locations 6 mm from the limbus. Using these optional power settings, the blindly placed burns ranged from minimal to moderate intensities without any retinal holes. The burn diameters were not significantly different between the buckles ($p=0.05$). Mildly higher power settings were required to reach the same burn intensities with conjunctiva. The higher power settings</p>

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	<p>were required for the thicker buckles. The further posterior the treatment site, the higher the power required. Sizes of burn did not vary significantly with buckle thickness. Transbuckle photocoagulation using the DioPexy Probe without retinal visualization was possible in this study.</p>
<p>RTD-TS37 Transscleral Retinal Diode Laser Photocoagulation in Macaque Monkey: An Histological Study Boros AS,¹ Parducz A,² Sary G,³ Benedek G,³ McHugh DA.⁴ ¹Department of Ophthalmology Albert Szent-Györgyi Medical University, Szeged, Hungary; ²Biological Research Center Szeged, Hungary; ³Department of Physiology Albert Szent-Györgyi Medical University Szeged, Hungary; ⁴King's College Hospital, London, UK. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S957. Abstract nr 5053, 1999</p>	<p>Using the 810 nm, infrared OcuLight photocoagulator and DioPexy Probe, transscleral diode laser retinal irradiation was applied in a Macaque monkey. The indented target zone and diode red aiming beam were visualized with a 20 D lens and indirect ophthalmoscope. Treatment parameters were varied between powers of 250 and 500 mW and pulse durations of 200 to 1000 ms. Following humane sacrifice, the enucleated eye was prepared for histological analysis. Dose-dependent morphological changes were observed. Threshold for visible damage occurred at a power of 250 mW and pulse duration of 200 ms. In all lesions, the primary site of absorption of incident energy was the RPE, with formation of a central coagulum. Secondary damage due to thermal diffusion was observed in the neuroretina and choroid. At lower radiant energies, the thermal diameter profile extended to the outer nuclear layer internally and the choriocapillaris externally. At high exposures, the zone of disruption included the inner nuclear and mid-choroidal zone. Breakdown of the BRB resulted in an annular separation of the neuroretinal-RPE interface at the edge of the impact zone, with splitting of the mid retinal layers occurring at high power. No laser-related scleral damage was observed. With the appropriate corrections for species differences, this information will help to establish more precise treatment in the management of clinical conditions.</p>
<p>RTD-TS38 Trans-Scleral Diode Laser Photocoagulation in Proliferative Sickle Cell Retinopathy Seiberth V. Ophthalmology 106:1828-1829, 1999</p>	<p>The major threat to vision in patients with sickle cell diseases is vascular proliferation in the peripheral retina (proliferative sickle retinopathy [PSR]), which may lead to vitreous hemorrhage or retinal detachment. In eyes with cloudy optical media or with poor mydriasis, PSR cannot be treated by transpupillary photocoagulation; therefore, the good tissue transmission of the 810 nm diode laser makes transscleral retinal coagulation possible in these eyes. The authors share a case study of transscleral diode laser photocoagulation applied to both eyes of a 30 year old man with hemoglobin sickle cell disease. A localized scatter technique was used placing 90 gray-white spots of approximately 1000 µm diameter in the right eye and 154 spots in the left eye. Spots were placed approximately one half burn diameter apart and extended from two disc diameters posterior to the lesion to two disc diameters anterior to the lesion and 1 clock hour to each side. No attempt was made to treat the proliferation or feeding vessels directly. Duration of a single laser burn was 500 ms. Laser power was 600 mW. After coagulation, vascular proliferation receded in both eyes, as did vitreous hemorrhage in the left eye. Twelve months after treatment, dye leakage on FA had completely disappeared. During treatment and follow-up (22 months) there were no adverse side effects of laser therapy (e.g. conjunctival or scleral damage). Conclusion: Transscleral diode laser photocoagulation proved to be an effective and safe treatment in a case of proliferative sickle cell retinopathy with vitreous bleeding.</p>

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<p>RTD-TS39 Pilot Trial of Transscleral Diode Laser Retinopexy and Vitrectomy in Primary Rhegmatogenous Retinal Detachment Without Scleral Buckling</p> <p>Morales-Canton V,^{1,2} Quiroz-Mercado H,^{1,2} Hernandez-Da Mota S,^{1,2} Buitrago M,^{1,2} Blanco-Moreno E,^{1,2} Namba-Bando T,^{1,2}</p> <p>Asociacion Para Evitar La Ceguera en Mexico, Hospital Dr. Luis Sanchez Bulnes¹, U.N.A.M. Mexico City, Mexico.²</p> <p>[ARVO Abstract]. Invest Ophthalmol Vis Sci. 41(4): S660. Abstract nr 3503, 2000</p>	<p>A prospective, noncomparative case series of 11 consecutive patients with primary rhegmatogenous retinal detachments underwent transscleral diode laser retinopexy and two port pars plana vitrectomy lacking scleral buckling, using BIOM system to reattach retina. Patients with chronic detachments, a retinal break greater than 90°, history of uveitis or infectious retinopathy, proliferative vitreoretinopathy or vitreous hemorrhage were excluded. By 6 months, 9 of 11 retinas were successfully repaired following only one operation. One of the retinas redetached at 2 weeks and the other one at 3 weeks and no patient developed PVR. Following air-fluid exchange, the use of perfluorocarbon liquids and scleral buckling both retinas remained attached. No complications were found with the use of diode laser retinopexy. Visual outcomes in all patients were 20/100 or better in seven of cases studied. Conclusion: In this pilot series, transscleral diode laser retinopexy combined with vitrectomy served as a safe and effective procedure in obtaining a chorioretinal scar and relieving vitreous traction in retinal detachment surgery.</p>
<p>RTD-TS40 Transscleral Infrared Laser for Retinal Ablation without Retinal Visualization in an Experimental Model</p> <p>Steidl SM, Tsilou E, Choe H.</p> <p>Retina 20:655-659, 2000</p>	<p>The primary goal of this study was to evaluate whether TSCPC laser can deliver adequate photocoagulation intensity at predetermined parameters without direct retinal visualization and without forming retinal holes. The secondary objective was to determine if silicone scleral buckles affect these results. 810 nm laser photocoagulation was delivered to eyes of 6 pigmented rabbits using the DioPexy Probe, G-Probe and EndoProbe*. Probes were placed directly on the sclera, on conjunctiva, and on silicone scleral buckles in a circumferential pattern 4 mm and 6 mm from the limbus. Results: A DioPexy Probe placed on the sclera achieved moderate retinal photocoagulation intensity in 75% of spots 4 mm from the limbus and in 50% of spots 6 mm from the limbus. Retinal holes were only formed when using the G-Probe. An association between burn intensity and the presence of conjunctiva was seen for the G-Probe (P = 0.0001) but not for the DioPexy probe (P = 0.125). Photocoagulation spots did not exceed moderate intensity through any of the silicone scleral buckles tested.</p> <p><u>Treatment Parameters</u></p> <p>Duration: 500 ms was used as a constant value for each of the laser parameters. Power: Minimum and maximum power settings were tested in a remote portion of the eye. Then, a mean between the two extremes was chosen as the power setting used during the study.</p> <p>Conclusions: Transscleral infrared photocoagulation applied without retinal visualization did not cause retinal hole formation with a retina probe placed directly on conjunctiva, sclera, or scleral buckle material. A G-Probe created retinal holes when placed directly on the sclera. A decrease in power was required for all treatments closer to the limbus. Data from this study would indicate that the DioPexy probe should be stocked in the operating room for transscleral use, even in the face of the common availability of the G-Probe.</p> <p><u>Additional Notes</u></p> <p>Greater power is needed for transbuckle treatment in general,</p>

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and this power requirement increases in a linear fashion as buckle thickness increases. A 53% increase in laser power was required for treatment through a 1.9 mm thickness scleral buckle. A clean scleral surface was required for optimal laser penetration for all probes. Regional variation in pigmentation may affect the reproducibility of photocoagulation spots by affecting a localized melanin based thermal reaction. "Pop" sounds associated with a break in Bruch's membrane or a break in Bruch's membrane and the retina were undistinguishable. Therefore the authors do not consider audible indicators as a reliable determinant of retinal damage.

*The EndoProbe placed perpendicular to the scleral surface only occasionally achieved TSRPC at very high laser settings which varied considerably. The EndoProbe often required cleaning from thermal interaction with the tissue, and as a result, the study was conducted with the G-Probe and DioPexy Probe only.

Additional Education Material Available on:

Retinal Tears and Detachments

RTD-T Treatment Guidelines: Diode Laser Transscleral Retinal Photocoagulation*

A one page reference source that summarizes the importance of:

1. DioPexy Probe placement and indentation
2. Focused aiming beam
3. Titrating to a light-gray endpoint
4. Treatment parameters based on pigmentation

*This guideline should be used in conjunction with the IRIS Medical DioPexy Probe Operator's Manual, and the video, "Transscleral Retinal Photocoagulation with the DioPexy™ Probe."

RTD-A Applications Note: Laser Indirect Ophthalmoscopy

This applications note reviews the laser indirect's indications for use, optics of laser indirect ophthalmoscopy, and treatment techniques.

RETINOPATHY of PREMATURITY

<i>Laser Indirect Photocoagulation</i>	
<p>ROP-LI1 Laser Photocoagulation for Stage 3+ Retinopathy of Prematurity McNamara A, Tasman W, Brown G, Federman J. Ophthalmology 98:576-580, 1991</p>	<p>Twenty-two infants with "threshold" stage 3+ retinopathy of prematurity were entered into a prospective, randomized clinical trial to compare the efficacy of transscleral cryotherapy versus laser photocoagulation delivered by the indirect ophthalmoscope. The results suggest that laser therapy is as effective as cryotherapy in the treatment of ROP.</p>
<p>ROP-LI2 Laser Photocoagulation for Threshold Retinopathy of Prematurity Iverson D, Trese M, Orgel I, Williams G. Arch Ophthalmol 109:1342-1343, 1991</p>	<p>Twelve eyes were randomized to photocoagulation or cryotherapy for treatment of threshold stage 3 (TS 3) ROP. The mean number of freezing applications was 51, ranging from 46 to 61. The mean number of photocoagulation burns was 410, ranging from 138 to 655. Regression was evident within 7 to 10 days after a single treatment with either modality in 10 of 12 eyes. All eyes undergoing photocoagulation appeared less inflamed and had less conjunctival chemosis in the period immediately after therapy. Although longer follow-up is required, laser therapy appears at least as effective as cryotherapy in inducing regression of TS 3 ROP.</p>
<p> ROP-LI3 Diode Laser Photocoagulation for Retinopathy of Prematurity McNamara A, Tasman W, Vander J, Brown G. Arch Ophthalmol 110:1714-1716, 1992</p>	<p>In a prospective, randomized clinical trial comparing transscleral cryotherapy with laser photocoagulation in the treatment of "threshold" stage 3+ ROP, 32 infants were treated with 810 nm diode laser photocoagulation in one eye. The results suggest that diode laser photocoagulation is as effective as cryotherapy in the treatment of ROP.</p>
<p>ROP-LI4 Photocoagulation with the Laser Indirect Ophthalmoscope for Retinopathy of Prematurity Benner J. Seminars in Ophthalmology 7:177-181, 1992</p>	<p>A comparison of argon and diode infrared laser photocoagulation using the LIO for ROP was found to be equally effective for treating threshold ROP. This article also discusses the technique for LIO photocoagulation.</p>
<p>ROP-LI5 Transient Punctate Lenticular Opacities as a Complication of Argon Laser Photoablation in an Infant with Retinopathy of Prematurity Drack A, Burke J, Pulido J, Keech R. Am J of Ophthalmol 113:583-584, 1992</p>	<p>Twin girls were diagnosed with ROP 6 weeks after birth. One twin received bilateral peripheral laser photoablation with the diode laser through an indirect ophthalmoscope delivery system. The other twin received argon laser photoablation using an indirect delivery system. Results: Laser treatment is easier to perform than cryotherapy on infants with posterior disease. However, the cataractogenic effect of argon wavelengths should be considered when using this treatment modality for ROP.</p>
<p>ROP-LI6 Comparison of Photocoagulation with the Argon, Krypton, and Diode Laser Indirect Ophthalmoscopes in Rabbit Eyes Benner J, Huang M, Morse L, Hjelmeland L, Landers M. Ophthalmology 99:1554-1563, 1992</p>	<p>Photocoagulation was performed with argon green, krypton red, and diode infrared laser indirect ophthalmoscopes in a grid pattern within one sector of the same eye of 14 Dutch-belted rabbits. Results showed photocoagulation with the argon green, krypton red, or diode infrared laser indirect ophthalmoscopes is a safe and effective method of retinal ablation.</p>

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<p>ROP-LI7 Diode Laser Photocoagulation for Prethreshold, Posterior Retinopathy of Prematurity Fleming T, Runge P, Charles S. Am J Ophthalmol 114:589-592, 1992</p>	<p>Nine infants with posterior ROP were treated by using the 810 nm diode laser through an indirect ophthalmoscopic delivery system. Treatment was commenced as soon as plus disease (defined as tortuosity and dilation of posterior vessels) developed. Laser burns were applied to the avascular retina for 360°, all the way to the ora serrata. Spots were placed one half burn width apart by using a dull gray-white laser photocoagulation mark as the endpoint. Both eyes of each patient were treated in the same session. All 18 eyes showed complete regression of the plus disease.</p>
<p>ROP-LI8 Diode Laser for Retinopathy of Prematurity - Early Outcome Goggin M, O'Keefe M. Br J Ophthalmol 77:559-562, 1993</p>	<p>Twenty-one eyes received diode laser retinal photocoagulation using an IRIS Medical OcuLight SL, 810 nm diode laser system within 36 hours of the observation of threshold disease. Follow-up examination was carried out by 1 week after laser treatment and later frequency of examination depended on the response to treatment. Regression was noted, on average, 5 days after application of laser therapy. This study confirms diode laser photocoagulation is an effective treatment for threshold ROP and further controlled trials are needed to refine it.</p>
<p>ROP-LI9 Comparison of Cryotherapy and Diode Laser Indirect Ophthalmoscope (LIO) Photocoagulation for Stage 3+ Retinopathy of Prematurity Tiwari R, Lerebours F, Kilmanjaro H. [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 837. Abstract nr 667, 1993</p>	<p>Twenty eyes were treated with cryotherapy and 12 eyes were treated with 810 nm diode (LIO) photocoagulation. The diode laser was performed with the setting of 200-300 mW power and 0.2 sec. duration with a 20D lens. Sixteen of the 20 (80%) of cryotherapy treated eyes and 12 of 12 (100%) diode laser treated eyes had a favorable outcome. Post operatively, the diode laser treated eyes did not have conjunctival chemosis or lid edema. After a minimum follow-up of 6 months, results suggest that diode laser photocoagulation is an effective modality in preventing blindness in neonates with threshold Stage 3+ ROP.</p>
<p>ROP-LI10 Laser Treatment for Retinopathy of Prematurity McNamara A. Current Opinion in Ophthalmology 4:76-80, 1993</p>	<p>The author compares a multicenter trial of cryotherapy with a separate 810 nm diode laser photocoagulation study to determine whether laser photocoagulation is as effective as cryotherapy in reducing the likelihood of an unfavorable result in threshold, stage 3+ ROP and to determine any differences in the incidence of complications between the two modes of therapy. Laser photocoagulation has been shown to decrease the likelihood of an unfavorable outcome in the treatment of threshold stage 3+ ROP, is particularly useful in the management of posterior ROP, and should be applied at an earlier stage of disease when ROP involves zone I or posterior zone II.</p>
<p>ROP-LI11 A Comparison of Argon and Diode Photocoagulation Combined with Supplemental Oxygen for the Treatment of Retinopathy of Prematurity Benner J, Morse L, Hay A, Landers M. Retina 13:222-229, 1993</p>	<p>The efficacy of argon and diode laser photocoagulation of the avascular peripheral retina for threshold ROP was compared in a prospective trial. The study group included nine premature infants (17 eyes). One eye was treated with the 810 nm diode laser indirect ophthalmoscope and the fellow eye was treated with the argon LIO. The mean duration of the follow-up period was 9.7 ±2.6 months. Two patients sustained burns of the tunica vasculosa lentis and anterior lens capsule in the argon laser treated eye but not in the fellow diode treated eye. All 17 eyes had complete regression of ROP and favorable outcomes. The diode and argon LIO appear to be equally effective in treating threshold ROP. The diode LIO appears to have advantages over the argon LIO systems for treating advanced ROP.</p>

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<p>ROP-LI12 Diode Laser Photocoagulation for Threshold Retinopathy of Prematurity. A Randomized Study Hunter DG, Repka MX. Ophthalmology 100:238-244, 1993</p>	<p>Patients were enrolled under a prospective, randomized protocol. One eye of each patient with symmetric, threshold ROP was treated with an 810 nm diode laser, while the other eye was treated with cryotherapy. Compared with cryotherapy, the diode laser was more convenient, technically easier to administer, and better tolerated by the patient. Diode laser peripheral retinal ablation appeared to be as effective as cryotherapy for the treatment of threshold ROP.</p>
<p> ROP-LI13 Diode Laser Photocoagulation for Zone 1 Threshold Retinopathy of Prematurity Capone A, Diaz-Rohena R, Sternberg P, Mandell B, Lambert M, Lopez P. Am J Ophthalmol 116:444-450, 1993</p>	<p>The 810 nm diode LIO was used to treat 17 infants (30 eyes) with zone 1 threshold ROP. Diode laser photoablation of the peripheral retina was found to be an effective treatment for threshold ROP located in zone 1. The authors note that some advantages of the diode laser system are its portability and ease of use, precision of treatment, and minimal postprocedural adnexal inflammation.</p>
<p> ROP-LI14 Argon Laser-induced Cataract in an Infant with Retinopathy of Prematurity Pogrebniak A, Bolling J, Steward M. Am J Ophthalmol 117:261-262, 1994</p>	<p>Ablation of peripheral retina with an argon laser indirect ophthalmoscope was recommended to treat a 10 1/2 week old boy with stage I, posterior zone II ROP in the right eye and stage 1, zone 1 ROP in the left eye with plus disease in both eyes. By 2 weeks after treatment, a fibrin clot had appeared in the anterior chamber and a cataract was detectable in the right eye. The treatment parameters for the right eye were 2,552 applications, 0.70- to 1.00-W power, and 0.2- second duration. The authors believe that absorption of laser energy may have resulted in rupture of the lens capsule and in the development of a mature cataract with associated intraocular inflammation. This case demonstrates the need for considering the risk of cataract in determining the role of laser photocoagulation for treatment of ROP.</p>
<p>ROP-LI15 Treatment of the "Rush Form" ROP: Diode Laser - Interferon vs. Cryotherapy Gagliano C, Scuderi A, Di Pietro M, Saporito N, Tina G, Reibaldi A. Institute of Ophthalmology, Univ. of Catania, Italy [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1440. Abstract nr 861, 1994</p>	<p>Eight newborns (16 eyes) with ROP "rush form" were observed and randomized into two treatment groups to compare the efficacy of the diode laser treatment in association with interferon (IFN) therapy and cryotherapy in "rush form" ROP. The first group (8 eyes) was treated with 810 nm diode laser in the peripheral retina anteriorly to the ridge and medical treatment was started with IFN alfa 2b at variable dosage according to body surface for 10 weeks. The second group (8 eyes) was treated with cryotherapy. Favorable outcome was observed in five eyes (62.5%) in the first group and in two eyes (25%) in the second group. Analysis of the unfavorable outcome for each infant revealed that diode laser-IFN therapy reduces the risks of new hemorrhages, retinal detachment and retinal fold. Conclusions: The association of diode laser and IFN therapy could have efficacy in the "rush form" ROP treatment but the small number of cases due, to the infrequency of the disease, needs a multicenter study to establish the validity of this therapy.</p>
<p> ROP-LI16 Indirect Diode Laser Photocoagulation for Threshold and Posterior Pre-threshold Retinopathy of Prematurity Margolis T, Duker J, Reichel E, Puliafito C. Vitreoretinal Service, New England Eye Center, Tufts Univ. School of Medicine, Boston, MA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1443. Abstract nr 877, 1994</p>	<p>One hundred and twenty infants were screened for ROP of which 13 (22 eyes) underwent 810 nm diode laser treatment to determine if indirect diode laser photocoagulation is effective in producing a favorable outcome in infants with severe ROP. The mean gestational age at birth was 26 weeks with a mean birthweight of 792 grams. Eight eyes (36%) had posterior prethreshold disease at the time of treatment while 14 (64%) had reached threshold. Patients were followed for an average of 12 weeks after laser treatment. Of five eyes requiring retreat-</p>

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	<p>ment, two had unfavorable outcomes. Overall, five eyes (23%) had unfavorable outcomes including one (12%) in the prethreshold group and four (28%) in the threshold group. No complications were associated with any of the treatments. Conclusion: Diode laser photocoagulation for severe ROP appears to be as effective as cryotherapy in preventing unfavorable outcomes and offers several advantages in terms of safety, side effects, and cost.</p>
<p>ROP-LI17 Diode Laser Indirect Ophthalmoscope Treatment of Threshold Retinopathy of Prematurity Reibaldi A, Biondi P, Di Pietro M, Scuderi A. Video Presentation V37. XXVIIth ICO. Toronto, Canada June, 1994</p>	<p>Fourteen premature newborns (28 eyes) with threshold ROP (five contiguous or eight cumulative 30° clock hours of stage 3 ROP in zone I or II, with plus disease), were treated with the 810 nm diode laser indirect ophthalmoscope with topical anesthesia in zone 1. The patients were followed for 6 to 12 (average 7.4) months. In 24 eyes (86%), regression of the ridge and plus was noted, while in 4 eyes (14%) an unfavorable outcome was observed (stage 4 ROP treated with scleral buckling in 1 eye, macular fold in 1 eye, stage 5 ROP treated with open-sky vitrectomy in 1 eye, and stage 5 ROP in 1 eye, which was not treated because of the poor visual prognosis). Our results suggest that the efficacy of diode laser treatment in ROP is comparable to that of cryotherapy, but the diode laser is less aggressive to the sclera.</p>
<p>ROP-LI18 Laser Therapy for Retinopathy of Prematurity The Laser ROP Study Group Arch Ophthalmol 112:154-156, 1994</p>	<p>The Laser ROP Study Group was formed to complete a meta-analysis of three published, randomized laser ROP trials and one unpublished, nonrandomized ROP trial. Two hundred ninety-three eyes from the four studies were reviewed. All eyes in each series had threshold stage 3+ ROP with threshold criteria of five contiguous or eight accumulated clock hours of extraretinal fibrovascular proliferation. Argon or 810 nm diode laser treatment was applied to the avascular retina, and minimum follow-up was 3 months. Results are summarized in two tables: Table 1 details the odds ratio between cryotherapy and laser therapy, Table 2 details results of treatment in infants randomized to receive laser treatment in one eye and cryotherapy in the fellow eye. Both analyses indicate that laser therapy is at least as effective as cryotherapy.</p>
<p>ROP-LI19 Refractive Outcome Following Diode Laser versus Cryotherapy for Eyes with Retinopathy of Prematurity Algawi K, Goggin M, O'Keefe M. Br J Ophthalmol 78:612-614, 1994</p> <p><i>See ROP-LI32, pg. 210 for 3 Year Follow-up Results</i></p>	<p>The refractive error in 15 eyes with threshold retinopathy of prematurity treated with 810 nm diode laser photocoagulation was compared with 25 eyes with the same disease severity treated by cryotherapy. Mean follow-up was 13 months. Myopia was present in 6 eyes (40%) of the first group ranging from -1.50 to -3.50 diopters, while 23 eyes (92%) showed myopia which ranged from -0.50 to -8.00 diopters in the cryotherapy group. Nine eyes (60%) were hypermetropic at less than +3.0 diopters in the laser group, while only 2 eyes (8%) of the cryotherapy group showed hypermetropia. There was no significant difference in astigmatism between the two groups. Eyes with threshold disease treated with diode laser photocoagulation developed significantly less myopia than those treated with cryotherapy.</p>
<p>ROP-LI20 Cataracts in Infants Treated with Argon Laser Photocoagulation for Threshold Retinopathy of Prematurity Christiansen S, Bradford JD. Am J Ophthalmol 119:175-180, 1995</p>	<p>The records of 51 consecutive patients (100 eyes) treated only with argon laser photocoagulation for threshold ROP were reviewed. Patient characteristics and treatment variables were compared between infants who developed cataracts and those who did not. Complete opacification of the lens nucleus and cortex developed in 6 eyes of 4 patients between 19 and</p>



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<p><i>For Response, See following listing: ROP-LI21.</i></p>	<p>99 days after laser therapy. Eyes that developed permanent cataracts were noted to have a prominent anterior tunica vasculosa lentis at the time of treatment. After laser therapy, these eyes developed hyphema, shallowing of the anterior chamber, corneal edema, and progressive opacification of the lens. When compared with eyes that did not develop cataract, no statistically significant difference in number of burns, zone or clock hours of extraretinal proliferation, birth weight, gestational age, or age at treatment was found.</p>
<p>ROP-LI21 Cataract in Infants Treated with Argon Laser Photocoagulation for Threshold Retinopathy of Prematurity Campolattaro B, Lueder G. Am J Ophthalmol (Letter) 120:264-265, 1995</p> <p><i>Response to letter. See previous listing, ROP-LI20, pg. 206</i></p>	<p>The authors agree that possible causes of cataract when treated with the indirect argon laser photocoagulation is a frequent association of a prominent tunica vasculosa lentis in affected patients with ROP. They also share a recent experience that suggests another possible mechanism for the development of cataracts in infants treated with photocoagulation for retinopathy of prematurity: Their hypothesis for the development of cataract in their patient was a nanophthalmic left eye that was predisposed to the development of uveal effusion after indirect diode laser treatment. The left eye received 1,151 burns, and the right eye received 1,164 burns with the power setting at 200 mW and the duration at 200 msec. The uveal effusion resulted in anterior rotation of the ciliary body and shallowing of the already narrow anterior chamber. The cataract developed because of corneal-lenticular apposition. The absence of choroidal effusions and other complications in their patient's normally sized right eye, supports their hypothesis.</p>
<p>ROP-LI22 Effectiveness of Diode Laser Photocoagulation for Zone I Threshold Retinopathy of Prematurity Redens TB,¹ Kooragayala LM,² Pramanik A,³ Schulman JA.⁴ Departments of ^{1,2,4}Ophthalmology and ³Pediatrics, Louisiana State Univ.; Medical Center of Shreveport, LA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): 569. Abstract nr 335, 1995</p>	<p>Between 1992 and 1994, 24 consecutive eyes (16 patients) with zone I threshold ROP were entered into this prospective study. New infrared diode laser treatment was performed in 22 of 24 eyes within 24 hours of diagnosing threshold ROP. Follow-up ranged from 4 to 33.2 months with a mean of 19.1 months. Twenty-three of 24 eyes achieved favorable anatomical results. Six eyes required re-treatment; and treatment complications occurred in five eyes. The incidence of unfavorable outcome in zone I threshold ROP eyes (4.2%) is much lower in this small series compared to the Cryo-ROP study (75%). These results suggest diode laser photocoagulation is an effective method for treatment of zone I threshold ROP eyes.</p>
<p> ROP-LI23 Diode Laser Photocoagulation for Stage 3+ Retinopathy of Prematurity Seiberth V, Linderkamp O, Vardarli I, Knorz M, Liesenhoff H. Graefe's Arch Clin Expo Ophthalmol 233:489-493, 1995</p>	<p>To evaluate the efficacy and safety of diode laser photocoagulation, the authors included 42 eyes with stage 3+ ROP of 24 preterm infants in a prospective clinical study. Photocoagulation treatment was performed using an 810 nm diode laser with a laser indirect ophthalmoscope delivery system. Follow-up ranged from 3 to 16 months. In 39 eyes (93%), ROP regressed after a single laser treatment and the outcome was a flat, attached retina. One eye (2%) had a second laser session and another eye (2%) had additional retinal detachment surgery, resulting in the regression of ROP and a flat, attached retina. Another eye (2%) failed treatment and ROP progressed to stage 5, although additional retinal detachment surgery was performed. The success rate was 41 (98%) out of 42 eyes. Neither lenticular opacities nor cataract formation were encountered. Diode laser photocoagulation for stage 3+ ROP showed only minor side effects and was at least as effective as cryotherapy treatment.</p>

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 <p>ROP-LI24 Diode Laser Photocoagulation for Threshold Retinopathy of Prematurity in Eyes with Tunica Vasculosa Lentis Seiberth V, Linderkamp O, Vardarli I, Knorz M, Liesenhoff H. Am J Ophthalmol 119:748-751, 1995</p>	<p>In a prospective clinical study, threshold retinopathy of prematurity was treated in 14 eyes of 7 consecutive preterm infants with tunica vasculosa lentis by using the 810 nm diode laser indirect ophthalmoscope. Laser power ranged from 200 to 400 mW (mean 260±52 mW). Duration of a single spot was 200 msec. Number of burns ranged from 1,060 to 2,132 (1,556±315). There were neither lenticular opacities nor cataract formation. Retinopathy of prematurity regressed in all eyes, and the outcome was a flat, attached retina. Diode laser photocoagulation with the laser indirect ophthalmoscope can be used safely in eyes with tunica vasculosa lentis.</p>
 <p>ROP-LI25 Transscleral versus Transpupillary Diode Laser Photocoagulation for Stage 3+ Retinopathy of Prematurity Seiberth V, Vardarli I, Knorz MC, Liesenhoff H. Presentation. D.O.G. Meeting Heidelberg. Mannheim/Heidelberg September 1995. German J Ophthalmol 1(Suppl):127, 1995 <i>Also listed as ROP-TS1, pg. 227</i></p>	<p>Twenty eyes of 10 infants (gestational age 24-27 weeks, mean 25.7±0.9 weeks; birth weight 480-908 g mean 777±175 g) with ROP stage 3+ were treated with diode infrared laser photocoagulation. One eye of each infant was treated transsclerally while the fellow eye had transpupillary coagulation using the laser indirect ophthalmoscope. Follow-up ranged from 2 to 14 months (mean 7.5±2.3 months.) In 10 (100%) eyes treated transpupillary and in 9 (90%) eyes treated transsclerally, ROP regressed after a single or a second laser treatment and the outcome was a flat, attached retina. One eye (10%) with zone I disease failed after transscleral laser treatment and ROP progressed to stage 4 A with a retinal fold and partially attached retina, although additional retinal detachment surgery with an encircling band was performed. No adverse side effects occurred as a result of retinal/preretinal bleeding in the ridge in five eyes (25%). There were no adverse side effects. Conclusion: Transscleral diode laser coagulation for treatment of ROP stage 3+ proved to be as effective and safe as transpupillary diode laser photocoagulation.</p>
<p>ROP-LI26 Threshold Retinopathy of Prematurity. Transition from Cryopexy to Laser Treatment Hammer M, Pusateri T, Hess J, Sosa R, Stromquist C. Retina 15:486-489, 1995</p>	<p>Seventy-six eyes in 41 patients were treated for acute retinopathy of prematurity from January 1991 to April 1994. Fifty-six eyes in 30 patients had zone 2 disease. Of these 30 patients, 11 received laser treatment (810 nm diode or argon) and 20 received cryopexy treatment; there was at least one anatomically successful eye in each patient. Twenty eyes in 10 patients had zone 1 disease. Seven patients had bilateral laser treatment (four 810 nm diode, three argon). Three patients had bilateral cryopexy. None of the three eyes with zone 1 disease treated with cryopexy were successful. Laserpexy and cryopexy are of equal efficacy in treating zone 2 disease. For the treatment of zone 1 disease, laserpexy is more effective than cryopexy, and diode and argon laser are of equal efficacy. Transition from cryotherapy to laser therapy can be accomplished easily by an experienced retinal surgeon. Excellent results can be obtained in zone 2 disease. Although zone 1 disease presents special problems, good results can be obtained. The laser is more precise than cryopexy in treating the retina. The increased precision of the laser allows the surgeon to treat closer to the vascular ridge with reduced risk of vitreous hemorrhage relative to cryopexy. Treatment close to the ridge is thought to be important in causing regression of the disease. Also, cryopexy is more traumatic than laser treatment, which may stimulate proliferative factors, increasing the risk of stage 3, 4, or 5 anatomic outcome.</p>

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<p>ROP-LI27 Fotocoagulación con Láser de Diodo en la Retinopatía del Prematuro «umbral» Peralta Calvo J, Abelairas Gómez J, Fonseca Sandomingo A. St. Ophthalmology 14:215-219, 1995</p> <p>Abstract - English Article - Spanish</p>	<p>Fourteen infants (24 eyes) with threshold ROP were treated to assess the efficacy and safety of diode laser photocoagulation. The avascular retina was photocoagulated if it showed at least 5 contiguous (150°) or 8 cumulative (240°) clock hours of stage 3+ in zone I or II. General anesthesia was used; noncontiguous applications were used. The anterior segment was explored with a portable slit lamp after the procedure. Twenty-one (87.5%) eyes obtained total regression of the disease. The three eyes with unfavorable outcomes were those of severe stage 3+ in central zone II, and progressed to stage 5. Every case was followed for 2 months or longer. The complications noted were two mild preretinal hemorrhages attributable to accidental photocoagulation of the ridge. Conclusion: Diode laser photocoagulation is effective in the treatment of threshold ROP, mainly in the cases without severe proliferation, and lack of serious complications.</p>
<p>ROP-LI28 Diode Laser Photocoagulation to the Vascular Retina for Progressively Advancing Retinopathy of Prematurity O'Keefe M, Burke J, Algawi J, Goggin M. Br J Ophthalmol 79:1012-1014, 1995</p>	<p>The purpose of this study was to estimate the effectiveness of diode (810 nm) laser photocoagulation of the retina posterior to the ridge in eyes with retinopathy of prematurity (ROP). Diode laser photocoagulation was applied (using the OcuLight SL photocoagulator) posterior to the fibrovascular ridge in stage 4a ROP in six eyes of four infants and in advancing stage 3+ in two eyes of one infant. Seven eyes had previously been unsuccessfully treated with diode laser photocoagulation anterior to the ridge. The laser power used varied between 300 and 100 mW and the duration between 200 and 500 ms. Increased power and duration were required to elicit a visible burn in areas where subretinal fluid was present. Six eyes of four children had total regression; two eyes of two children had flat macula with residual peripheral tractional detachment and maintained vision. The preliminary results indicate that diode laser photocoagulation posterior to the ridge may be a useful treatment in late stage 3 and stage 4A ROP following failed laser treatment to the avascular retina in threshold stage 3 disease. The specific advantages of this treatment modality are the ability to carry out treatment without general anesthesia, the facility to respond rapidly to advancing disease and thus titrate the "dose" of treatment to the individual eye, avoidance of lesions to the sclera and the external eye surface, and perhaps the minimization of myopia in later life.</p>
<p>ROP-LI29 Significant Ocular Complications Following Diode Laser Treatment for Retinopathy of Prematurity Mills M,¹ Schulman JA,¹ Kooragayala LM,¹ Pramanik A,² Tseng P.³ Depr of ¹Ophthalmology and ²Pediatrics, Louisiana State Univ. Medical Center, Shreveport, LA, ³Department of Pediatrics, Willis Knighton Hospital, Shreveport, LA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S127. Abstract nr 606, 1996</p>	<p>Seventy-one consecutive eyes (45 infants) with threshold ROP treated with diode laser photocoagulation were followed for the development of significant ocular complications. Thirty-seven eyes had zone I threshold ROP. Sixty-nine of 71 eyes (97.2%) achieved favorable anatomical results. Follow-up ranged from 5.53 to 50.2 months with a mean of 22.87 months. Significant ocular complications following diode laser photocoagulation for threshold ROP occurred in 5 of 71 (7%) eyes. Complications observed post-operatively (each in an individual eye) included corneal opacification hyphema, scleral abscess, cataract (caused by pigment dispersion from accidental clipping of iris) and a dense preretinal hemorrhage.</p>

<p>ROP-LI30 The Effectiveness of Diode Laser Treatment in Achieving a Favorable Anatomical Outcome in Eyes with Zone I Threshold Retinopathy of Prematurity Schulman JA, Kooragayala LM, Redens TA. Department of Ophthalmology, LSU Medical Center, Shreveport, LA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S128. Abstract nr 613, 1996</p>	<p>Thirty-seven consecutive eyes (23 infants) with zone I threshold ROP were treated with binocular indirect ophthalmoscope (BIO) diode laser photocoagulation to determine the effectiveness of BIO diode laser photocoagulation in producing a favorable anatomical outcome in infants with zone I threshold retinopathy of prematurity. An unfavorable anatomical outcome was defined as a retrolental mass obscuring the posterior pole, a retinal detachment involving zone I, or retinal fold involving the macula. Thirty-five of 37 eyes (94.6%) demonstrated a favorable anatomical outcome. Follow-up ranged from 5.53 to 47.53 months with a mean of 26.13 months. All but four eyes were treated within 24 hours of threshold determination. Eleven eyes required retreatment. Despite laser treatment, two eyes progressed to stage 4A, and scleral buckling was performed on both eyes. One eye progressed to stage 5 while the retina reattached in the second eye. A third eye, following treatment developed a hyphema, precluding fundus examination for 2 weeks. The eye had progressed to stage 5 when the fundus became visible. Conclusion: BIO diode laser treatment for eyes with zone I threshold ROP appears to be more effective than cryopexy in preventing unfavorable anatomical outcomes.</p>
<p>ROP-LI31 Transscleral versus Transpupillary Diode Laser Photocoagulation for Threshold Retinopathy of Prematurity Sieberth V, Vardarli I, Jendritza W, Knorz MC, Liesenhoff H. University Eye Clinic, Klinikum Mannheim, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S695. Abstract nr 3176, 1996</p> <p><i>Also listed as ROP-TS2, pg. 227</i></p>	<p>The 810 nm diode laser wavelength makes lens-sparing transscleral coagulation of the retina possible, and to evaluate the efficacy and safety of transscleral diode laser coagulation for threshold ROP, the authors performed a controlled clinical study. Forty eyes of 20 preterm infants (gestational age 24-29 weeks, mean 26.8±1.6 weeks; birth weight 540-1200 g, mean 859±163 g) with threshold ROP were treated with diode laser photocoagulation. One eye of each infant was treated transsclerally while the fellow eye had transpupillary coagulation using the laser indirect ophthalmoscope. Follow-up ranged from 4 to 22 months (mean 10.5±6.3 months). Main outcome measure was the regression of acute ROP and the incidence of adverse treatment effects. In 20 (100%) eyes treated transpupillary and in 19 (95%) eyes treated transsclerally ROP regressed after a single or a second laser treatment and the outcome was a flat, attached retina. One eye (5%) with zone I disease failed after transscleral laser treatment and ROP progressed to stage 4B with a partially attached retina, although retinal detachment surgery with an encircling band was performed. No adverse side effects as a result of diode laser treatment were noted except for a small amount of retinal/preretinal bleeding in the ridge in 9 (45%) transsclerally and in 5 (25%) transpupillary coagulated eyes. There were no adverse side effects (e.g. bleeding, cataract formation) in the anterior segments of the eyes. Conclusion: The results suggest that transscleral 810 nm diode laser coagulation for treatment of threshold ROP is as effective and safe as transpupillary diode laser photocoagulation.</p>
<p>ROP-LI32 Refractive Outcome in Eyes with Retinopathy of Prematurity Treated with Cryotherapy or Diode Laser: 3 Year Follow-up Knight-Nanan DM, O'Keefe M. Br J Ophthalmol 80:998-1001, 1996</p> <p><i>See ROP-LI19, pg. 206 for Initial Study</i></p>	<p>This study compared the refractive error of 43 infant's eyes 1 to 3 years after either cryotherapy or 810 nm diode laser treatment for threshold retinopathy of prematurity. Seventeen eyes were treated with cryotherapy; 26 eyes were treated with 810 nm diode laser. Mean follow-up for cryotherapy was 5 years (range 4 to 9 years); mean follow-up for 810 nm diode laser was 2.5 years (range 1 to 4 years). All infants underwent cycloplegic refraction during follow-up. In the diode laser treated group, there was no</p>



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	<p>trend towards increasing myopia; the refraction in these eyes stabilized after 1 year. In the cryotherapy treated group, there was a significant increase in the degree of myopia between 1 and 3 years of follow-up. No significant difference was found in the degree of astigmatism between cryotherapy and diode laser treatment groups. <i>Results showed there were significantly fewer myopes in the diode laser treated group than the cryotherapy treated group up to 3 years after the procedure.</i></p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">Treatment</th> <th rowspan="2"># of eyes</th> <th colspan="3">Percentage of Eyes with Myopia Follow-up</th> </tr> <tr> <th>1 year</th> <th>2 years</th> <th>3 years</th> </tr> </thead> <tbody> <tr> <td>Cryotherapy</td> <td>17</td> <td>88.2%</td> <td>88.2%</td> <td>94%</td> </tr> <tr> <td>810 nm Diode Laser</td> <td>26</td> <td>38.5%</td> <td>42.9%</td> <td>46%</td> </tr> <tr> <td>Difference</td> <td></td> <td>49.8%</td> <td>45.4%</td> <td>48.7%</td> </tr> </tbody> </table>	Treatment	# of eyes	Percentage of Eyes with Myopia Follow-up			1 year	2 years	3 years	Cryotherapy	17	88.2%	88.2%	94%	810 nm Diode Laser	26	38.5%	42.9%	46%	Difference		49.8%	45.4%	48.7%
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<p>ROP-LI33 Visual Outcome of Bilateral Threshold Stage 3 Retinopathy of Prematurity (ROP) Randomized to Laser or Cryotherapy Ross RD, Page TP, Trese MT. Royal Oak, MI Poster 295. AAO. Chicago, IL October, 1996</p>	<p>In a masked evaluation, the authors compared visual outcomes of 6 patients, 6 years after randomization treatment with laser photocoagulation in one eye and cryotherapy in the fellow eye. In cryotherapy treated eyes, the average distance was 20/150, visual acuity (spherical equivalent -6.75 diopters) (6 eyes); significant fundus findings included retinal pigment epithelial mottling temporally (2 eyes), pre-phthisical changes (2 eyes), and normal (2 eyes). In laser treated eyes, the average distance was 20/40 (spherical equivalent -4.90 diopters) (6 eyes); significant fundus findings included normal (5 eyes) and macular dragging (1 eye). Laser may have fewer side effects than cryotherapy for threshold ROP.</p>																							
<p>ROP-LI34 Retinal Sliding with High Myopia Occurs Following Laser Treatment for Severe Retinopathy of Prematurity Mintz-Hittner HA, Kretzer FL. Houston, TX Free Paper. AAO. Chicago, IL October, 1996</p>	<p>Anatomic outcome at greater than 1 year was reviewed for 110 eyes of 56 preterm infants weighing ≤ 1250 grams at birth who were treated with diode laser. Anatomic success rate was 94.6%. ROP severity correlated with retinal sliding (in disc diameters on fluorescein angiograms), and with myopia (in diopters). Retinal sliding along Bruch's membrane with high myopia occurs in severe ROP treated by laser.</p>																							
<p>ROP-LI35 Cryotherapy and Laser Treatment for Acute Retinopathy of Prematurity: Refractive Outcomes, a Longitudinal Study Laws F, Laws D, Clark D. Br J Ophthalmol 81:12-15, 1997</p>	<p>This study focused on the refractive error at 3 and 12 months of 19 patients who underwent cryotherapy and 15 patients who underwent laser (either argon or diode) treatment for threshold retinopathy of prematurity (ROP). Results showed that laser therapy is associated with lower degrees of myopia than cryotherapy during the first year of life, which is clinically significant in terms of visual performance and development. At 3 months and at 1 year, the cryotherapy group had a statistically significant higher degree of myopia in both eyes ($p < 0.05$ at 3 and 12 months). The myopia increased at a greater rate in the cryotherapy treated infants over the 9 month study period. There was a trend to higher levels of astigmatism in the cryotherapy treated infants, but this did not reach statistical significance. Disease location, whether anterior or posterior, appeared to have some influence on the incidence of myopia. The more posterior the disease, the more severe the myopia and the trend was for more myopia in those treated with cryotherapy; however, there were more eyes with posterior disease in the cryotherapy treated group which may have influenced these results.</p>																							



<p>ROP-LI36 Randomized Comparison of Diode Laser Photocoagulation Versus Cryotherapy for Threshold Retinopathy of Prematurity: 3 Year Outcome White JE, Repka MX. J Pediatr Ophthalmol Strabismus 34:83-87, 1997</p>	<p>Nineteen patients were entered into a prospective randomized treatment protocol, in which one eye received cryotherapy and one eye received diode laser photocoagulation. Asymmetric eyes were randomly assigned. Two patients have died and five patients are no longer available for 3 year outcome exams. Seven males and five females participated with a mean birth weight of 638 grams and a mean gestational age of 24.9 weeks. Two patients had asymmetrical disease and received laser photocoagulation. Two discordant structural outcomes were present among the 10 symmetrical cases. The laser-treated eyes had the favorable outcome; the cryotherapy-treated eyes had the unfavorable outcome. The geometric mean visual acuity after laser photocoagulation was 20/52; after cryotherapy, it was 20/91 (p=0.046). The mean refractive error was -6.60 diopters (D) after laser photocoagulation and -7.62 D after cryotherapy. Seven patients (58%) have developed strabismus. Laser photocoagulation appears to have an outcome comparable to cryotherapy when the patients are examined 3 years following therapy. These data, including visual acuity and refractive error, suggest that laser photocoagulation may have a minimal advantage over cryotherapy in the treatment of ROP.</p> <table border="1"> <thead> <tr> <th></th> <th colspan="2">Laser</th> <th></th> </tr> <tr> <th></th> <th>Photocoagulation</th> <th>Cryotherapy</th> <th>p value</th> </tr> </thead> <tbody> <tr> <td>Number of eyes treated</td> <td>13</td> <td>11</td> <td></td> </tr> <tr> <td>Geometric mean visual acuity</td> <td>20/46</td> <td>20/72</td> <td>0.05</td> </tr> <tr> <td>Mean refractive error</td> <td>-5.97 D</td> <td>-7.06 D</td> <td>NS</td> </tr> <tr> <td>Favorable structural outcome</td> <td>13/13</td> <td>9/11</td> <td>NS</td> </tr> </tbody> </table>		Laser				Photocoagulation	Cryotherapy	p value	Number of eyes treated	13	11		Geometric mean visual acuity	20/46	20/72	0.05	Mean refractive error	-5.97 D	-7.06 D	NS	Favorable structural outcome	13/13	9/11	NS
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<p>ROP-LI37 Mild Diode Laser Treatment for Retinopathy of Prematurity Melki SA, Chrousos GA, Wagner DG. Center for Sight, Georgetown Univ., Washington DC [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S745. Abstract nr 3439, 1997</p>	<p>The authors performed a serial retrospective study of 56 eyes (of 33 infants) which developed threshold ROP and were treated with indirect diode laser photocoagulation. All eyes were treated to a mild endpoint with near confluent burns completely covering the avascular retina with topical anesthesia with intravenous sedation in the NICU. Laser parameters averaged 1400 spots, 268 mW, 0.4 second duration per eye. Follow-up ranged from 3 to 32 months: 54/56 (96.4%) of the eyes had complete regression of extra-retinal vascularization and plus disease with laser treatment; 56/56 (100%) of the eyes had no cataract after laser treatment; 2/56 eyes (3.6%) of one infant developed progressive tractional detachments involving the macula and underwent surgery with one eye developing a macular fold while the other eye had a normal appearing macula. Mild near confluent indirect diode laser treatment of threshold ROP in the NICU may offer significant benefit in ROP.</p>																								
<p>ROP-LI38 Influence of Treatment Modality on Refractive Outcome in Retinopathy of Prematurity Smyth KL, Haigh PM, O'Donoghue EP. Royal Eye Hospital, Manchester, UK [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S746. Abstract nr 3446, 1997</p>	<p>In a sequential study, the authors compared early refractive changes in 3 consecutive groups of infants treated with either laser therapy or cryotherapy for threshold ROP. All groups were comparable in terms of gestational age, birthweight and age at treatment. The first group, Group A, N = 8, were treated with bilateral cryotherapy. The third group, Group C, N = 6, were treated with bilateral laser therapy. The second group, Group B, N = 8, were treated during the unit's transition from cryo to laser and were managed with cryotherapy to one randomly selected eye and laser to the fellow. Subsequent outpatient follow-up involved full ocular examination and cycloplegic refraction. At a mean age of 11 months, significant differences in refractive error between the groups were found. The mean spherical equivalent</p>																								

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	<p>refractive error in Group A was -3.9 DS, whereas that in Group C was +0.57 DS. The asymmetrically treated group, Group B, had a high incidence of anisometropia with 5 of the 8 babies having a refractive difference between the two eyes greater than or equal to 1.5 DS. In 7 of the 8 babies in this group, the more myopic eye was that which had been treated with cryotherapy. These early results suggest that cryotherapy for ROP is associated with a greater degree of myopia.</p>															
<p>ROP-LI39 Pain and Stimulation in Laser Treatment for Retinopathy of Prematurity Li HK,¹ Norcross-Nechay K,² Marquez BA,² Dejean BJ,¹ Khorrami AM,¹ Richardson J.³ ¹Department of Ophthalmology & Visual Sciences, ²Department of Neurology, ³Department of Pediatrics, Univ. of Texas Medical Branch Galveston, TX [ARVO Abstract]. Invest Ophthalmol Vis Sci. 38(4): S974. Abstract nr 4515, 1997</p>	<p>Eight infants with threshold ROP were randomized to four groups of diode or argon laser photocoagulation using either midazolam or fentanyl. Continuous sixteen-channel EEGs were recorded before, during and after laser treatment. Infant behavior, respiratory excursions, vital signs and oxygen saturation were also monitored. Results: Baseline EEGs showed age-appropriate patterns of awake, active sleep and quiet sleep. In all infants, administration of midazolam or fentanyl produced the “discontinuous” pattern of quiet sleep during argon green or diode laser photocoagulation. Abrupt arousal patterns appeared in the EEG accompanied by distressed behavior whenever a scleral depressor was applied to the midazolam groups. No or minimal distress was observed in the fentanyl groups. Conclusions: Laser treatment using argon green or diode wavelength laser may not cause pain in preterm infants with ROP. Fentanyl, but not midazolam, produces adequate analgesia and anesthesia for stimulation and pain associated with scleral depression.</p>															
<p>ROP-LI40 Transscleral vs. Transpupillary Diode Laser Photocoagulation for the Treatment of Threshold Retinopathy of Prematurity Seiberth V, Linderkamp O, Vardarli I. Arch Ophthalmol 115:1270-1275, 1997 <i>Also listed as ROP-TS3, pg. 228</i></p>	<p>To evaluate the efficacy and safety of transscleral diode laser photocoagulation for acute proliferative ROP, the authors performed a controlled clinical study in 25 preterm infants with threshold ROP in both eyes: One eye of each infant was treated transsclerally with the OcuLight® and DioPexy™ probe and the fellow eye was treated transpupillary using the OcuLight and laser indirect ophthalmoscope.</p> <p>Treatment Parameters:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th style="text-align: center;"><u>Transscleral</u></th> <th style="text-align: center;"><u>Transpupillary</u></th> </tr> </thead> <tbody> <tr> <td>Power</td> <td style="text-align: center;">250 - 600 mW</td> <td style="text-align: center;">160 - 450 mW</td> </tr> <tr> <td>Spot Size</td> <td style="text-align: center;">1000 µm</td> <td style="text-align: center;">480 µm</td> </tr> <tr> <td>Duration</td> <td style="text-align: center;">200 - 600 ms</td> <td style="text-align: center;">200 ms</td> </tr> <tr> <td>Number of Burns</td> <td style="text-align: center;">153 - 877</td> <td style="text-align: center;">329 - 2078</td> </tr> </tbody> </table> <p>Follow-up ranged from 2 to 22 months. After transpupillary coagulation, ROP regressed in all 25 of the eyes; after transscleral coagulation, ROP regressed in 24 of the 25 eyes. Transscleral diode laser coagulation is as effective in the treatment of threshold ROP as transpupillary diode laser photocoagulation.</p>		<u>Transscleral</u>	<u>Transpupillary</u>	Power	250 - 600 mW	160 - 450 mW	Spot Size	1000 µm	480 µm	Duration	200 - 600 ms	200 ms	Number of Burns	153 - 877	329 - 2078
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<p>ROP-LI41 Follow-Up After Transscleral Diode Laser Photocoagulation For Retinopathy of Prematurity Stage 3+ Akkoyun I¹, Seiberth V^{1,2}, Jendritza W¹, Vögele C¹, Liesenhoff H¹. ¹University Eye Clinic, Klinikum Mannheim, D-68135 Mannheim, Germany; ²Depart-</p>	<p>To evaluate the safety of transscleral diode laser treatment for ROP stage 3+, the authors prospectively examined 30 eyes of 30 very low birth weight infants (gestational age 23 to 31 weeks, mean ± SD 26.6 ± 1.8; birth weight 510-1200, 855 ± 170) quarterly after regression of acute ROP. Examinations included assessment of anterior segment, fundus, vision, refractive error and biometry. Follow-up ranged from 10 to 48 months</p>															

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<p>ment of Ophthalmology, Marienhospital Osnabrueck, D-49074 Osnabrueck, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S819. Abstract nr 3792, 1998</p> <p><i>Also listed as ROP-TS4, pg. 228</i></p>	<p>(29.6 ±11.2). Control group consisted of the 30 fellow eyes treated transpupillary using the laser indirect ophthalmoscope. In 29 of 30 eyes (97%) of transscleral and all (100%) transpupillary treated eyes, the outcome was a flat and attached retina. There were no anterior segment abnormalities (e.g., iris burns, syneciae, cataract) in all eyes of both groups. Visual acuity, refractive error and biometry showed no significant differences between the transpupillary and transscleral treated eyes. These results indicate that transscleral diode laser photocoagulation can safely be used for the treatment of ROP stage 3+.</p>																						
<p>ROP-LI42 A Comparison of Laser Photocoagulation with Transscleral Cryotherapy in the Treatment of Threshold Retinopathy of Prematurity Connolly BP, McNamara JA, Sharma S, Regillo C, Tasman W. Ophthalmology 105:1628-1631, 1998</p>	<p>This study evaluates an average of 5.8 years follow-up (range 4.3 – 7.6 years) of 25 infants with bilateral threshold ROP, from previously reported clinical studies (<i>See ROP-LI1 and ROP-LI3, page 157</i>) in which one eye was randomized to cryotherapy and the other eye to laser treatment (argon or infrared). The goals of this study were 1) to determine whether there was a significant difference between the visual outcomes of eyes treated with cryotherapy vs. laser treatment, and 2) to compare the refractive status of eyes treated with laser to their cryotherapy-treated counter-parts. Both the laser- and cryotherapy-treated groups had similar preoperative characteristics.</p> <p>1) Visual Outcomes (based upon reliable Snellen or illiterate e-chart visual acuities obtained from 21 children)</p> <table border="1"> <thead> <tr> <th>Treatment Modality</th> <th>Good Vision 20/50 or Better</th> <th>Poor Vision 20/60 or Worse</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>Laser</td> <td>17 (81%)</td> <td>4 (19%)</td> <td>21</td> </tr> <tr> <td>Cryotherapy</td> <td>8 (38%)</td> <td>13 (62%)</td> <td>21</td> </tr> <tr> <td>Total</td> <td>25</td> <td>17</td> <td>42</td> </tr> </tbody> </table> <p>2) Refractive Outcomes (only 23 eyes were available for follow-up)</p> <p>Laser-treated eyes were less myopic than cryotherapy-treated eyes, the difference being statistically significant.</p> <table border="1"> <thead> <tr> <th>Laser compared to cryotherapy</th> <th>Mean SE</th> </tr> </thead> <tbody> <tr> <td>Laser-treated (argon and diode)</td> <td>-3.05 D</td> </tr> <tr> <td>Cryotherapy-treated counterpart</td> <td>-5.08 D</td> </tr> </tbody> </table> <p>p = 0.0072</p> <p>This study suggests that laser photocoagulation was more likely to result in a good visual outcome with less myopia compared to cryotherapy treatment. The odds that an eye treated with laser had a good visual outcome were 6.91 times greater than for eyes treated with cryotherapy (95% confidence interval, 1.70-28).</p>	Treatment Modality	Good Vision 20/50 or Better	Poor Vision 20/60 or Worse	Total	Laser	17 (81%)	4 (19%)	21	Cryotherapy	8 (38%)	13 (62%)	21	Total	25	17	42	Laser compared to cryotherapy	Mean SE	Laser-treated (argon and diode)	-3.05 D	Cryotherapy-treated counterpart	-5.08 D
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<p>ROP-LI43 Treatment Outcomes in Fellow Eyes after Laser Photocoagulation for Retinopathy of Prematurity Brooks SE, Johnson M, Wallace DK, Paysse EA, Coats DK, Marcus DM. Am J Ophthalmol 127:56-61, 1999</p>	<p>The authors reviewed records from 103 patients undergoing bilateral 810 nm diode laser peripheral retinal photocoagulation with LIO delivery for ROP at three academic medical centers. The goal of treatment was essentially confluent ablation of the avascular retina up to, but not including, the ridge. Laser variables were available in 101 of the 103 cases. There was no significant difference in average laser power or number of</p>																						

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	<p>applications per eye among the three study centers. Mean minimum laser power used was 271 mW; mean maximum laser power used was 307 mW; mean number of laser applications per eye were 1,151; and pulse duration typically used was 300 mw. The data were analyzed to determine the rate of successful structural outcomes among all eyes as well as the interocular outcome concordance. Unfavorable structural outcomes were categorized by macular dragging judged clinically significant enough to adversely affect visual function, retinal fold involving the macula, or retinal detachment involving the macula. Outcomes were otherwise categorized as structurally favorable. A successful structural outcome was observed in 182 (88%) of 206 eyes. Eighty-eight patients (85.4%) had bilateral favorable outcomes. Nine patients (8.7%) had bilateral unfavorable outcomes, and 6 patients (5.8%) had one favorable and one unfavorable eye. No cataracts were observed in any of the 206 eyes treated. The outcome was concordant between fellow eyes in 94.2% of patients. This rate was higher than predicted if fellow-eye outcomes were truly independent ($p < .00001$) and did not depend on study center, laser settings or location of the ROP. Serious complications related to treatment were uncommon. Complications included limited vitreous hemorrhage in 8 eyes of 5 patients; small, localized subretinal hemorrhages in 5 eyes of 3 patients; episodes of apnea and/or bradycardia during treatment in 2 cases; bilateral hyphema in 1 infant; and conjunctival tear in 1 infant. Conclusions: These data confirm the overall effectiveness of diode laser photocoagulation in preventing unfavorable structural outcomes in eyes with threshold ROP. The high rate of success, even in eyes with posterior disease, coupled with the apparent low rate of acute complications supports the role of bilateral 810 nm, diode laser treatment in cases of bilateral threshold ROP.</p>
<p>ROP-LI44 Anterior Segment Changes in Newborn Rabbit Eyes with a Tunica Vasculosa Lentis After Argon Green and Diode Red Laser Rao PK,¹ Mitra R,² Rhee P,¹ Wirostko W,¹ Pulido J.³ ¹Medical College of Wisconsin, ²Retina Associates of Cleveland, ³University of Illinois, Chicago [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S293. Abstract nr 1550, 1999</p>	<p>Transpupillary retinal photocoagulation using the argon green (6 eyes) or diode red (13 eyes) lasers was performed on 19 newborn pigmented rabbits' eyes. Treatment was placed unilaterally to allow the fellow eye to serve as the control. Anterior segment changes were evaluated with slit lamp biomicroscopy and light microscopy using H&E and PAS stains for 21 days after treatment. Results: Anterior lenticular opacities developed in one of six eyes treated with argon green laser. No opacities developed in diode laser treated or control eyes. Tunica vasculosa lentis persistence beyond 14 days after treatment occurred in 4 of 4 (100%) eyes treated with argon laser as compared to 0 of 4 untreated eyes ($p < 0.05$). Similarly, a tunica vasculosa lentis was seen at 7 days after treatment in 11 of 12 eyes (92%) treated with diode laser as compared to 2 of 12 (17%) untreated eyes ($p < 0.01$). No eye treated with diode laser demonstrated tunica vasculosa lentis at day 14. Conclusions: Transpupillary argon laser may cause lenticular opacities in eyes with a tunica vasculosa lentis. Both argon and diode laser delays regression of the tunica vasculosa lentis. Argon laser may cause a greater delay in regression of the tunica vasculosa lentis than the diode laser.</p>

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<p>ROP-LI45 Phthisis Bulbi Following Retinopexy for Threshold Retinopathy of Prematurity Cingle KA, Capone, Jr. A, Drack AV, Lambert SR. Emory Eye Center, Emory University, Atlanta, GA [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S478. Abstract nr 2520, 1999</p>	<p>The authors reviewed nine eyes of eight patients who had undergone prompt indirect infrared diode laser retinopexy for threshold ROP and had developed post-laser cataracts and other complications. The clinical course following laser treatment was remarkable for marked anterior segment inflammation including corneal opacification in some cases. Within a time span of 1-2 weeks, cataract formation was noted in the treated eye when the inflammation subsided. Other subsequent findings included iris atrophy with depigmentation, heterochromia (when unilateral), pigmented membrane across the iris, ciliary body depigmentation and hypotony. In one case, a ruptured posterior lens capsule was noted intraoperatively during cataract surgery. The patient went on to develop hypotony and phthisis bulbi. Conclusion: The authors report a clinical scenario following laser retinopexy for ROP consisting of dramatic ocular inflammation, leading to hypotony and phthisis bulbi. An indolent subacute pharmacophalactic endophthalmitis is postulated to be the etiology of this uncommon symptom complex. Examination within 72 hours post-laser treatment, aggressive topical steroid therapy and prompt lensectomy are recommended. Conclusion: Phthisis bulbi may develop in some infantile eyes that develop cataracts following laser retinopexy for ROP.</p>
<p>ROP-LI46 Visual Outcomes after Laser Photocoagulation for Threshold Retinopathy of Prematurity Connolly BP, McNamara A, Regillo CD, Tasman W, Sharma S. Ophthalmology 106:1734-1738, 1999</p>	<p>A retrospective, noncomparative case series of 35 infants with threshold ROP treated with 810 nm diode laser photocoagulation from 1991 to 1996 was studied to determine the long-term visual acuity (VA). After bilateral laser treatment, 14 (56%) of 25 patients who were capable of accurate VA testing had 20/50 or better best-corrected visual acuity (BCVA) in at least 1 eye with 11 (44%) of 25 patients having at least 20/50 BCVA in both eyes. After unilateral treatment, 4 (40%) of 10 had 20/50 or better BCVA in the treated eye while 5 (50%) of 10 laser-treated eyes had a BCVA at least equal to the untreated fellow eye. Compared to eyes with 4 or more diopters (D) of myopia, those with less than 4 D of myopia were 6.4 times more likely to achieve 20/50 or better BCVA (95% confidence interval, 1.7 – 22.7). The average age at follow-up was 3.7 years. Conclusion: After laser photocoagulation for threshold ROP, 29 (48%) of 60 eyes had 20/50 or better VA. Eyes with 4 or more D of myopia were significantly less likely to achieve 20/50 or better VA than eyes with less than 4 D of myopia.</p> <p><i>Note:</i> After 5 1/2 years of follow-up, the Cryo-ROP investigators reported that 13% of cryotherapy-treated eyes achieved 20/40 or better VA. In contrast, 17% of the eyes randomized to observation were 20/40 or better. Cryotherapy, it was suggested, may have some detrimental effect on the ultimate visual potential. In contrast, laser photocoagulation does not appear to have such an adverse effect on visual potential and may result in better final BCVA. In the current report, 26 (43%) of 60 eyes from 35 patients were 20/40 or better, which is considerably better than both the treatment and control groups from the 5 1/2 year Cryo-ROP data.</p>

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	<p style="text-align: center;">Comparison of Laser and Cryotherapy</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 30%; text-align: center;"><u>Laser</u></th> <th style="width: 30%; text-align: center;"><u>Cryo</u></th> </tr> </thead> <tbody> <tr> <td>Surgical Trauma</td> <td style="text-align: center;">Minimal</td> <td style="text-align: center;">Great</td> </tr> <tr> <td>Discomfort</td> <td style="text-align: center;">Minimal</td> <td style="text-align: center;">Great</td> </tr> <tr> <td>Reaction</td> <td style="text-align: center;">Clearly visible</td> <td style="text-align: center;">Not as clear as laser</td> </tr> <tr> <td>Subretinal hemorrhage or bands</td> <td style="text-align: center;">Rare</td> <td style="text-align: center;">Occasional</td> </tr> <tr> <td>Portable</td> <td style="text-align: center;">Yes (diode)</td> <td style="text-align: center;">No</td> </tr> <tr> <td>Tunica Vasculosa Lentis</td> <td style="text-align: center;">May be troublesome (argon)</td> <td style="text-align: center;">Not problematic</td> </tr> <tr> <td>Elevated Ridge in Periphery</td> <td style="text-align: center;">Laser application to the peripheral retina may be blocked</td> <td style="text-align: center;">Not problematic</td> </tr> <tr> <td>Mild Vitreous Hemorrhage</td> <td style="text-align: center;">Difficult to treat</td> <td style="text-align: center;">May be treatable if not dense</td> </tr> <tr> <td>Retinal Detachment</td> <td style="text-align: center;">Ineffective</td> <td style="text-align: center;">May be effective if it is shallow</td> </tr> <tr> <td>Restless babies</td> <td style="text-align: center;">Nearly impossible</td> <td style="text-align: center;">May be possible and quicker</td> </tr> </tbody> </table>		<u>Laser</u>	<u>Cryo</u>	Surgical Trauma	Minimal	Great	Discomfort	Minimal	Great	Reaction	Clearly visible	Not as clear as laser	Subretinal hemorrhage or bands	Rare	Occasional	Portable	Yes (diode)	No	Tunica Vasculosa Lentis	May be troublesome (argon)	Not problematic	Elevated Ridge in Periphery	Laser application to the peripheral retina may be blocked	Not problematic	Mild Vitreous Hemorrhage	Difficult to treat	May be treatable if not dense	Retinal Detachment	Ineffective	May be effective if it is shallow	Restless babies	Nearly impossible	May be possible and quicker
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Restless babies	Nearly impossible	May be possible and quicker																																
<p>ROP-LI47 A Comparison of Dense versus Less Dense Diode Laser Photocoagulation Patterns for Threshold Retinopathy of Prematurity Banach MJ, Ferrone PJ, Trese MT. Ophthalmology 107:324-328, 2000</p>	<p>A retrospective, nonrandomized, comparative trial (Group 1: n = 12 patients) and a prospective, randomized, clinical trial (Group 2: n = 46 patients) was conducted to determine if the density of 810 nm diode laser photocoagulation for the treatment of zone 1 or zone 2 threshold ROP affects the rate of progression of the disease. A total of 107 eyes from 58 patients were treated within 72 hours of diagnosis and observed for at least 3 months after treatment with two different diode laser photocoagulation procedures: a dense, near confluent laser pattern or a less dense pattern with burns spaced 1 to 1.5 burn widths apart. For analysis, the retrospective and randomized outcome data were grouped. Results: The rate of progression to stage 4 or 5 ROP in cohort 1 (the near confluent laser treatment group) was 2 of 56 eyes (3.6% overall, 0% of zone 1 eyes, and 3.8% of zone 2 eyes). The rate of progression in cohort 2 (the less dense pattern) was 15 of 51 eyes (29% overall, 44% of zone 1 eyes, and 21% of zone 2 eyes). The difference between the overall rate of the two groups was highly significant (P = 0.0003). Mean time to retreatment was 16 days in cohort 1 and 24 days in cohort 2. Retreatments were performed if skipped areas were identified and plus disease persisted for 2 weeks or more after the initial treatment. Conclusion: A dense pattern of 810 nm diode laser treatment for threshold ROP and prompt retreatment for residual plus disease significantly reduces the rate of progression in eyes with zone 2 disease (P = 0.02) and may be beneficial in eyes with zone 1 disease.</p>																																	

<p>ROP-LI48 Outcome after Laser and Surgical Treatment for Retinopathy of Prematurity Kychenthal A,^{1,3} Katz X,^{2,3} Dorta P.³ Clinica Alemana de Santiago, Santiago, Chile,¹ Clinica Las Condes, Santiago, Chile,² Hospital del Salvador, Santiago, Chile.³ [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S336. Abstract nr 1761, 2000</p>	<p>To study the structural outcome after laser and surgical treatment in a series of infants with zone I and II ROP, 32 consecutive eyes in 16 infants with zone I ROP and 65 eyes in 35 infants with zone II ROP were treated with indirect diode laser. Additionally, five eyes with retinal detachment secondary to ROP were surgically treated. Structural outcome was evaluated at 3 months. Results: In the laser group 14 out of 32 eyes (43.8%) with zone I ROP had unfavorable outcome compared with 6 out of 65 eyes (9.2%) with zone II ROP (p=0.001). Treatment age was significantly less (p=0.005) for zone I group than for zone II group (35.7 vs. 37.5 weeks). In the surgery group 2 out of 5 eyes (40%) had a favorable outcome. Conclusion: Laser for Zone I ROP is not as effective as for Zone II. Zone I eyes need earlier treatment. Surgery can effectively attach the retina in some cases.</p>
<p>ROP-LI49 Diode Laser Treatment of Posterior Retinopathy of Prematurity Axer-Siegel R, Snir M, Cotlear C, Maayan A, Frilling R, Rosenbaltt I, Weinberger D, Kremer I, Sirotta L. Br J Ophthalmol 84:1383-1386, 2000</p>	<p>Forty-eight eyes of 25 premature babies with threshold ROP in zone I (23 eyes) and posterior zone II (25 eyes) were treated with the IRIS Medical infrared OcuLight and LIO. Confluent burns were applied to the avascular retina. In 18 eyes, an additional row of laser burns was added posterior to the ridge. Follow-up ranged from 3 to 25 months (mean 14 months). Results: Favorable anatomical results were noted in 41 eyes (85.4%). ROP stage 5 developed in 2 eyes; ROP stage 4A developed in 4 eyes, and ROP stage 4B in 1 eye. Three of the eyes with stage 4A were successfully buckled; the fourth was not operated on and remained demarcated by laser scars. The only intraoperative ocular complication was a small local preretinal bleeding in 2 patients.</p> <p><u>Treatment Parameters</u> Tight scatter of laser applications was performed, with a half burn diameter between burns, from the ridge up to the ora serrata. The whole circumference of the avascular retina was treated with moderate white burns.</p> <p>Power: 0.3 to 0.5 W Duration: 0.2 - 0.5 seconds Number of applications: 800 – 1550 (average 1243) Retreatment: 11 eyes (23%) <i>Retreatment rate decreased from 29% during the first 2 years to 12% in the third year.</i></p> <p>Conclusions: The infrared diode laser was found to be a safe and effective treatment for posterior ROP.</p>
<p>ROP-LI50 Outcomes After Laser Therapy for Threshold Retinopathy of Prematurity (ROP) Foroozan R, Connolly BP, Tasman W. AAO Scientific Poster 262. Dallas, TX, 2000</p>	<p>To determine the incidence of regressed threshold ROP after laser treatment, 120 eyes of 81 patients were followed for a minimum of 12 months to assess anatomic outcomes. Unfavorable outcomes were defined as retinal detachment and retinal fold. Results: One-hundred-nine eyes (91%) had a favorable outcome. Zone 1 eyes appeared to be 3.3 times more likely to have an unfavorable outcome compared to Zone 2 eyes, but the 95% confidence interval (0.8 – 14.5) did not support this statistically. Conclusions: Laser therapy is effective for threshold ROP.</p>

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<p>ROP-LI51 Clinical Outcome of Confluent Laser Photoablation for Retinopathy of Prematurity Aaberg, Jr TM; Fallaha N, Drack AV, Lambert SR. Emory Eye Center, Emory University, Atlanta, GA. [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S681. Abstract nr 3666, 2000</p>	<p>The authors conducted a retrospective study of 29 patients (56 eyes) with ROP treated with confluent diode laser photoablation. Three main outcomes were evaluated: 1) the rate of progression; 2) the timing and frequency of laser retreatment; and 3) postoperative complications. Eyes received a mean of 1935 ± 968 (range, 963 to 4535) laser burns administered in a confluent pattern. Results: Eight eyes (14%) progressed to a stage 4 disease. One eye (1.8%) underwent a second treatment for persistent stage 3 disease. Postoperative complications included: corneal edema (n=2), hyphema (n=2), anterior segment ischemia (n=2), posterior synechiae (n=2), cataract (n=2), vitreous hemorrhage (n=5), and macular ectopia (n=2). Conclusions: The infants in this series received significantly more laser burns than infants reported in the literature receiving scatter (mean, 500 to 1200 burns) or near confluent (mean, 693 burns) laser photoablation. While confluent laser photoablation almost eliminated the need for supplemental treatment (1.8% compared to 35%), it was associated with a high rate of postoperative complications and a rate of progression to stage 4 or 5 disease comparable to that reported with scatter treatment (0 to 29%). Near confluent photoablation has been reported to have lower rate of progression (3.6%). Confluent laser photoablation lowers the rate of supplemental treatment, but is associated with a higher rate of complications. The rate of progression appears to be no better than that reported with near confluent treatment. Based on these findings, the authors do not recommend using confluent laser photoablation to treat threshold ROP.</p>
<p>ROP-LI52 Iris Atrophy, Cataracts, and Hypotony Following Peripheral Ablation for Threshold Retinopathy of Prematurity Kaiser RS, Trese MT. Royal Oak, MI. Arch Ophthalmol 119:615-617, 2001</p>	<p>The authors report on 8 eyes of 5 patients following confluent treatment for threshold ROP. None of the eyes demonstrated a retinal detachment at the time the anterior segment changes were identified, which the authors feel is representative of an anterior segment ischemia including cataracts, iris atrophy, hypotony, and corneal haze. Six of the 8 eyes underwent lensectomy and vitrectomy with a fluid-air exchange and still went on to develop phthisis. Two of the 8 eyes underwent lensectomy and vitrectomy and received silicone oil instead of fluid-air exchange. These eyes had a beneficial anatomic result from this therapy.</p> <p>Clinical examination of all eyes revealed confluent anterior retinal treatment, regression of threshold ROP, and the absence of a retinal detachment. The ciliary body was not accidentally treated in any of the cases reported. A possible mechanism for developing anterior segment ischemia following treatment of ROP can be made by comparing laser treatment in proliferative diabetic retinopathy with laser treatment in ROP. The major difference in treating these diseases is the location and confluence of the laser burns. Treatment of proliferative diabetic retinopathy tends to spare the far peripheral portions of the retina, whereas treatment of ROP includes the entire anterior avascular retina from the edge of the pars plicata back to the anterior edge of the ridge of proliferative retinopathy covering the entire circumference of the far peripheral retina. In addition, during treatment of ROP there is significant scleral depression, which could impair the circulation in the long posterior ciliary arteries.</p>

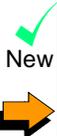
Reference Catalog: Summaries of Studies

	<p>A potential treatment to preserve the physical structure of the eye after this reported complication is with the use of silicone oil. The 2 eyes in which silicone oil was placed maintained normal anatomic structure (at 6 months follow-up) compared with the eyes that only had a fluid-air exchange and went on to become hypotonous. This report should not discourage physicians from being aggressive with the treatment of ROP but instead should prompt investigation to further advance our methods of treatment and our understanding of its complications.</p>
<p>ROP-LI53 Diode Laser Photocoagulation for Retinopathy of Prematurity: A Histopathologic Study Park P, Eagle Jr RC, Tasman WS. Ophthalmic Surg Lasers 32:63-66, 2001</p> <p><i>Also listed as HIST17, pg. 238</i></p>	<p>This case describes the ocular histopathologic findings of a pair of eyes in a severely premature infant treated with diode laser photocoagulation for bilateral stage 3 ROP for 360° in zone 1 with severe plus disease. 1473 laser burns were applied to the right eye, and 1407 to the left eye. The right eye responded to treatment; the left eye developed persistent vitreous hemorrhage and total retinal detachment. At 9 months postpartum, the infant died from renal and hepatic failure. The eyes were sent to Wills Eye Hospital where they were processed routinely for light microscopy.</p> <p>The histopathologic examination of laser burns in the right eye disclosed segmental areas of chorioretinal scarring with retinal atrophy and gliosis, loss of RPE and extensive atrophy of the choroid and its vasculature. The left eye had iris neovascularization, a chronic organized vitreous hemorrhage and a totally detached retina. These results resembled those reported after transscleral cryotherapy; however, the degree of chorioretinal atrophy and scarring found in the eye treated with diode laser photocoagulation appears to be slightly less severe than cryotherapy. Compared to cryotherapy, laser therapy is relatively simple and may be safer, i.e. general anesthesia, sedation, and conjunctival incisions are not required.</p>
<p>ROP-LI54 Randomized Comparison of Diode Laser Photocoagulation versus Cryotherapy for Threshold Retinopathy of Prematurity: Seven-Year Outcome Shalev B, Farr AK, Repka MX. Am J Ophthalmol 132:76-80, 2001</p>	<p>To report the structural and functional outcomes at a minimum of 7 years postmenstrual age after randomized treatment of threshold ROP with laser ablation or cryotherapy, 19 patients were entered into a prospective, randomized protocol, in which 1 eye received cryotherapy, while the other eye received diode laser photocoagulation. Asymmetric eyes were randomly assigned. Two patients have died, and 7 were no longer available for 7-year outcome examinations, leaving 10 children for analysis. There were 8 symmetrical cases treated in both eyes. Of these, there were 6 concordant and 2 discordant structural outcomes. Results: The laser-treated eyes had the favorable outcome in each instance. The geometric mean VA of the paired eyes after laser photocoagulation was 20/33, and after cryotherapy it was 20/133 (P=.03). The mean refractive error was -6.50 diopters after laser photocoagulation and -8.25 diopters after cryotherapy (P=.27), although one of the cryotherapy eyes could not be refracted because of phthisis. All 10 eyes receiving laser photocoagulation had a favorable structural outcome at 7 years follow-up. In the cryotherapy group of 8 eyes, 6 had favorable retinal structures, and 2 had an unfavorable structural outcome (1 was phthisical after total retinal detachment, and the other had a retinal fold that involved the macula). There was no instances of cataract developing during the entire follow-up</p>

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	<p>period. Conclusions: Laser photocoagulation appears to be associated with a structural and functional outcome at least as good as cryotherapy 7 years after therapy. VA and refractive error data suggest that laser photocoagulation may have an advantage over cryotherapy.</p>
<p>ROP-LI55 Laser Therapy for Retinopathy of Prematurity Banach MJ, Berinstein DM Curr Opin Ophthalmol 12:164-170, 2001</p> <p><i>Also listed as ROP-TS8, pg. 230</i></p>	<p>In this review, the most recent advances of ROP and its accurate diagnosis are discussed. All current aspects of laser photocoagulation are discussed, including the indications for treatment, equipment, anesthesia, treatment techniques, complications, postoperative care, and structural outcomes. Systemic parameters that may affect ocular outcomes are also addressed. Some highlights:</p> <p><u>Laser Treatment Technique</u> Laser treatment should be instituted within 72 hours of the diagnosis of threshold disease. The authors use the 810 nm OcuLight laser with an indirect delivery system to apply laser treatment to avascular retina immediately anterior to the ridge of extraretinal fibrovascular proliferation and extending to the ora serrata for 360° in all cases. A moderately intense, gray-white burn is the desired target intensity. Laser settings to achieve the desired lesion intensity vary, but often range from a power of 150 mW to 400 mW and duration of 0.2 to 0.3 seconds. The mean number of burns have ranged from 410 to 1556 in these reports, but this can vary considerably depending on the posterior extent of the ridge and the resultant spot size.</p> <p>Complications: Laser photocoagulation using the indirect delivery system has potential immediate ocular complications that include inadvertent macular burns, and both vitreous and choroidal hemorrhage. Thermal injuries to the cornea, iris, and lens can also occur. Cataracts are well described following indirect laser treatment for ROP.</p> <p>Postoperative care: Immediately after laser treatment, steroid drops or ointment may be applied. Follow-up examinations are performed weekly until the regression of plus disease and fibrovascular proliferation occurs, then every 2 to 4 weeks until 3 months of age (corrected).</p> <p><u>Transscleral Retinal Photocoagulation</u> Transscleral diode lasers are also available for treating ROP. The transscleral probe is applied to the external surface of the sclera and has a diode aiming beam that allows the targeted retina to be visualized using an indirect ophthalmoscope. To achieve a grayish, white burn, the authors used powers between 500 and 750 mW and a pulse duration of 2 to 3 seconds. Advantages of transscleral treatment when compared with transpupillary treatment include the reduced risk of thermal injury to the iris and lens, and the ability to treat through media opacities such as vitreous hemorrhage and miotic pupils. Disadvantages include the technical difficulty in treating zone 1 disease just anterior to the ridge without conjunctival incisions. Although the vast majority of infants can be safely treated with transpupillary laser applications, transscleral diode laser may play a role in select cases.</p>


New

	<p>Conclusions: The management of ROP has changed dramatically over the past 15 years. Peripheral retinal ablation is the standard treatment for threshold ROP. Although cryotherapy remains a viable option, laser photocoagulation with the indirect delivery system has become the treatment of choice for threshold ROP.</p>
<p> ROP-LI56 A Comparison of Laser Photocoagulation with Cryotherapy for Threshold Retinopathy of Prematurity at 10 Years. Part 1. Visual Function and Structural Outcome Ng EYJ, Connolly BP, McNamara JA, Regillo CD, Vander JF, Tasman W. Ophthalmology 109:928-935, 2002</p>	<p>An extended follow-up of a randomized controlled clinical trial of 118 eyes of 66 patients, randomly assigned to receive either cryotherapy or laser photocoagulation for threshold ROP, was conducted to assess visual and structural outcomes after laser photocoagulation and transscleral cryotherapy for threshold ROP after 10 years. Of the 25 patients who returned for the 10 year follow-up, 19 had undergone bilateral treatment, and 6 had undergone unilateral treatment. Detailed examinations were performed on a total of 23 laser-treated eyes and 21 cryotherapy-treated eyes.</p> <p>Cryotherapy and/or laser photocoagulation was administered within 72 hours of the diagnosis of threshold ROP. The first 29 laser treatments performed before October 1990 were performed in an operating room using a liquid cooled argon ion laser. In October 1990, the infrared OcuLight diode laser became available and was used in the remaining treatments.</p> <p>Results: <u>Visual Outcome</u> - Eyes treated with laser had a mean BCVA of 20/66 (Snellen equivalent), whereas cryotherapy-treated eyes had a mean BCVA of 20/182 (Snellen equivalent) (P=0.015, n=42). Compared with eyes treated with cryotherapy, eyes treated with laser photocoagulation were 5.2 times more likely to have a 20/50 or better BCVA (95% confidence interval, 1.37-19.8, n=42). Eyes treated with cryotherapy were 7.2 times (95% confidence interval, 1.54-33.6, n=33) more likely to develop retinal dragging compared with laser treatment. By linear regression analysis, ETDRS VA was inversely proportionate to the degree of retinal dragging in both laser (r= -0.637, P= 0.006) and cryotherapy (r = -0.517, P=0.040) treated eyes.</p> <p><u>Anatomic Outcome</u> - Of the 21 eyes treated with cryotherapy, 4 (19%) eyes had unfavorable outcomes (2 eyes developed stage 5 ROP, 1 eye developed stage 4B ROP, and the other eye developed a macular fold). There were 2 (10%) unfavorable outcomes among the 23 eyes treated with laser; both developed stage 5 ROP. Among the 21 patients with favorable outcomes in both eyes, 13 had strabismus (62%) and 6 had received amblyopia therapy (29%). Ptosis, loss of cilia, and cortical cataract were among probably treatment-related complications that were noted in this study.</p> <p>Conclusions: The 10-year follow-up results of this study suggested that laser photocoagulation used in the treatment of ROP resulted in better visual and anatomic outcome and was associated with less long-term morbidity than cryotherapy treatment.</p>

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	<p>Although this trial was smaller than the Multicenter Trial of Cryotherapy for ROP, it is unlikely that another trial of similar scale will be undertaken to compare cryotherapy with laser photocoagulation.</p> <p>Note: Although both laser treatment and cryotherapy are ablative treatments, the type of tissue damage differs. Transscleral cryotherapy to the developing sclera causes retinal, choroidal, and scleral disruption and may perpetuate disorganized scar tissue formation. The photocoagulation burns produced by a transpupillary diode laser (810 nm) produce retinal and choroidal changes. Compared with comparable argon laser spots, diode laser burns show more of an effect in the choroid.</p>
<p> New</p> <p></p> <p>ROP-LI57 A Comparison of Laser Photocoagulation with Cryotherapy for Threshold Retinopathy of Prematurity at 10 Years. Part 2. Refractive Outcome Connolly BP, Ng EYJ, McNamara JA, CD Regillo, Vander JF, Tasman W. Ophthalmology 109:936-941, 2002</p>	<p>An extended follow-up of a randomized controlled clinical trial of 118 eyes of 66 patients, randomly assigned to receive either cryotherapy or laser photocoagulation for threshold ROP, was conducted to determine the refraction of each of these patients approximately 10 years after treatment, with specific attention to the role of the cornea, AC depth, and axial length of the eye. Twenty-five patients (44 eyes treated) were available for follow-up examination 10 years later.</p> <p>Eyes treated with cryotherapy were significantly more myopic than those treated with laser photocoagulation. When comparing patients with bilateral treatment, the mean spherical equivalent (SE) of eyes treated with laser was -4.48 diopters (D) compared with a mean SE of -7.65 D for eyes treated with cryotherapy ($n = 15$ pairs of eyes, $P = 0.019$). Cryotherapy-treated eyes had a mean axial length of 21.7 mm versus 22.9 mm for laser-treated eyes ($P = 0.024$, $n = 12$ pairs of eyes). The anterior chamber depth and lens thickness averaged 2.86 mm and 4.33 mm, respectively, in the cryotherapy-treated eyes compared with 3.42 mm and 3.95 mm in the laser-treated eyes ($P < 0.001$, $n = 12$ pairs for both measurements). There were no statistical differences in anterior corneal curvature and central corneal thickness between the two treatment modalities. Crystalline lens power bore the strongest correlation to refractive outcomes in both laser-treated ($r = 0.885$, $P < 0.001$) and cryotherapy-treated eyes ($R = 0.591$, $P = 0.026$). Although keratometric readings were higher than normal values in these eyes, there was no correlation to the degree of myopia. Conclusions: Laser-treated eyes were significantly less myopic than cryotherapy-treated eyes. Lens power seemed to be the predominant factor contributing to the excess myopia.</p>
<p> New</p> <p></p> <p>ROP-LI58 Diode Laser Photocoagulation to the Ridge and Avascular Retina in Threshold Retinopathy of Prematurity Steinmetz RL, Brooks HL. Retina 22:48-52, 2002</p>	<p>A retrospective review of 82 consecutive eyes in 43 preterm infants with stage 3+ threshold disease who had both the peripheral avascular retina and the ridge treated with diode laser photocoagulation was conducted. All eyes were treated within 72 hours of the detection of threshold disease. An unfavorable outcome consisted of either 1) retinal fold involving the macula; 2) any retinal detachment involving zone I, or 3) a retrolental tissue or "mass" that obscured the posterior pole.</p> <p>Treatment parameters included a spot size of approximately 600 μm, 0.2 second duration, and power of 200 to 500 mW.</p>

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	<p>Confluent laser burns were applied to the peripheral avascular retina, including the ridge and all associated extraretinal fibrovascular proliferation for 360°. On average, 1,245 burns of confluent laser photocoagulation were given per eye (range, 400 – 1,760 burns). Often, increased laser energy was required to obtain the gray-white burn intensity similar to those placed in the peripheral retina. In many eyes, localized hemorrhage occurred at the ridge during treatment, but in no instance did hemorrhage prevent the completion of the laser treatment. In all eyes, the hemorrhages cleared within 3 to 4 weeks and none were associated with an unfavorable outcome. All postoperative eyes received either an antibiotic or an antibiotic/steroid ointment twice daily for 3 days.</p> <p>Patients were followed-up for a mean of 18 months (range, 3 – 72 months), with a median follow-up of 12 months. At the 3-month follow-up, a favorable anatomic outcome occurred in 79 eyes (96%). The 3 eyes with unfavorable outcomes, all had received complete initial laser photocoagulation for zone I disease, but 2 of the eyes were in one infant who was unable to be examined and re-treated in the critical weeks that followed. It is therefore conceivable that additional laser treatment to both the ridge and peripheral avascular retina could have salvaged these eyes and improved the favorable outcome rate. There were no intraoperative complications. Postoperative intraocular hemorrhage occurred in 8 eyes (10%) and resolved without sequelae. Supplemental laser was required in only 2 eyes (2%). Conclusions: Diode laser photocoagulation to the ridge and peripheral avascular retina in threshold ROP is associated with a favorable anatomic outcome. The risk of postoperative intraocular hemorrhage and the need for supplemental laser photocoagulation is low.</p>
<p> ROP-LI59 Treatment of Threshold Retinopathy of Prematurity with Diode Laser Lee AC, Kim JE, Perkins SL, Connor TB, Han DP. Ophthalmology, Medical College of Wisconsin, Milwaukee, WI. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 1240, 2002</p>	<p>To evaluate the outcome of indirect diode laser on the treatment of threshold ROP and to report demographic changes, a retrospective chart review of 111 eyes of 61 babies treated for threshold ROP between 1991 and 2001 was conducted. Fourteen eyes had zone 1 disease at the time of laser treatment, while 97 eyes had zone 2 disease. The median length of follow-up was 2 months (range, 0 to 94 months). Regression of neovascularization was achieved in 96/111 eyes (86%). Thirty-six percent of eyes with zone 1 disease progressed to stage 4 or 5 disease, while 10% of the initial zone 2 eyes progressed. The mean gestational age at birth (25 weeks) and at time of treatment (37 weeks) and the mean birth weight between eyes with zone 1 versus zone 2 were not statistically different ($p=0.3-0.9$). Five eyes (5%) developed stage 4a disease, 6 eyes (5%) developed 4b disease, and 4 (3.5%) eyes developed stage 5 disease. There was no statistical difference in mean gestational age at birth (25.0 versus 25.2 weeks, $p=0.74$) and mean birth weight (746 versus 724 grams, $p=0.78$) between individuals that progressed compared with those that stabilized. During 1991 to 2001, there was a statistically significant trend towards lower mean gestational age at time of birth (Pearson correlation = -0.36, $p = 0.005$) and mean birth weight (Pearson correlation = -0.35, $p = 0.0041$). Conclusion: Favorable outcome was noted in 86% of eyes after laser treatment, which is comparable to other published studies. A larger number of eyes with zone 1</p>

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	<p>disease progressed to stage 4 or stage 5 disease as compared to zone 2 disease; however, there was no difference in mean birth weight or gestational age at time of birth.</p>
<p> ROP-LI60 Diode Laser Photocoagulation and Vitrectomy for the Management of Retinopathy of Prematurity in Chile Kychenthal A,¹ Katz X,² Dorta P,³ Stevenson R.³ ¹Clinica Alemana & Hospital Salvador, Santiago, Chile; ²Clinica Las Condes, Santiago, Chile; ³Hospital Salvador, Santiago, Chile. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 1248, 2002</p>	<p>Forty consecutive eyes in 20 infants with zone I ROP and 93 eyes in 49 infants with zone II ROP were treated with indirect diode laser to study the clinical characteristics and treatment outcome after laser and surgical treatment in a series of infants with ROP. In the zone I group, two anatomical subgroups (anterior and posterior) were defined. Additionally, 28 eyes with retinal detachment secondary to ROP were surgically treated. Structural outcome was evaluated at 3 months. In the laser group, 20 out of 40 eyes (50%) with zone I ROP had unfavorable outcome compared with 6 out of 93 eyes (6.5%) with zone II ROP ($p < 0.001$). Treatment age was significantly less ($p=0.001$) for zone I group than for zone II group (35.7 vs 37.2 weeks). Fourteen out of 34 eyes (41.2%) with anterior zone I ROP and 6 out of 6 (100%) eyes with posterior zone I ROP had unfavorable outcome ($p=0.007$). In the surgery group 13 out of 17 eyes (76.5%) with stage 4 and 5 out of 11 eyes (45.5%) with stage 5 ROP had a favorable outcome. Conclusion: Laser for Zone I ROP is not as effective as for Zone II. Zone I eyes need earlier treatment. Surgical intervention can effectively attach the retina in some cases of stage 4 and 5 ROP.</p>
<p> ROP-LI61 Re-Treatment with Diode Laser Photocoagulation for Severe Retinopathy of Prematurity: Indications and Results Wallace DK,¹ Freedman SF,² Coats DL,³ Sprunger DT,⁴ Brooks SE.⁵ ¹University of North Carolina, Chapel Hill, NC; ²Duke University, Durham, NC; ³Baylor College of Medicine, Houston, TX; ⁴Indiana University, Indianapolis, IN; ⁵Augusta, GA. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4014, 2002</p>	<p>Records were reviewed from 26 patients who received a second diode laser treatment for ROP on at least 1 eye at 1 of 5 centers over the past 4-7 years. Indications for re-treatment included skipped areas, persistent plus disease and/or stage 3, and progression of disease. An unfavorable anatomic outcome was defined, as in the CRYO-ROP study, as a retinal fold through the macula, a retinal detachment in zone I, or a retrolental mass. Of 36 eyes in 26 patients who received a second diode laser treatment, 31 (86%) had a favorable anatomic outcome and 5 (14%) had an unfavorable outcome. The mean interval between first and second treatment was 16 days (range 4-68). The mean number of laser spots at first treatment was 1675 (1319-2600) in zone I eyes and 1093 (300-1929) in zone II eyes. The mean number of spots at second treatment was 693 (157-1842) in zone I eyes and 364 (100-1274) in zone II eyes. Conclusion: When an eye with severe ROP fails to regress after laser treatment, prompt retreatment directed at untreated or lightly treated avascular retina results in a favorable anatomic outcome in most cases.</p>
<p>  ROP-LI62 Acquired Cataracts after Diode laser Photocoagulation for Threshold Retinopathy of Prematurity Paysse EA, Miller A, Brady McCreery KM, Coats DK. Ophthalmology 109:1662-1665, 2002</p>	<p>A retrospective, noncomparative, interventional case series to report the incidence of acquired cataract after diode laser photocoagulation for threshold ROP was conducted. One hundred fifty-three infants (293 eyes) with threshold ROP received transpupillary diode laser photocoagulation using the 810 nm OcuLight laser system. The entire avascular peripheral retina was treated, using either a 20-diopter (D) or a 28-D condensing lens to visualize the retina. One hundred fifty-four eyes were treated with a pulse mode, with a laser energy</p>

duration per spot averaging 300 milliseconds (pulse mode), and 132 eyes were treated with a continuous mode, with the laser energy duration set a 9000 milliseconds (continuous mode). Four eyes were treated with a combination of pulse and continuous mode laser. The treatment mode was not recorded in 3 eyes. The power setting varied between cases from 185 mW to 800 mW (mean, 307 mW) in the pulse group and from 130 to 600 mW (mean, 255 mW) in the continuous mode group. The laser power was titrated to achieve the desired end point of a gray-white retinal burn, and the laser spots were placed approximately one half of a burn width apart in a scatter pattern. When using the continuous mode, scatter treatment was achieved by moving the laser's aiming beam from one site to another as soon as a burn appeared. In this way, interrupted laser burns were spaced approximately one half burn width apart despite having the laser set on a continuous mode. Patients were evaluated after surgery at 1- to 2-week intervals for 4 weeks and then again between 6 and 12 weeks after surgery. Subsequent follow-up visits were spaced out according to the physician's discretion.

Results: One hundred four (203 eyes) of the 153 patients (68%) had follow-up for at least 6 months. One cataract (0.003%) in 293 eyes occurred after transpupillary diode laser photocoagulation. This cataract consisted of peripheral cortical punctate lenticular opacities, first detected 7 weeks after laser treatment. These peripheral cortical lenticular opacities were not visually significant and were non-progressive after 24 months of follow-up. Before surgery, the eye had zone 2, stage 3 ROP with severe plus disease and a prominent persistent anterior tunica vasculosa lentis at the time of treatment. Pulse mode laser was used in this eye. Limited uptake of laser energy was noted in this eye, requiring high power and multiple burns to treat the avascular retina fully. The following treatment parameters were used in this eye: power, 300 to 550 mW; duration of laser energy per burn, 400 milliseconds; and number of burns, 2889. A progressive stage 4A retinal detachment also developed in this eye requiring pars plana vitrectomy with silicone oil placement. The cataract did not progress before or after silicone oil placement.

Conclusions: The authors believe that post-laser cataracts are more likely the result of thermal damage from absorption of laser energy by lens proteins or hemoglobin in the blood circulating through a persistent anterior tunica vasculosa lentis and that they should, for the most part, occur in the first postoperative weeks after the laser treatment. If true, this phenomenon of laser energy absorption is likely to be less frequent with diode than with argon laser surgery because of the reduced absorption of diode laser energy by hemoglobin. The low incidence and the absence of visually significant cataracts suggest a potential advantage of transpupillary laser treatment with the diode over the argon laser. This advantage may be especially true in infants with significant persistent anterior tunica vasculosa lentis. A prospective, randomized clinical trial may be helpful in further clarifying these issues.

RETINOPATHY of PREMATURITY

Transscleral Retinal Photocoagulation (TSRPC)



<p>ROP-TS1 Transscleral versus Transpupillary Diode Laser Photocoagulation for Stage 3+ Retinopathy of Prematurity Seiberth V, Vardarli I, Knorz MC, Liesenhoff H. Presentation. D.O.G. Meeting Heidelberg. Mannheim/Heidelberg September 1995. German J Ophthalmol 1(Suppl):127, 1995</p> <p><i>Also listed as ROP-LI25, pg. 208</i></p>	<p>Twenty eyes of 10 infants (gestational age 24-27 weeks, mean 25.7±0.9 weeks; birth weight 480-908 g. mean 777±175 g) with ROP stage 3+ were treated with diode infrared laser photocoagulation. One eye of each infant was treated transsclerally while the fellow eye had transpupillary coagulation using the laser indirect ophthalmoscope. Follow-up ranged from 2 to 14 months (mean 7.5±2.3 months.) In 10 (100%) eyes treated transpupillary and in 9 (90%) eyes treated transsclerally, ROP regressed after a single or a second laser treatment and the outcome was a flat, attached retina. One eye (10%) with zone I disease failed after transscleral laser treatment and ROP progressed to stage 4 A with a retinal fold and partially attached retina, although additional retinal detachment surgery with an encircling band was performed. There were no adverse side effects as a result of retinal/preretinal bleeding in the ridge in five eyes (25%). Conclusion: Transscleral diode laser coagulation for treatment of ROP stage 3+ proved to be as effective and safe as transpupillary diode laser photocoagulation.</p>
<p>ROP-TS2 Transscleral versus Transpupillary Diode Laser Photocoagulation for Threshold Retinopathy of Prematurity Sieberth V, Vardarli I, Jendritza W, Knorz MC, Liesenhoff H. University Eye Clinic, Klinikum Mannheim, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S695. Abstract nr 3176, 1996</p> <p><i>Also listed as ROP-LI31, pg. 210</i></p>	<p>The 810 nm diode laser wavelength makes lens-sparing transscleral coagulation of the retina possible, and to evaluate the efficacy and safety of transscleral diode laser coagulation for threshold ROP, the authors performed a controlled clinical study. Forty eyes of 20 preterm infants (gestational age 24-29 weeks, mean 26.8±1.6 weeks; birth weight 540-1200 g. mean 859±163 g) with threshold ROP were treated with diode laser photocoagulation. One eye of each infant was treated transsclerally while the fellow eye had transpupillary coagulation using the laser indirect ophthalmoscope. Follow-up ranged from 4 to 22 months (mean 10.5±6.3 months). Main outcome measure was the regression of acute ROP and the incidence of adverse treatment effects. In 20 (100%) eyes treated transpupillary and in 19 (95%) eyes treated transsclerally ROP regressed after a single or a second laser treatment and the outcome was a flat, attached retina. One eye (5%) with zone I disease failed after transscleral laser treatment and ROP progressed to stage 4B with a partially attached retina, although retinal detachment surgery with an encircling band was performed. No adverse side effects as a result of diode laser treatment were noted except for a small amount of retinal/preretinal bleeding in the ridge in 9 (45%) transsclerally and in 5 (25%) transpupillary coagulated eyes. There were no adverse side effects (e.g. bleeding, cataract formation) in the anterior segments of the eyes. Conclusion: The results suggest that transscleral 810 nm diode laser coagulation for treatment of threshold ROP is as effective and safe as transpupillary diode laser photocoagulation.</p>

Reference Catalog: Summaries of Studies

<p>ROP-TS3 Transscleral vs. Transpupillary Diode Laser Photocoagulation for the Treatment of Threshold Retinopathy of Prematurity Seiberth V, Linderkamp O, Vardarli I. Arch Ophthalmol 115:1270-1275, 1997</p> <p><i>Also listed as ROP-LI40, pg. 213</i></p>	<p>To evaluate the efficacy and safety of transscleral diode laser photocoagulation for acute proliferative ROP, the authors performed a controlled clinical study in 25 preterm infants with threshold ROP in both eyes: One eye of each infant was treated transsclerally with the OcuLight and DioPexy Probe and the fellow eye was treated transpupillarily using the OcuLight and laser indirect ophthalmoscope.</p> <p>Treatment Parameters:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th style="text-align: center;"><u>Transscleral</u></th> <th style="text-align: center;"><u>Transpupillary</u></th> </tr> </thead> <tbody> <tr> <td>Power</td> <td style="text-align: center;">250 - 600 mW</td> <td style="text-align: center;">160 - 450 mW</td> </tr> <tr> <td>Spot Size</td> <td style="text-align: center;">1000 μm</td> <td style="text-align: center;">480 μm</td> </tr> <tr> <td>Duration</td> <td style="text-align: center;">200 - 600 ms</td> <td style="text-align: center;">200 ms</td> </tr> <tr> <td>Number of Burns</td> <td style="text-align: center;">153 - 877</td> <td style="text-align: center;">329 - 2078</td> </tr> </tbody> </table> <p>Follow-up ranged from 2 to 22 months. After transpupillary coagulation, ROP regressed in all 25 of the eyes; after transscleral coagulation, ROP regressed in 24 of the 25 eyes. Transscleral diode laser coagulation is as effective in the treatment of threshold ROP as transpupillary diode laser photocoagulation.</p>		<u>Transscleral</u>	<u>Transpupillary</u>	Power	250 - 600 mW	160 - 450 mW	Spot Size	1000 μ m	480 μ m	Duration	200 - 600 ms	200 ms	Number of Burns	153 - 877	329 - 2078
	<u>Transscleral</u>	<u>Transpupillary</u>														
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Spot Size	1000 μ m	480 μ m														
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<p>ROP-TS4 Follow-Up After Transscleral Diode Laser Photocoagulation For Retinopathy of Prematurity Stage 3+ Akkoyun I,¹ Seiberth V,^{1,2} Jendritza W,¹ Vögele C,¹ Liesenhöf H.¹ ¹University Eye Clinic, Klinikum Mannheim, Germany; ²Department of Ophthalmology, Marienhospital Osnabrueck, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S819. Abstract nr 3792, 1998</p> <p><i>Also listed as ROP-LI41, pg. 213</i></p>	<p>To evaluate the safety of transscleral diode laser treatment for ROP stage 3+, the authors prospectively examined 30 eyes of 30 very low birth weight infants (gestational age 23 to 31 weeks, mean \pm SD 26.6 \pm 1.8; birth weight 510-1200, 855 \pm 170) quarterly after regression of acute ROP. Examinations included assessment of anterior segment, fundus, vision, refractive error and biometry. Follow-up ranged from 10 to 48 months (29.6 \pm 11.2). Control group consisted of the 30 fellow eyes treated transpupillarily using the laser indirect ophthalmoscope. In 29 of 30 eyes (97%) of transscleral and all (100%) transpupillary treated eyes, the outcome was a flat and attached retina. There were no anterior segment abnormalities (e.g., iris burns, synechiae, cataract) in all eyes of both groups. Visual acuity, refractive error and biometry showed no significant differences between the transpupillary and transscleral treated eyes. These results indicate that transscleral diode laser photocoagulation can safely be used for the treatment of ROP stage 3+.</p>															
<p>ROP-TS5 Refractive Error after Transscleral Diode Laser Photocoagulation for Threshold Retinopathy of Prematurity Woldt C,¹ Seiberth V,¹ Akkoyun I,² Hugger P.² ¹Department of Ophthalmology, Marienhospital Osnabrueck, Johannisfreiheit 2-4, D-49074 Osnabrueck, Germany; ²University Eye Clinic, Theodor-Kutzer-Ufer, D-68135 Mannheim, Germany [ARVO Abstract]. Invest Ophthalmol Vis Sci. 40(4): S477. Abstract nr 2515, 1999</p>	<p>Refractive error was measured prospectively in 16 eyes of 16 preterm infants (gestational age 24 to 31 weeks, mean \pm SD 26.9 \pm 1.9; birth weight 540 to 1200 g, mean \pm SD 849 \pm 174) treated at random with transscleral diode laser photocoagulation for threshold ROP. Controls were the 16 fellow eyes treated transpupillarily. Mean refractive error was not significantly different in the second year after coagulation in transsclerally (-3.5 \pm 5.4 D) or transpupillarily (-3.0 \pm 5.1D) coagulated eyes ($p=0.8$). However, the transsclerally coagulated eyes showed slightly more myopia than the transpupillarily coagulated fellow eyes, though the difference was not statistically significant ($p=0.08$).</p>															

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<p>ROP-TS6 Transscleral Diode Laser in the Treatment of Retinopathy of Prematurity Davis AR, Jackson H, Trew D, McHugh JDA, Aclimandos WA. Eye 13;571-576, 1999</p>	<p>Transscleral diode laser (TSDL) treatment with the IRIS Medical infrared (810 nm) OcuLight photocoagulator and DioPexy Probe was performed in 14 eyes of 8 babies with threshold ROP (stage III+). All 14 eyes showed regression of plus disease at 1 week after treatment. Twelve eyes began to show signs of regression of abnormal neovascularization at 2 weeks. At last follow-up, 11 eyes (79%) showed a favorable outcome. Three (21%) eyes developed traction retinal detachments. Minimal chemosis and lid edema were observed in all patients. The degree of conjunctival edema was minimal and resolved in 24 hours in all cases. Conclusion: TSDL photocoagulation is an effective and technically straightforward alternative to cryotherapy in the treatment of ROP. The combination of transscleral and indirect laser may prove to be the ideal regimen for treatment of ROP, particularly in babies with extensive disease in zone 1 or those who need re-treatment.</p> <p><u>Treatment Parameters</u> All treatment was transconjunctival. The desired visible endpoint was a greyish-white retinal lesion.</p> <p>Duration: 2 – 3 seconds Power: 500 to 750 mW Anesthesia: The authors' preferred method is general anesthesia.</p>
<p>ROP-TS7 Transscleral Diode Laser Photocoagulation in Acute Retinopathy of Prematurity Seiberth V, Woldt C, Linderkamp O. Klin Monatsbl Augenheilkd 215;241-246, 1999</p> <p>Article – German Abstract - English</p>	<p>In a controlled clinical study, 60 eyes of 30 very low birth weight infants with threshold ROP were treated with diode laser photocoagulation. One eye of each infant was coagulated transsclerally while the fellow eye had transpupillary coagulation using the LIO. Follow-up ranged from 2 to 38 months. Results: In 29 (97%) out of 30 eyes treated transsclerally and in 30 (100%) out of 30 eyes treated transpupillary, the outcome was a flat, attached retina. Three eyes had a second laser treatment and 2 eyes had additional retinal detachment surgery. One eye (3%) with zone 1 disease failed after transscleral laser treatment and additional retinal detachment surgery with partially detached retina (stage 4B). No adverse side effects as a result of laser treatment were noted except for a small amount of retinal/preretinal bleeding in the ridge and a vitreous bleeding. There were no adverse side effects in the anterior segments of the eyes. Conclusion: Transscleral diode laser coagulation for treatment of threshold ROP proved to be as effective as transpupillary diode laser photocoagulation. Only minor side effects were noticed. Transscleral diode laser photocoagulation is an advantageous treatment method in eyes with preexisting risk of cataract formation in transpupillary treatment.</p>


ROP-TS8 Laser Therapy for Retinopathy of Prematurity

Banach MJ, Berinstein DM
 Curr Opin Ophthalmol 12:164-170,
 2001

Also listed as ROP-LI55, pg. 221

In this review, the most recent advances of ROP and its accurate diagnosis are discussed. All current aspects of laser photocoagulation are discussed, including the indications for treatment, equipment, anesthesia, treatment techniques, complications, postoperative care, and structural outcomes. Systemic parameters that may affect ocular outcomes are also addressed. Some highlights:

Laser Treatment Technique

Laser treatment should be instituted within 72 hours of the diagnosis of threshold disease. The authors use the 810 nm OcuLight laser with an indirect delivery system to apply laser treatment to avascular retina immediately anterior to the ridge of extraretinal fibrovascular proliferation and extending to the ora serrata for 360° in all cases. A moderately intense, gray-white burn is the desired target intensity. Laser settings to achieve the desired lesion intensity vary, but often range from a power of 150 mW to 400 mW and duration of 0.2 to 0.3 seconds. The mean number of burns have ranged from 410 to 1556 in these reports, but this can vary considerable depending on the posterior extent of the ridge and the resultant spot size.

Complications: Laser photocoagulation using the indirect delivery system has potential immediate ocular complications that include inadvertent macular burns, and both vitreous and choroidal hemorrhage. Thermal injuries to the cornea, iris, and lens can also occur. Cataracts are well described following indirect laser treatment for ROP.

Postoperative care: Immediately after laser treatment, steroid drops or ointment may be applied. Follow-up examinations are performed weekly until the regression of plus disease and fibrovascular proliferation occurs, then every 2 to 4 weeks until 3 months of age (corrected).

Transscleral Retinal Photocoagulation

Transscleral diode lasers are also available for treating ROP. The transscleral probe is applied to the external surface of the sclera and has a diode aiming beam that allows the targeted retina to be visualized using an indirect ophthalmoscope. To achieve a grayish, white burn, the authors used powers between 500 and 750 mW and a pulse duration of 2 to 3 seconds. Advantages of transscleral treatment when compared with transpupillary treatment include the reduced risk of thermal injury to the iris and lens, and the ability to treat through media opacities such as vitreous hemorrhage and miotic pupils. Disadvantages include the technical difficulty in treating zone 1 disease just anterior to the ridge without conjunctival incisions. Although the vast majority of infants can be safely treated with transpupillary laser applications, transscleral diode laser may play a role in select cases.

Additional Education Material Available on:

Retinopathy of Prematurity

ROP-P Patient Education Brochure:

Understanding Retinopathy of Prematurity

A 16 page brochure created to help parents understand the eye, the disease, and the treatment of ROP.

RTD-A Applications Note:

Laser Indirect Ophthalmoscopy

This applications note reviews the laser indirect's indications for use, optics of laser indirect ophthalmoscopy, and treatment techniques.

Reference Catalog: Summaries of Studies

HISTOLOGY

<p>HIST1 Semiconductor Laser Endophotocoagulation of the Retina Puliafita C, Deutsch T, Boll J, To K. Arch Ophthalmol 105:424-427, 1987</p>	<p>A successful retinal endophotocoagulation in the eyes of Dutch-belted rabbits, using high-power phased-array semiconductor lasers, emitting at 808 and 817 nm. To the authors' knowledge, this study is the first in which therapeutically useful lesions were produced using a diode laser and demonstrates the feasibility of using these highly efficient and compact laser sources for ophthalmic photocoagulation.</p>
<p>HIST2 Retinal Photocoagulation with Diode Laser Operating from a Slit Lamp Microscope Brancato R, Pratesi R, Leoni G, Trabucchi G, Giovannoni L, Vanni U. Lasers Light Ophthalmol 2:73-78, 1988</p>	<p>Retinal photocoagulations in the eyes of six pigmented rabbits were performed using a slit lamp microscope coupled with a semiconductor laser emitting at 811 nm continuous wave. To the authors' knowledge this study is the first in which therapeutically useful lesions were produced using a diode laser delivered via a slit lamp microscope. It demonstrates the feasibility of using these highly efficient and compact laser sources in ophthalmology.</p>
<p>HIST3 Transpupillary Retinal Photocoagulation in the Eyes of Rabbit and Human Using a Diode Laser McHugh JDA, Marshall J, Capon M, Rothery S, Raven A, Naylor RP. Lasers Light Ophthalmol 2:125-143, 1988</p>	<p>Retinal photocoagulation was performed on a number of rabbit and human eyes using a diode laser. The retinal burns were examined by light and electron microscopy and were found to be similar to those produced by argon and, more particularly, by krypton photocoagulations. The implications of these findings are discussed in relation to the potential use of diode lasers in treating retinal conditions.</p>
<p>HIST4 Macular Photocoagulation of Human Retina with a Diode Laser. A Comparative Histopathological Study McHugh JDA, Marshall J, ffytche T, Hamilton P, Raven A. Lasers Light Ophthalmol 3:11-28, 1990</p>	<p>Macular photocoagulation was performed on two human eyes with a diode laser emitting at 810 nm. Damage was confined to the outer retina, retinal pigment epithelium and choroid. This was in contrast to the appearances seen following argon blue-green photocoagulation of the macula, in which inner retinal damage was observed associated with absorption by macular pigments. The implications of these findings are discussed in relation to the potential advantages of treating common macular conditions with infrared diode lasers.</p>
<p>HIST5 Histopathologic Results of Retinal Diode Laser Photocoagulation in Rabbit Eyes Smiddy W, Hernandez E. Arch Ophthalmol 110:693-698, 1992</p>	<p>Diode laser photocoagulation was applied to rabbit retina simulating scatter treatment using an endolaser probe and in a manner simulating treatment of peripheral retinal breaks using a transscleral retinopexy probe. Clinically appearing mild, moderate, and severe burns were created by altering the burn duration in one eye and by altering the power setting in the fellow eye. Histopathologic results demonstrated the clinically evident dose-response effect with sparing of inner retinal cellular elements with mild burns and full-thickness retinal cell loss with severe burns.</p>

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<p>HIST6 Histopathologic Characteristics of Diode Laser-Induced Chorioretinal Adhesions for Experimental Retinal Detachment in Rabbit Eyes Smiddy W, Hernandez E. Arch Ophthalmol 110:1630-1633, 1992</p>	<p>A retinal break and localized retinal detachment were induced in 10 rabbit eyes. The retinal break was treated within regions of detached retina using diode laser transscleral retinopexy (four eyes), diode laser indirect ophthalmoscopy (two eyes), or retinocryopexy (two eyes). Two eyes were left as untreated controls. The clinical and histopathologic effects were studied 1 day and 3 weeks after initial treatment. Suitable chorioretinal adhesions were induced with all treatment modalities. The extent of tissue effects was greater in cryopexy and smaller in laser treatment. The histopathologic characteristics of the lesions induced by diode laser indirect ophthalmoscopy were similar to those seen with transscleral diode treatment and were more focal than those seen with cryopexy. Transscleral and transpupillary diode laser photocoagulation were effective in inducing chorioretinal adhesions in detached retina in this experimental model in rabbits.</p>
<p> HIST7 Blood-Retinal Barrier Breakdown Caused by Diode vs. Argon Laser Endophotocoagulation Sato Y, Berkowitz B, Wilson C, de Juan Jr. E. Arch Ophthalmol 110:277-281, 1992</p>	<p>The effects of argon and 810 nm diode laser endophotocoagulation on blood-retinal barrier breakdown using real-time magnetic resonance imaging following intravenous gadolinium-diethylenetriaminepentaacetic acid injection was compared. Histopathologic examination performed 2 days following photocoagulation showed less damage of the retinal pigment epithelium and more severe occlusion of the choriocapillaris and deep choroidal vessels in diode laser-treated eyes.</p>
<p>HIST8 Chorioretinal Alterations in Pigmented Rabbit after Diode Laser Application Triviño A, Andrés MV, Ramírez JM, Ramírez AI, Salazar JJ, Gómez-Ulla F, Gómez-Torrijos F. Arch Soc Esp Oftalmol. 69:319-326, 1995</p> <p>Abstract - English/Spanish Article - Spanish</p>	<p>Retinal photocoagulation was performed in the eyes of pigmented rabbits using a slit lamp microscope coupled with a semiconductor laser (IRIS Medical) emitting 810 nm infrared radiation. Power used was 150 mW with an exposure time of 0.2 seconds in continuous wave and 200 µm of spot diameter to produce chorioretinal burns ophthalmoscopically similar from those induced with conventional wavelengths. The retinal burns were examined by light microscopy at 3 and 7 days after the treatment. Histologic examination revealed the main change in the sensory retina, retina pigment epithelium and choroid. After 7 days, the authors observed the existence of a scar tissue with phagocytic cells and glia.</p>
<p>HIST9 Destruction of Age-Related Lipid Components in Bruch's Membrane and Retinal Pigment Epithelium of Human Retina with a Diode Laser. A Histopathological Study Ruskovic D,¹ Ulbig MW,¹ Rothbacher HH,¹ Stefani FH¹, Hamilton AMP,² McHugh JDA.³ ¹Univ. Eye Hospital, Munich, Germany, ²Moorfields Eye Hospital, London, UK, ³Kings College Hospital, London, UK [ARVO Abstract]. Invest Ophthalmol Vis Sci; 37(3): S131. Abstract nr 619, 1996</p>	<p>Grid laser treatment for diffuse diabetic macular edema is a well recognized mode of treatment and recently it has been shown that just a few laser burns can lead to the disappearance of confluent soft macular drusen in eyes with AMD. Age-related lipid deposits at the level of Bruch's membrane and the retinal pigment epithelium are considered a predisposing factor for the development of drusen in AMD. Furthermore, the age-related accumulation of lipid components may explain why maturity onset diabetics are more prone to develop long standing macular edema than juvenile onset diabetics. Donor eyes and eyes with a large peripheral choroidal melanoma due for enucleation in patients older than 45 years were lasered with a near infrared diode laser (810 nm) in the macular region. Laser settings were to produce a visible greyish threshold burn of 125 or 200 microns spot size. Frozen sections of Bruch's membrane and the retinal pigment epithelium for light microscopy were stained with oil-red-0. Lipid components of Bruch's membrane</p>

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	<p>were stained with oil-red-0. In areas treated with diode laser irradiation there was a change in the appearance of tissue staining with oil-red-0 within Bruch's membrane. Conclusion: Accumulating lipid components within Bruch's membrane may interfere with transport of fluid and debris from the sensory retina towards the choroid. Laser induced changes of these lipid components may restore active transport mechanisms from the retina to the choroid.</p>
<p>HIST10 Histopathologic and Immunohistochemical Findings of Transscleral Diode Retinopexy: Comparative Studies with Cryoretinopexy Kim JH,¹ Oum BS,² Lee SH.³ ¹Department of Ophthalmology, Pusan Veterans Hospital; ²Department of Ophthalmology Pusan National Univ. Hospital; ³Lee's Eye Clinic, Pusan, Korea [ARVO Abstract]. Invest Ophthalmol Vis Sci. 37(3): S403. Abstract nr 1874, 1996</p> <p><i>Also listed as RTD-TS23, pg. 192</i></p>	<p>The authors performed transscleral diode laser retinopexy or cryoretinopexy in 25 pigmented rabbits to compare clinical, histopathologic, and immunohistochemical features of chorioretinal lesions. The eyes were enucleated at 2 hours, 1 week, 1 month, and 3 months after retinopexy. Tissues were sectioned and light and electromicroscopic stains were made. Immunohistochemical studies by the avidin biotin peroxidase complex method with antibodies for Muller cell, astrocyte, retinal pigment epithelium and macrophage (5 immunological markers - GFAP, vimentin, S-100, Cytokeratins, and antimacrophage) were done. Lesions produced by cryotherapy showed full-thickness overlying retinal destruction compared with those produced by transscleral diode which showed reaction primarily at the outer retina and choroid. Remarkable expressions of GFAP, vimentin and S-100 epitopes were seen in chorioretinal scar tissues made with cryo and with less intensity in diode induced retinopexy. This study indicates that both diode laser retinopexy and cryoretinopexy lesions showed similar deep retinal Muller cell reaction as demonstrated by the immunohistochemical studies; histopathologically, less inner retinal destruction was observed using transscleral diode laser.</p>
<p>HIST11 A Comparative Study of the Effects of Argon and Diode Laser Photocoagulation on Retinal Oxygenation Funatsu H, Wilson CA, Berkowitz BA, Sonkin PL. Graefe's Arch Clin Expo Ophthalmol 235:168-175, 1997</p>	<p>The central hypotheses driving this study is that hypoxia plays a causative role in the pathogenesis of vasoocclusive retinal disease and that retinal hypoxia can be relieved by photocoagulation. Because of the potential for differences in biologic response to different wavelengths of laser light, the authors sought to determine whether retinal oxygenation is affected similarly by diode (DLP) and argon (ALP) laser photocoagulation. An OcuLight 810 nm, diode laser and a System 900, argon, 488 and 514 nm (Coherent) laser were used to compare their effects on the preretinal oxygen tension (P_{O_2}) in rabbits directly over photocoagulated retina, and in between laser lesions. The authors were able to demonstrate that the preretinal P_{O_2} was significantly higher over confluent laser lesions compared to untreated eyes and that DLP lesions had significantly higher P_{O_2} values than did ALP lesions. On post-treatment day 5, a significant increase of P_{O_2} was found in the preretinal space in between the DLP lesions, which was not found between the ALP lesions. Scatter photocoagulation with DLP or ALP produced no sustained increase in preretinal P_{O_2}. Preretinal oxygen tension was measured by FTBA, an inert, biocompatible, perfluorinated organic compound that has been used as a surgical device for retinal reattachment surgery in human eyes, and has been shown suitable for fluorine MRS studies in vivo. This study demonstrates that both DLP or ALP produce increased oxygenation of the inner retina in an animal model, and under certain conditions, DLP produces a greater P_{O_2} response than does ALP.</p>

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<p>HIST12 Cellular Response to Hard Drusen and Lipid Deposits in Human Bruch's Membrane Following Diode Laser Photocoagulation Ruskovic D,¹ Ulbig MW,¹ Mueller AJ,¹ McHugh DA,² Marshall J.³ ¹University Eye Hospital, Munich, Germany; ²King's college Hospital, London, UK; ³St. Thomas' Hospital, London, UK [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S369. Abstract nr 1723, 1998</p>	<p>Five patients with age-related lipid deposits or hard drusen in Bruch's membrane were lasered using a diode laser (810 nm) 2 weeks, 1 week and 3 to 1 days before enucleation due to a malignant choroidal melanoma. Nine eyes of diabetic patients and donors with laser scars and hard drusen were also included. Immediately after surgery, the eyes were processed for transmission electron microscopy and lipid histochemistry. The laser burns applied 1-14 days before histological evaluation revealed persistence of lipid deposits and hard drusen. However both retinal pigment epithelial and choroidal inflammatory cells were observed in direct apposition to Bruch's membrane with occasional cellular intrusions. Finally, in longstanding laser scars, the lipid content of Bruch's membrane was reduced in the irradiated areas, whereas distant hard drusen remained intact. Conclusions: Laser-induced loss of photoreceptors and remodeling of Bruch's membrane in the process of wound healing reduces age-related lipid deposits in the long-term. The degradation of neutral lipids obviously is confined to the site of laser impact, but a remote effect with resorption of retinal and subretinal fluid seems possible.</p>
<p>HIST13 Histopathological Differences in the Effect of Diode versus Argon Laser in Human Corneal and Iris Tissues HO CL, Chew P, Wong JS, Chee C, Tock E. Department of Ophthalmology, National University Hospital; Singapore National Eye Centre; Department of Pathology, National University of Singapore [ARVO Abstract]. Invest Ophthalmol Vis Sci. 39(4): S712. Abstract nr 3273, 1998</p> <p><i>See related abstract: G-P11, pg. 141</i></p>	<p>Six enucleated human cadaveric eyes with 3 grades of corneal clarity were used; 2 eyes with clear, 2 with intermediate clarity and 2 with hazy corneas. Half of the corneal disc trephined from each eye was treated with argon blue-green laser and the other half treated with diode laser. Half of each iris was then treated directly with argon blue-green laser and the other half with diode laser. The same number of shots was applied for each half. The energy settings used for each laser on all tissues were identical; 1.0 W, 0.1 s duration, 100 mm spot size. Histopathological studies were then performed on the corneal and iris tissues. Results: Diode laser did not produce morphological damage in all the 3 grades of corneas whereas argon laser caused burns in the hazy corneas. Diode laser produced full-thickness burns in the irides with single shots, whereas argon laser tended to produce partial-thickness burns with each shot. Conclusions: Diode laser is effective for anterior segment procedures in Asian eyes with brown irides. It is possibly a better alternative to the argon blue-green laser as it has superior corneal penetration with less corneal damage, especially in hazy corneas, and more effective photothermal effect on the brown Asian iris than argon laser at identical energy settings.</p>
<p>HIST14 Diode Laser Irradiation Induces Apoptosis in Human Retinal Pigment Epithelial Cell Culture Morse LS,¹ Barak A,¹ Mazow Gelfman C,¹ Hjelmeland L,¹ Goldkorn T.² ¹Dept of Ophthalmology, UC Davis, Sacramento, CA; ²Signat Transduction Laboratory, UC Davis, Davis, CA. [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S413. Abstract nr 2180, 2000</p>	<p>The authors developed a RPE cell culture model for studying the effects of laser injury on the human RPE cells. ARPE-19 cells were grown to confluency and then irradiated with diode laser using fiber optic delivery system positioned at constant distance from the cells. Morphologic evaluation of the apoptotic changes in RPE cells around laser injuries were determined by TUNEL staining and Annexin-V labeling. Quantitative analysis of the apoptotic changes induced by different laser energies and different times were done by flow cytometric analysis of the Annexin-V and by scoring for the incidence of apoptotic chromatin changes (TUNEL) using microscopic analysis. Results: Laser injury induced apoptosis in the RPE cells around the laser injury site, indicated by both TUNEL staining and Annexin-V labeling. An increase in the amount of apoptotic cells was found with the high laser energy power (100mW-2000mW) or with long duration of laser irradiation (0.1sec. -9.0sec.). Apoptotic changes were</p>

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	<p>first detected four hours after the laser irradiation when using Annexin-V labeling, and eight hours when using TUNEL staining. Conclusions: Laser irradiation induces apoptotic cell death in RPE cells adjacent to the laser injury site. This model is suitable for studying and screening various compounds for their anti-apoptotic efficiency in preventing laser injury.</p>
<p>HIST15 Up-Regulated Expression of SCF mRNA in the Mouse Retina After Laser Photocoagulation Kawamura H, Tanaka Y, Shiraishi A, Okamoto S,¹ Tokushige H,² Ohashi Y.¹ ¹Dept of Ophthalmology, Univ. of Ehime, Ehime, Japan; ²Research Laboratories, Senju Pharmaceutical Co., Ltd, Kobe, Japan. [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S656. Abstract nr 3478, 2000</p>	<p>Stem cell factor (SCF) is a potent growth factor affecting proliferation, differentiation and migration as well as secretory functions of various cells of different origin and function. Recently, Zhang et al reported the expression of SCF/c-kit system in neural cells after brain injury. To explore a functional role of SCF/c-kit in retinal wound healing, the authors investigated SCF mRNA expression in the mouse retina after laser photocoagulation. Mice were anesthetized with intraperitoneal injection of pentobarbital (70 mg/kg) and both pupils were dilated with 0.5% topical tropicamide and then 20 laser spots (800 nm, 0.1 sec, 200 mW) were placed around the macula of each mouse. The experimental animals were examined regularly, and sacrificed at different times. The excised tissues were then subjected to histological examination, northern blot hybridization and in situ hybridization. Results: Histological analysis revealed that the outer nuclear layer was totally disrupted 1 day after laser photocoagulation and was gradually replaced with the cells which migrated from the inner nuclear layer within 4 weeks. Northern blot hybridization showed a weak SCF mRNA expression in normal eye and up-regulated SCF mRNA expressions at 3 and 7 days after laser photocoagulation. Conclusions: Results suggest that SCF may be involved in the retinal wound healing after laser photocoagulation.</p>
<p>HIST16 Upregulation of Pigment Epithelium-Derived Factor (PEDF) Following Laser Photocoagulation Ogata N, Jo N, Wong L, Otsuji T, Matsumura M, Tombran-Tink J. Department of Ophthalmology Kansai Medical University, Osaka, Japan; George Washington University Medical Center, Washington, DC [ARVO Abstract]. Invest Ophthalmol Vis Sci.41(4): S656. Abstract nr 3488, 2000</p>	<p>The aim of this study was to examine the changes in the expression of PEDF in the RPE cells and the retina after laser photocoagulation. Human RPE cells (ARPE-19 cell line) grown to confluence were photocoagulated (0.1 second, 100 μm, 350 mW, 300 spots/Ø35 mm dish.) Following laser photocoagulation, RPE cells were harvested at 6, 24, 48, and 72 hrs for RNA isolation. Panretinal laser photocoagulation was performed on Brown Norway rats (0.05 second, 500 μm, 50 mW, 100 spots/eye.) Six hrs, 1 day, 3, 7, and 14 days after, sensory retina was collected and RNA was isolated. Reverse transcription-polymerase chain reaction (RT-PCR) and semiquantitative PCR analysis were carried out to determine the expression of PEDF. Results: mRNA expression of PEDF was upregulated in RPE cells 6 to 24 hrs after laser photocoagulation, then gradually decreased to the levels before photocoagulation. mRNA expression of PEDF was detected in normal rat retina. Upregulation of PEDF was also observed 6 hrs to 3 days after photocoagulation, then gradually decreased by 2 weeks to the levels observed in normal retinas. Conclusions: Laser photocoagulation is one of the most effective treatments for ocular angiogenic disorders. Previous studies reported that photocoagulated RPE cells secrete an angiogenic inhibitor such as TGFβ. In this study, the authors demonstrated that PEDF was expressed in the rat retina and laser photocoagulation induced the upregulation of PEDF in the RPE cells and the retina. These results indicate that PEDF can affect photocoagulation that results in the regression of the neovascularization by its antiangiogenic activity and may also protect retinal cells from the laser damage.</p>

<p>HIST17 Diode Laser Photocoagulation for Retinopathy of Prematurity: A Histopathologic Study Park P, Eagle Jr RC, Tasman WS. Ophthalmic Surg Lasers 32:63-66, 2001</p> <p><i>Also listed as ROP-LI53, pg, 220</i></p>	<p>This case describes the ocular histopathologic findings of a pair of eyes in a severely premature infant treated with diode laser photocoagulation for bilateral stage 3 ROP for 360° in zone 1 with severe plus disease. 1473 laser burns were applied to the right eye, and 1407 to the left eye. The right eye responded to treatment; the left eye developed persistent vitreous hemorrhage and total retinal detachment. At 9 months postpartum, the infant died from renal and hepatic failure. The eyes were sent to Wills Eye Hospital where they were processed routinely for light microscopy.</p> <p>The histopathologic examination of laser burns in the right eye disclosed segmental areas of chorioretinal scarring with retinal atrophy and gliosis, loss of RPE and extensive atrophy of the choroid and its vasculature. The left eye had iris neovascularization, a chronic organized vitreous hemorrhage and a totally detached retina. These results resembled those reported after transscleral cryotherapy; however, the degree of chorioretinal atrophy and scarring found in the eye treated with diode laser photocoagulation appears to be slightly less severe than cryotherapy. Compared to cryotherapy, laser therapy is relatively simple and may be safer, i.e. general anesthesia, sedation, and conjunctival incisions are not required.</p>
<p>HIST18 Dose-Dependent Histology and Heat Shock and Other Protein Expression in Transpupillary Thermotherapy of Normal Pigmented Rabbit Eyes Morimura Y,¹ Okada AA,¹ Hayashi A,² Fujioka S,² Kawahara S,¹ Hida T.¹</p> <p>MIP</p> <p>¹Department of Ophthalmology, Kyorin University School of Medicine, Tokyo, Japan, ²Department of Ophthalmology, Osaka University Medical School, Osaka, Japan [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S226. Abstract nr 1218, 2001</p> <p><i>Also listed as AMD-TTT16, pg, 22</i></p>	<p>We performed TTT in normal pigmented rabbit eyes to study dose-dependent histological changes and examine expression of heat shock proteins (HSPs), tumor necrosis factor (TNF)-α and vascular cell adhesion molecule (VCAM)-1. TTT was performed using an 810 nm diode laser with spot size 1.2 mm, power 50 mW, and varying durations of 15, 30 or 60 seconds. Eyes were enucleated 4 weeks after treatment and examined by light and electron microscopy. Immunohistochemical staining for HSP60, HSP70, TNF-α, and VCAM-1 were performed. Fundus examination both immediately and 4 weeks after treatment revealed no discernable changes at TTT sites. Electron microscopy revealed photoreceptor outer segment and retinal pigment epithelial (RPE) cell disruption; these changes were more prominent with longer durations of treatment. Eyes treated for 30 or 60 seconds also showed partial closure of the choriocapillaris. Immunohistochemical staining showed that RPE cells and anterior choroidal vessels in the area treated by TTT stained positively for HSP60, HSP70, TNF-α, and VCAM-1. Conclusions: Despite the lack of funduscopically visible changes to the retina and choroid, TTT resulted in dose-dependent changes at the cellular level in the photoreceptor outer segments, RPE cells and anterior choroid. Furthermore, positive immunohistochemical staining for HSP60, HSP70, TNF-α and VCAM-1 in the RPE and anterior choroidal vessels indicates that induction of these molecules plays a role in the tissue response to TTT in normal pigmented rabbit eyes.</p>

<p>HIST19</p> <p>Comparison of the Effects of Transpupillary Thermotherapy (TTT) of Pigmented and Albino Rabbit Retina</p> <p>MIP</p> <p>Jim KH, Park TK, Yu SY, KwaK HW. Kung Hee University; Department of Ophthalmology, Seoul, Korea [ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S444. Abstract nr 2398, 2001</p> <p><i>Also listed as AMD-TTT24, pg, 26</i></p>	<p>TTT was delivered using infrared diode laser at 810 nm (IRIS Medical) and applied with 3 mm spot size, 50 seconds duration, and 100 – 600 mW (pigmented rabbits) and 200 – 1200 mW (albino rabbits). At 1 week and 4 weeks after TTT, fundus photographs and simultaneous FAG/ICG angiogram with SLO (Rodentstock, Munich, Germany) were taken before sacrifice. Light and electron microscopic examination were performed. Results: In pigmented rabbits, visible fundus change was identified at funduscopy finding even with minimal power setting (100 mW). Obliteration of choroidal vessels was shown on ICG angiogram. In microscopic examination, entire layers of neural retina, RPE cells, and deep choroid were severely damaged at center of treated field. Whereas, in albino rabbits, fundus changes were not observed at any power setting; however focal thrombosis at margin of lesion was identified on ICG angiogram after power of 300 mW. In microscopic examination, tissue damage was developed up to 600 mW and the lesion extended into the superficial choroid posteriorly and outer neural retina anteriorly. Conclusion: The effect of TTT was increased with fundus pigmentation. Clinically we should adjust TTT power setting according to the amount of melanin pigmentation.</p>
<p>HIST20</p> <p>The Histopathologic Effects of Transpupillary Thermotherapy in Human Eyes</p> <p>MIP</p> <p>Connolly BP,¹ Regillo CD,¹ Eagle RC,² Shields CL,³ Shields JA,³ Moran H.⁴</p> <p>¹Retina Service, Wills Eye Hospital, Philadelphia, PA, ²Pathology Department, Wills Eye Hospital Philadelphia, PA, ³Oncology Service, Wills Eye Hospital Philadelphia, PA, ⁴Retina Research, Wills Eye Hospital Philadelphia, PA</p> <p>[ARVO Abstract] Invest Ophthalmol Vis Sci. 42(4): S513. Abstract nr 2763, 2001</p> <p><i>Also listed as AMD-TTT25, pg. 26</i></p>	<p>A prospective, dose-response study of TTT using an infrared diode laser at 810 nm, 2 mm spot size, 60-second duration, and power levels of 430, 530, or 630 mW. Treatment was directed to otherwise normal retinal tissue in eyes with uveal melanoma that were within 10 days of enucleation. Serial sections through the treatment sites were examined by light microscopy. Results: A total of 8 TTT spots were applied in 3 eyes. Full-thickness alterations were evident in high dose (630 mW) and medium dose (530 mW) treatment areas, especially in eyes with greater fundus pigmentation. The low dose (430 mW) treatment sites had either no damage or limited outer retinal changes. Patients described pain or had visible retinal changes (during or after treatment) only at dose levels that resulted in full-thickness histopathologic changes. Conclusions: Variable histopathologic retinal changes occur with TTT. The degree of tissue damage appears to be related to both dose level and fundus pigmentation.</p>
<p>HIST21</p> <p>Alteration of the Vascular Supply in the Rabbit Ciliary Body by Transscleral Diode Laser Cyclophotocoagulation</p> <p>Schlote T, Beck J, Rohrbach JM, Funk RHW.</p> <p>Graefe's Arch Clin Exp Ophthalmol 239;53-58, 2001</p> <p><i>Also listed as G-TS93, pg. 130</i></p>	<p>This study evaluates the alteration of the ciliary body vascularization by contact diode TSCPC (IRIS Medical OcuLight SLx and G-Probe) in pigmented chinchilla bastard rabbits. Preliminary experiments were conducted to determine the parameters for diode laser TSCPC of the pars plana or pars plicata. Then, treatment of the pars plicata (3 rabbits) or pars plana (3 rabbits) was performed in the right eye of 6 rabbits. After 2, 6 and 12 weeks, histologic and transmission electron microscopic studies were performed. Furthermore, 3 rabbits received pars plicata cyclophotocoagulation of the right and pars plana cyclophotocoagulation of the left eye. After 2, 6 and 12 weeks, vascular casts of the ciliary body were investigated by scanning electron microscopy.</p> <p style="text-align: right;"><i>continued nex page</i></p>

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	<p><u>Treatment Parameters</u> For treatment of the pars plicata that induced a homogeneous whitening of the ciliary processes: Power: 2.0 W Duration: 2.0 seconds Limbus Distance: 0.3 mm with paraxial orientation of the G-Probe.</p> <p>For treatment of the pars plana: Power: 1.0 W Duration: 2.0 seconds Limbus Distance: 1.2 mm with paraxial orientation of the G-Probe.</p> <p>Results: Histologic and transmission electron microscopic studies showed a marked coagulation necrosis with subsequent ciliary body atrophy, destruction of the ciliary epithelium, pigment dispersion in the ciliary body stroma and peripheral anterior synechiae. Examination of vascular casts of the ciliary body revealed a marked rarefication of the capillary network within the treated areas of the ciliary body in all eyes and at every time of investigation. Anterior to the laser burns, the capillary network was not markedly affected in the eyes with cyclophotocoagulation of the pars plana. After 3 months, short vessel sprouts were seen, but regeneration was mostly incomplete. Results indicate that the pressure-lowering effect of photocoagulation of the pars plicata is a synergistic effect of the direct destruction of the ciliary epithelium and the indirect, ischemic damage of ultrafiltration and ciliary epithelium caused by extensive, probably irreversible destruction of the capillary network. The pressure-lowering effect of photocoagulation of the pars plana is not caused by an extensive ischemic reaction in the pars plicata. This may support the hypothesis of increased uveoscleral outflow as the main pressure-lowering mechanism. Conclusions: The vascular casting technique is an excellent method for the investigation of changes in ciliary body vascularization after cyclodestruction. This study is the first to demonstrate a marked rarefication of the ciliary body vascularization after diode laser TSCPC using vascular casts. The results suggest that alteration of vascularization probably acts as a strong synergistic mechanism in the decrease of intraocular pressure after cyclophotocoagulation of the pars plicata.</p>
<p> HIST22 Temperature Dependence of Thermal Damage to the Sclera: Exploring the Heat Tolerance of the Sclera for Transscleral Thermotherapy Rem AI, Oosterhuis JA, Journée-de Korver H, van den Berg TJTP, Keunen JEE. Exp Eye Res 72, 153-162, 2001</p> <p><i>Also listed as OCU-TS6, pg. 180</i></p>	<p>Thermal damage to the human sclera in relation to temperature and duration of exposure was studied in order to determine the heat tolerance of the sclera with respect to TSTT of choroidal melanoma. Samples of human sclera were submerged in saline for 10 seconds to 10 minutes at temperatures of 37 – 100°C. The effects of heat on the shape, weight and size of the samples were studied. Thermal damage of scleral collagen was examined by polarized light microscopy and electron microscopy (EM). The sclera was embedded in epoxy resin and stained with toluidine blue for LM and with uranyl acetate and lead citrate for EM. Thermal damage of scleral collagen on polarized LM was graded on a 5 point scale. Scleral damage was visible on macroscopic examination and on LM and EM in scleral heated at 65°C for 20 seconds or longer, at 70°C for 10 seconds or longer, and at higher temperatures. A sigmoidal function was used to define the relation between temperature and changes in diameter, thickness, and weight of scleral samples. Using fitted functions, the</p>

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	<p>threshold temperature for thermal damage was estimated to be 59 – 61°C when samples were heated for 10 minutes, 62-63°C when heated for 1 minute, and 66 – 67°C when heated for 10 seconds. The threshold exposure time at 60°C was estimated to be 7 – 12 minutes. Conclusion: These results indicate a temperature of 60°C for 1 minute is well tolerated by human donor sclera; information of in vivo studies is required to validate whether this setting can be used in TSTT for choroidal melanoma.</p>
<p>HIST23 Transscleral Laser Thermotherapy of Hamster Greene Melanoma: Inducing Tumour Necrosis without Scleral Damage Rem AI, Oosterhuis JA, Journée-de Korver JG, van den Berg TJTP. Melanoma Research 11:503-509, 2001</p> <p><i>Also listed as OCU-TS5, pg. 179</i></p>	<p>The feasibility of using TSTT to induce necrosis of choroidal melanoma without causing damage to the sclera was investigated. Fifty-two subcutaneously implanted hamster melanomas covered by human donor sclera were irradiated for 1 minute with an 810 laser using a 3 mm spot diameter, with and without cooling of the scleral surface by water at a temperature of 18 – 20°. Immediately after irradiation, the temperature of the scleral surface was measured with an infrared camera. Irradiation at 2000 mW, without cooling of the sclera, resulted in tumour necrosis to a mean depth of 4.4 mm and a mean diameter of 5.5 mm, without causing damage to the scleral collagen. The surface temperature of the sclera was 44.5°C, and the estimated temperature at the sclera-tumour interface was 60.1°C. There was a sharp demarcation between the viable and the necrotic part of the tumour. TSTT at 2500 mW, without cooling of the sclera, caused maximal tumour necrosis to a mean depth of 5.2 mm and a mean diameter of 5.9 mm; the scleral layers adjacent to the tumour had an estimated temperature of 67.6°C and showed signs of damage in 14% of the experiments. Cooling of the sclera resulted in less thermal damage to the sclera but also less tumour necrosis. Results indicate that TSTT can induce tumour cell necrosis in pigmented melanoma to a depth of several millimeters without causing damage to the sclera. This means that in the combined treatment of brachytherapy and TTT, TSTT has potential as a new modality for treating choroidal melanoma, where it may be an alternative to brachytherapy in order to avoid radiation-induced complications.</p>
<p>HIST24 Correlation between Iris Color and Ciliary Body Pigmentation. Possible Implications for Cyclophotoablation Treatment Nesher R,¹ Meshulam H,² Assia E,¹ Zamir E,² Peer J.²</p> <p>¹Sapir Medical Center, Kfar Saba, Tel-Aviv University Medical School, Israel. ²Hadassah Hebrew University Medical School, Jerusalem, Israel. International Congress of Ophthalmology Meeting. Sydney, Australia. 2002</p> <p><i>Also listed as G-TS103, pg. 138</i></p>	<p>Cyclophotoablation is dependent on the amount of laser absorbed by the tissue, which is related to the degree of tissue pigmentation. Current guidelines for laser power adjustment during treatment are not fully determined and some patients require repeated procedures. The authors hypothesized that if a correlation between iris color and degree of pigmentation of ciliary processes exists, this information would be valuable in pre-selection of treatment parameters, and possibly lead to better results. Thirty-one enucleated eyes were studied. The pigmented epithelium of the ciliary processes was qualitatively scored for 6 histological parameters: information on iris color was received by telephone interviews in 22 cases. In 9 cases, iris color was defined from the wet tissue. Nineteen eyes had brown iris (group A) and 12 eyes had light colored iris (group B). Group A had significantly increased cell pigmentation, blurring of cell margins, number and aggregation of melanosomes, and ciliary vascularization, and significantly decreased number of vacuoles, compared to group B (Mann-Whitney test, p <0.01). These results suggest a correlation between iris color and the degree of pigmentation of the ciliary processes. Iris color may serve as one of the factors determining laser power for cyclophotocoagulation. Future studies on correlation of iris color with cyclophotocoagulation treatment results are in order.</p>

New

New

New

HIST25**Clinic and Histopathologic Study of Transpupillary Thermotherapy in Pigmented Rabbits**

Rodrigues RP¹, Magalhães E^{2A}, Nehemy MB³, Campos C^{2A}, Passos E^{2A}, Salgado M^{2B}.

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2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 2621, 2002

Also listed as AMD-TTT45, pg. 37

TTT was delivered in 40 eyes of pigmented rabbits to evaluate the macroscopic and histologic effects induced by temperature elevation of TTT in the retina and choroid. Each eye received 4 laser pulses below the medullary fibers layer, using the 810 nm wavelength with fixed spot size of 3 mm. The exposure time was variable from 17 to 66 seconds, and interrupted if there was any retinal change during the procedure. The initial power was fixed in 300 mW and reduced 20, 40, and 60%. When retinal whitening was observed on the retina, 20% of laser pulse was reduced, until there was no macroscopic alteration. Histologic examination by light microscopy was performed 24 hours and 4 weeks after treatment. Results: All lesions with even minimal macroscopic whitening during TTT showed retinal and choroidal damage. 24 hours after TTT, the histologic study showed acute retinal necrosis, interstitial edema and choroidal vessels thrombosis. Four weeks after TTT, the histologic study of the lesions showed a glial scar. Conclusion: Clinical and histologic examinations by light microscopy showed correlate results. This experimental study in pigmented rabbits shows that it is important to interrupt the TTT application before any clinical change in the fundus.

New

HIST26**Determination of Retinal Thermal Dosimetry from Transpupillary Thermotherapy****MIP**

Ibarra MS,¹ Madjarov B,¹ Glazer-Hockstein C,¹ Mainster MA,² Maguire AM,¹ Bennett J,¹ Tolentino MJ.¹

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2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4412, 2002

Also listed as AMD-TTT50, pg. 39

The purpose of this study is to determine the effect of pigmentation, choroidal blood flow, and subretinal blood on TTT-induced temperature change on the retina. Direct retinal temperature measurements were performed using an ultra-fine thermocouple on New Zealand White (albino) and Dutch Belted (pigmented) rabbit eyes undergoing TTT. TTT was performed with an 810 nm OcuLight laser on a slit lamp delivery system using a 1.2 mm spot, 60 seconds duration, and a range of power settings between 50-1000 mW. Temperature measurements were taken in eyes in the presence or absence of choroidal blood flow and in eyes with subretinal blood. Results: Threshold power settings for albino and pigmented rabbits were 950 mW and 90 mW, respectively. When albino subthreshold power settings were applied to pigmented rabbits, temperature rise was greater than 1.5 fold higher than that of albino rabbits. Temperature rise in albino eyes with subretinal blood was at least two-fold higher than in eyes without subretinal blood. There was no change in temperature rise when choroidal blood flow was occluded. Conclusion: Performing TTT on pigmented individuals or in the presence of subretinal blood should warrant a relative decrease in power setting. The presence or absence of choroidal blood flow does not alter TTT temperature rise.

<p>New</p>	<p>HIST27 Comparative Study of Visible and Infrared Light in Transpupillary Thermotherapy Ito Y¹, Sodeyama T¹, Mori K¹, Anzail K¹, Takita Y¹, Imai D¹, Shibuya M¹, Yoneya S¹, Moshfeghi DM², Peyman GA³. ¹Ophthalmology, Saitama Medical College, Saitama, Japan; ²Ophthalmology, Cleveland Clinic Foundation, Cleveland, OH; ³Ophthalmology, Tulane University Health Sciences Center, New Orleans, LA. 2002 Annual Meeting Abstract and Program Planner accessed at www.arvo.org. Association for Research in Vision and Ophthalmology. Abstract 4419, 2002</p> <p><i>Also listed as AMD-TTT56, pg. 42</i></p>	<p>TTT was performed on eyes of Japanese monkeys to study a potential effect of TTT on the retina and choroid. Seven eyes were treated with a 635-nm wavelength and 5 eyes with the 810-nm wavelength. An area of the posterior fundus 1 mm in diameter was irradiated with 635 nm with varied exposure durations ranging from 30 to 80 seconds, eventually achieving 20, 50, and 79.2 J/cm². Irradiation with the 810-nm diode laser was also performed on the posterior fundus 2 mm in diameter. The duration was set at 60 seconds and the total energy alternated between 96, 115, and 153 J/cm². Clinical evaluations were made with funduscopy and FA and ICGA before and after treatment. The animals were sacrificed either immediately or 2 weeks after the treatment and the eyes were processed for histopathological study. Results: Laser lesions were not visible by funduscopy or angiography throughout the follow-up period. The light microscopy study, however, revealed that the outer nuclear layer showed pyknotic changes which were more significant with the 810-nm wavelength. The inner segments of the photoreceptors (IS) were swollen and vacuolated. The RPE also demonstrated vacuoles. Using electron microscopy, the cytoplasm of the IS appeared watery and had vacuolated mitochondria. The intercellular spaces of the IS were enlarged. The mitochondria in the RPE were vacuolated. The choriocapillaris and large choroidal vessels were attenuated or closed in some areas 2 weeks after treatment. These findings were common at all power settings with both the 635- and 810-nm laser wavelengths. Conclusion: TTT with 635- and 810-nm wavelength diode lasers occluded choroidal vessels; however, some damage to the inner retina occurred. Therefore, the indications and irradiation settings for TTT must be chosen with careful consideration.</p>
<p>New</p>	<p>HIST28 Pathology of Cyclodiode Laser: A Series of Nine Enucleated Eyes McKelvie PA, Walland MJ. Br J Ophthalmol 86:381–386, 2002</p> <p><i>Also listed as G-TS104, pg. 138</i></p>	<p>A detailed histological examination of 9 enucleation specimens was undertaken in conjunction with a retrospective review of patient case notes to study the histological effects of cyclodiode laser treatment in humans, and to compare these findings with the clinical course, treatment response, complications, and indications for enucleation. The time to enucleation ranged from 2 weeks to 4 years 1 month after diode (median 7 months). Causes of glaucoma were neovascular glaucoma in 4, chronic open angle glaucoma in 1, chronic angle closure following penetrating keratoplasty in 1, epithelial downgrowth in 2, and absolute pseudoexfoliation glaucoma in 1. All patients received diode laser therapy with the OcuLight SLx laser.</p> <p><u>Treatment Parameters</u> Power: 1500 mW to 2200 mW Duration: 1500 ms to 2100 ms Treatment Circumference: 180°– 360° Retreatments: 3 (33%) patients received 2 or more treatments</p> <p>Although all globes showed damage to pars plicata, intact ciliary processes within the treatment zone were present in all cases. Pars plana injury was also noted in two thirds of cases. Inflammation was mild. Ciliary epithelial proliferation was seen in most cases with increasing time following treatment, in a disorganized pattern, without replication of the ciliary epithelial bilayer. No</p>

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	<p>regeneration of the ciliary processes with fibrovascular cores was found. The 3 patients with good IOP control at enucleation had all had multiple diode treatments. Neither phthisis nor sympathetic ophthalmia was seen. Conclusions: Diode laser TSCPC produces very characteristic injury to pars plicata, which frequently extends into pars plana, but with only mild persisting inflammation. Ciliary processes are, however, frequently spared within the treatment zone and may account for early or late treatment failure. Histological examination in</p>
<p> HIST29</p> <p>Pre-Enucleation Transscleral Thermotherapy in Human Uveal Melanoma Keunen JEE, Oosterhuis JA, Rem Ai, Bleeker JC, Journée-de Korver Poster P10. Meeting of the Club Jules Gonin. Montreux, Switzerland. August 31 – Sept. 4, 2002</p> <p><i>Also listed as OCU-TS7, pg. 180</i></p>	<p>This study was conducted to determine the feasibility of TSTT for the treatment of uveal melanoma by exploring the range in temperature where heat exerts a necrosis in melanoma cells but does not harm the sclera. Experimental TSTT was performed in eyes with large uveal melanomas prior to enucleation. A custom-made scleral applicator was used with diode laser output and/or hot water at temperatures of 60 to 65°centigrade for conductive transscleral heating. The diameter of the applicator on the sclera was 7 mm and the exposure time was 1 minute per application. In general, 2 applications were given onto each eye. Histopathologic examination showed varying degrees of tumor necrosis in all treated areas, with incomplete occlusion of the blood vessels. A steep border in tumor necrosis between treated and non-treated areas was only noticed after diode laser TSTT and not after TSTT with hot water. Slight or no visible microscopic changes of the scleral collagen were noticed in the treated areas at temperatures between 60 to 65°centigrades. Conclusion: TSTT in the range of 60 to 65° centigrade may have potential as a new treatment modality for uveal melanoma.</p>
<p> HIST30</p> <p>The Effect of Transpupillary Thermotherapy on the Human Macula MIP Robertson DM, Salomão DR. Arch Ophthalmol 120:648-652, 2002</p> <p><i>Also listed as AMD-TTT62, pg. 45</i></p>	<p>A case report of a 65 year old woman who had a growing pigmented choroidal lesion in her left eye that had been observed to increase in thickness from 2.3 to greater than 4 mm during an interval of 9 years. Her VA was 20/20 OD and 20/25⁺³ OS. The right eye was normal. After therapeutic options were discussed, the patient chose enucleation. She agreed to have her retina exposed to light from the infrared laser for 60 seconds using a power of 800 mW. She also agreed to undergo color fundus photography and FA of the retina before and after light exposure. Five days after laser exposure, her eye was re-examined; 3 hours thereafter, her eye was enucleated. Laser exposure of the macula failed to produce a clinically recognizable reaction in the retina during the treatment, and no changes were recognized on results of a careful clinical examination 5 days after exposure. A FA 6 days after treatment showed no difference from the FA obtained immediately before the laser exposure. Although the central VA was reduced to 20/100 immediately after exposure, 5 days after TTT, the central VA had recovered to the pretreatment VA. The authors were unable to identify TTT-induced adverse effects in the retina or the RPE by means of clinical examination or FA. However, they observed histological and ultrastructural abnormalities in the tissue after the eye was enucleated, which may be explained by the presence of the preexisting retinal edema; however, some of the observed abnormalities could have been caused by light alone. No evidence of vascular closure or</p>

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	<p>coagulative necrosis in the small capillaries in the choroid was found. The absence of recognizable destruction of the retina and retinal vasculature observed in the single experiment does not ensure that vascular closure and retinal destruction will not occur when TTT is used to treat occult CNV. However, in this case, with clinical and angiographic evidence of mild retinal edema and no retinal or subretinal blood, a 60 second exposure of 800 mW using a 3 mm beam diameter did not cause clinically recognizable damage to the macular retina, the retinal vessels or the underlying choriocapillaris and other choroidal vessels.</p>
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GENERAL INFORMATION

<p>GEN1 Diode Lasers Meet Changing Needs in Ophthalmology Arias E. Optics & Photonics News 37-40, 1992</p>	<p>This article summarizes the history, current technical challenges, first clinical use, and clinical acceptance of the diode laser and its use in ophthalmology.</p>
<p>GEN2 Diode Laser Useful for Treating Variety of Eye Problems Henahan J. Ophthalmology Times October 1, 1992</p>	<p>An interview with Dominic McHugh, FRCS, FCOphth., of Moorfields Eye Hospital in London, in which he summarizes the uses of the diode laser for treatment of LTP, DME, and PDR. He addresses what he believes are the advantages of using the diode laser over the argon laser.</p>
<p>GEN3 The Therapeutic Range of Chorioretinal Photocoagulation with Diode and Argon Lasers. An Experimental Comparison Obana A, Lorenz B, Gässler A, Birngruber R. Lasers Light Ophthalmol 4:147-156, 1992</p>	<p>Thirty-five healthy eyes of 21 gray chinchilla rabbits were used for diode and 50 healthy eyes of 30 rabbits were used for argon laser photocoagulation. Photocoagulation was performed using three different spot sizes and seven different exposure times. The threshold powers for the onset of retinal blanching and choroidal hemorrhage, respectively, were determined for spot sizes of between 100 µm and 500 µm and exposure times of from 0.015 to 0.5 seconds. Results: Diode laser lesions developed more slowly than argon laser lesions, but on color fundus photographs taken 30 minutes after treatment, similar gray, gray-white or white lesions could be observed at all spot sizes and exposure times with both lasers when exposures with identical spot size and exposure time were compared. Conclusions: Decreasing exposure time to as short as 10 ms does not decrease the therapeutic bandwidth of the diode laser; and the pattern of hemorrhage with the diode laser is different from that of the argon laser.</p>
<p>GEN4 Exposure Time Dependant Variation in Diode Laser Energy Required for Retinal Photocoagulation Balles M, Agarwal A. University of Minnesota Medical School, Minneapolis, MN [ARVO Abstract]. Invest Ophthalmol Vis Sci. 34(4): 961. Abstract nr 1276, 1993</p>	<p>An 810 nm diode laser was used to perform retinal photocoagulation with exposure durations of 2 to 500 milliseconds in Dutch-belted rabbits. Power was gradually increased for each exposure duration until a reproducible grey retinal effect was produced. Results: Similar ophthalmoscopic and histologic lesions could be created at exposure durations of 2 to 500 milliseconds. There was a striking decrease in the energy required to create similar lesions with decreasing exposure duration. More than 10 times as much energy was required at 500 ms compared to 5 ms. Conclusions: Therapeutic goals may be accomplished while minimizing undesirable collateral retinal and choroidal damage by using total energy with short pulse duration laser exposures.</p>
<p>GEN5 Light Distribution of Ocular Endophotocoagulator Probes and Its Surgical Implications Whitacre M, Timberlake G, Stein R, Stanley A, Van Vleck S, Dominick K. Lasers Surg Med 15:62-73, 1994</p>	<p>Ophthalmic endophotocoagulator probe cone angle affects the spot size, working distance, laser output power requirement, tissue exposure time, and uniformity of tissue irradiance, which all affect ease and safety of clinical use. The cone angle and irradiance distribution of several ophthalmic endophotocoagulator delivery systems were studied by directing the laser energy emitted by them on a CCD video sensor at several angles of incidence. The irradiances followed a Gaussian distribution. At highly oblique angles of incidence, wide-angle probes produce unexpectedly higher and uneven tissue</p>

Reference Catalog: Summaries of Studies

	<p>irradiance. When numerous characteristics are considered, probes with a cone angle in the range of 10° have many advantages over narrower or wider angle probes. The laser systems studied were a Coherent Novus with an endophoto-coagulator probe, an IRIS Medical OcuLight with an IRIS Medical EndoProbe®, and a Biovision Crystal Focus Emerald with a Biovision Endocular Probe™. The cone angles determined by visual fitting of the irradiances predicted by the model to the measured profiles at the 0° angle of incidence were 10° for the Coherent laser, 11° for the IRIS Medical laser, and 22° for the Biovision laser. These are close to the cone angles determined by measurements of the 1/e² points. Based on the present model, it would appear that a desirable cone angle for endophotocoagulator probes is in the 10° range we observed in two of the tested probes.</p>																
<p>GEN6 Argon, Krypton and Diode Laser Transmission through Blood Cohen D, Shen JH, Ren Q, Smiddy W. Department of Ophthalmology, Bascom Palmer Eye Institute, Miami, FL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 35(4): 1750. Abstract nr 2292, 1994</p>	<p>To determine the transmission through blood of argon, krypton, and 810 nm diode laser energy, blood anticoagulated with EDTA was prepared with hematocrits of 0%, 46%, and 99%. Each laser was calibrated with salt solution filled 0.1, 0.2 and 0.5 mm quartz cuvettes to a power transmittance of 100 mW and a spot size of 500 μm. Blood was placed on an open cuvette and treated for one minute with either 100% CO₂ or 100% O₂. The cuvette was sealed and mounted in the laser's path. The laser power transmitted through the blood was measured using a five second pulse. Microscopic examination verified that no coagulation of the blood occurred. Only the argon and krypton laser had slightly lower transmittance through oxygenated blood than deoxygenated blood. The percent power transmittance through deoxygenated packed blood cells with hematocrit of 99% is listed below:</p> <table border="1"> <thead> <tr> <th>Cuvette</th> <th>Argon</th> <th>Krypton</th> <th>Diode (810 nm)</th> </tr> </thead> <tbody> <tr> <td>0.1 mm</td> <td>4</td> <td>50</td> <td>60</td> </tr> <tr> <td>0.2 mm</td> <td>0</td> <td>25</td> <td>35</td> </tr> <tr> <td>0.5 mm</td> <td>0</td> <td>6</td> <td>12</td> </tr> </tbody> </table> <p>Conclusions: The krypton laser and the diode laser transmit power through a thin film of blood.</p>	Cuvette	Argon	Krypton	Diode (810 nm)	0.1 mm	4	50	60	0.2 mm	0	25	35	0.5 mm	0	6	12
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<p>GEN7 Laser Photocoagulation of the Choroid Through Experimental Subretinal Hemorrhage Johnson M, Hassan T, Elner V. Arch Ophthalmol 113:364-370, 1995</p>	<p>Autologous, heparinized whole blood was injected beneath the neurosensory retina of pigmented rabbit eyes. After 30 to 60 minutes, confluent patches of moderate or severe diode, krypton, or argon laser burns were applied to adjacent healthy retina and continued into the region of the subretinal hematoma without varying the power setting or focal plane. Retina overlying treated subretinal hemorrhage showed no ophthalmoscopically visible signs of photocoagulation with diode energy, a faint gray reaction with krypton energy, and an intense white reaction with argon energy. Histopathologic analysis revealed photocoagulative inner choroidal damage beneath a mean (±SD) maximum blood thickness of 0.56±0.14 mm with severe diode burns, 0.42±0.09 mm with severe krypton burns, and 0.22±0.04 mm with severe argon burns. These data demonstrate that laser penetration of subretinal blood increases with longer wavelengths in vivo. Diode infrared laser energy is capable of penetrating subretinal blood to coagulate the choroid in the absence of ophthalmoscopically visible changes in the overlying retina.</p>																

Infrared Diode Laser Applications

<p>GEN8 Effect of Photocoagulation on Laser Power Transmission Through Human Retina Cohen SM,¹ Weishaar PD,² Murray TG.² ¹Tampa, FL; ²Bascom Palmer Eye Institute, Miami, FL [ARVO Abstract]. Invest Ophthalmol Vis Sci. 36(4): S833. Abstract nr 3843, 1995</p>	<p>In eight cadaver eyes, argon, krypton, and diode infrared laser were used to create mild gray or intense white confluent macular treatment zones. The retina was then removed from underlying RPE cells and choroid, and the percentage of retinal power transmission was measured compared to adjacent control retina. Control retinal transmission of the beam was 3.9 mW for argon green to 5.0 mW for krypton red and diode infrared lasers. Compared to untreated retina, the mean power transmission of argon green, krypton red, and diode laser was respectively reduced to 61%, 71%, and 71% by mild gray photocoagulation; and to 45%, 56%, and 53% by intense white photocoagulation. After initial photocoagulation, subsequent laser energy delivery through the same retinal tissue is diminished substantially and proportionally to the degree of retinal whitening. This implies that significant energy will be dissipated during re-photocoagulation. Longer wavelength lasers penetrate photocoagulated retina better.</p>
<p>GEN9 Lasers in Ophthalmology Krauss J, Puliafito C. Lasers Surg Med 17:102-159, 1995</p>	<p>This article reviews the principle uses of ophthalmic lasers, providing historical background with an emphasis on new applications and areas of investigation. Ophthalmic photocoagulation was the first medical laser application and has restored or maintained vision in millions of people. More recently, photodisruption and, increasingly, ablation have gained prominence for treating a wide range of ocular pathology. Many ophthalmic applications of lasers have been developed, but the field is a dynamic one which continues to evolve along with laser technology itself.</p>
<p>GEN10 Diode Lasers in Ophthalmology. A Review Article Barak A, Ashkenasi I, Belkin M. Middle East Journal of Ophthalmology 3:105-112, 1995</p> <p>Abstract - French/Arabic/English Article - English</p>	<p>This article introduces the reader to the physical properties of 780-850 nm diode lasers, their tissue interaction, and their use in treating retinal and glaucoma disorders. Because diode lasers are small, portable, versatile, and require minimal energy that can be supplied by standard house currents, the use of diode lasers by ophthalmologists is becoming increasingly common around the world.</p>
<p>GEN11 Laser de Diode Carlos de Miranda Goncalves J. Arq. Bras. Oftal. 59(1):103-104, 1996</p> <p>Article - Portuguese</p>	<p>This article summarizes clinical applications for the infrared (810 nm) wavelength. Plus, it reviews the use of the various delivery devices available for the diode laser.</p>

New

**GEN-12 Theoretical Bases of
Non-Ophthalmoscopically Visible
Endpoint Photocoagulation**

MIP

Lanzetta P, Dorin G, Pirracchio A,
Bandello R
Semin in Ophthalmol 16(1):008-011,
2001

Laser photocoagulation is a photothermal process in which heat is produced by the absorption of laser energy by targeted tissues. The purpose of the treatment is to induce thermal therapeutic damage, which causes biological reactions and ultimately beneficial effects. The current endpoint of laser photocoagulation of the chorioretina is an ophthalmoscopically visible retinal whitening. Retinal blanching is the sign that the retina itself has been thermally damaged and results in a number of undesired adverse events. The mechanisms underpinning the efficacy of laser photocoagulation are still poorly understood. However, recent hypotheses postulate that full thickness retinal damage may not be needed to obtain beneficial therapeutic effectiveness.

Preliminary studies with laser photocoagulation on animals demonstrated the ability to create therapeutic lesions confined around the RPE cells without causing apparent damage to the overlying retina. The laser impacts were not visible by slit lamp biomicroscopy at the time of laser delivery. Recent experiments showed that the beneficial effect of retinal photocoagulation is mediated by factors derived from the RPE. Non Ophthalmoscopically Visible Endpoint Photocoagulation (NOVEP) protocols might allow treatments that confine minimal therapeutic damage around the cells of the RPE and minimize the damage to the neurosensory retina.

In NOVEP treatments with repetitive MicroPulse photocoagulation, the RPE damage is accomplished through damage additivity rather than through an absolutely "right" temperature rise and this represents an important reassuring factor in successfully and reliably completing invisible clinical treatments. By choosing the proper laser wavelength, pulse duration and shape, and irradiance it is possible to administer effective minimally invasive treatments with NOVEP protocols. Diode laser MicroPulse photocoagulation represents a viable modality for the precise control and spatial confinement of laser lesions and may become the technique of choice for performing minimally invasive, retina-sparing NOVEP treatments of RPE-related retinal diseases in clinical practice.

