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Introduction:
We reasoned that greater precision and safety in retinal photocoagulation might be achieved by delivering a multiplicity of spots in a pattern created by a scanner rather than a series of individually placed lesions. We also wondered whether the pattern application time and patient discomfort could be further reduced by using shorter pulses than the conventional 100 milliseconds to 200 milliseconds recommended in the DRS and ETDRS.

Materials and Method:
Standard Zeiss SL 130 slit lamp, 514 nm argon ion laser, Pentium III PC running under MS Windows 2000 coordinated pulse duration; safety shutter control; scanner positioning; pattern geometry and aiming beam intensity. Scanning was achieved by mirrors mounted on a two-axis galvanometric scanner. Ten New Zealand Red/Hybrid rabbits anesthetized using ketamine, hydrochloride, xylazine, and glycopyrrolate, administered 30 minutes prior to procedure. Pupillary dilation achieved with one drop of 1% tropicamide and one drop of 2.5% phenylephrine hydrochloride. Single spots with pulse durations of 10ms, 20ms, 50ms, 100ms were used to determine threshold power levels required to achieve clinically acceptable standard lesion. Mainster contact lens was used. Spot diameter (in air) = 200 μm with top-hat beam profile. Spot size on retina ≈ 130 μm.

Patterns used:
4x4 array delivered. Post tx: sections of 1 μm in thickness were stained with toluidine blue and examined by light microscopy.

Conclusion:
Patterned photocoagulation with shorter pulses offers the following potential advantages compared with conventional manual application of single spots: (a) significantly improved efficiency, (b) increased safety with a central fixation spot and foveal exclusion zone, (c) increased uniformity and precision of spot placement, (d) more accurate placement of “subthreshold” lesions in a grid pattern, and (d) possible reduced pain and visual field defects due to reduced heat diffusion toward the choroid and inner retina.

Significance:
This pre-Pascal launch in vivo study forms the basis of the Pascal Method of pattern scanning & short pulse duration. The study demonstrated the efficacy, safety & accuracy of the Pascal Method parameters.
PASCAL Clinical and Pre-Clinical Article Abstracts

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Mark S Blumenkranz, Daniel Yellachich, Dan E Andersen, Michael W Witberger, David Mordaunt, George R Marcellino, Daniel Palanker.


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This pre-Pascal launch in vivo study forms the basis of the Pascal Method of pattern scanning & short pulse duration. The study demonstrated the efficacy, safety & accuracy of the Pascal Method parameters.

Objective:
Evaluate laser beam size, power and pulse duration of 1 to 100 ms on the characteristics of ophthalmoscopically visible retinal coagulation lesions.

Methods:
A 532-nm Nd:YAG laser was used to irradiate 36 retinas in Dutch Belt rabbits with retinal beam sizes of 66, 132 and 330 µm. Lesions were clinically graded 1 minute after placement, their size measured by digital imaging and their depth assessed histologically at different time points.

Conclusions:
At shorter pulse durations, the width and axial extent of the retinal lesions are smaller and less dependent on variations in laser power than at longer durations. The width of the therapeutic window, a measure of relative safety, increases with the beam size.

Significance:
Pulse durations of approximately 20 ms represent a optimal compromise between the favorable impact of speed, higher spatial localization and reduced collateral damage on one hand, and sufficient width of the therapeutic window (>3) on the other.


Objective:
To systematically assess the changes in retinal morphology during the healing of retinal photocoagulation lesions of various clinical grades.

Methods:
Rabbits were irradiated with a 532-nm Nd:YAG laser with a beam diameter of 330 µ at the retinal surface, a power of 175 mW, and pulse durations between 5 an 100 ms. Retinal lesions were clinically graded 1 minute after placement as invisible, barely visible, light, moderate, intense, very intense and rupture and were assessed histologically at six time points from 1 hour to 4 months.

Conclusions:
The decreasing width of the retinal damage zone suggests that photoreceptors migrating from unaffected areas fill in the gap in the photoreceptor layer. Laser photocoagulation parameters can be specified to avoid not only the inner retinal damage, but also permanent disorganization and scarring in the photoreceptor layer. These data may facilitate studies to determine those aspects of laser treatment necessary for beneficial clinical response and those that result in extraneous retinal damage.

Significance:
This study showed that by altering the pulse duration it is possible to alter the healing characteristics of the retina tissues, whereby shorter pulse duration limits collateral damage as well as encourage photoreceptor cell migration to lesion areas.


Background:
The Pascal is a semiautomated photocoagulator that delivers a pattern array of multiple burns in a rapid predetermined sequence with a single foot pedal depression. Each burn is reduced to 10 or 20 ms to achieve this. The authors report their early experience with the system.

Methods:
75 procedures done in 60 patients divided into four groups – group A, patients undergoing panretinal photocoagulation (PRP); group B, patients undergoing focal or modified grid macular laser; group C, patients undergoing macular grid and group D, patients undergoing retinopexy – were retrospectively studied.

Conclusions:
Although the shorter pulse duration of the Pascal necessitates the use of a higher power, it is not associated with adverse effects. The results here suggest that the Pascal photocoagulator is safe and effective, and offer several potential advantages related to the brief exposure time. No adverse effects noted when patterns were fired upon blood vessels or old laser burns.

Significance:
This first published study on experience with Pascal demonstrated the potential to reduce overall treatment duration, thereby reducing cost to hospital and patient, while at the same time, offering precision, safety, comfort and efficiency.


Conclusions:
A new PASCAL laser photocoagulator (OptiMedica, USA) was clinically tested. A total of 38 laser interventions were performed in 38 eyes with diabetic retinopathy (n = 25), peripheral retinal dystrophy (n = 2), retinal ruptures (n = 2), hemophthalmos (n = 3), primary open-angle glaucoma (n = 5), and ectopic pupil (n = 1). An example of successful use of the new laser unit for pupilloplasty for the ectopic pupil is given.
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Purpose:
To analyze the benefits, efficacy, and complications of the PASCAL photocoagulation laser system (OptiMedica, Santa Clara, CA, USA) in patients treated at our institution.

Methods:
We conducted a retrospective chart review of 19 patients (28 eyes) who underwent laser treatment using the PASCAL photocoagulation system from November 2006 to November 2007. These 28 eyes were divided into two groups; group 1 eyes underwent macular grid laser and group 2 eyes underwent panretinal photocoagulation. Treatment was performed for macular edema or for iris or retinal neovascularization. Outcomes measured included best-corrected visual acuity (BCVA), efficacy of laser treatment, complications, duration of the procedure, and pain perception, which were noted in the charts for panretinal treatments.

Conclusions:
Retinal photocoagulation by the PASCAL laser has comparable efficacy to historical results with conventional retinal photocoagulation in short-term follow-up. PASCAL photocoagulation can be performed quicker with less discomfort for patients.

Significance:
Another Pascal study demonstrating similar efficacy to conventional laser while being less painful for patients.


Purpose:
To establish safe laser parameter standards for 10–30 ms Pascal laser in clinical practice and to evaluate clinical and visual outcomes using this 532-nm multi-spot photocoagulation system.

Methods:
Retrospective observational case series of 313 patients treated between 2006 and 2008. Evaluation of eight groups: A-panretinal photocoagulation (PRP) for proliferative diabetic retinopathy (PDR); B-focal laser treatment for clinically significant diabetic macular oedema; C-grid laser for diffuse diabetic macular oedema; D-sector PRP for ischaemic branch retinal vein occlusion (I- BRVO); E-full PRP for ischaemic central retinal vein occlusions (I-CRVO); F-macular laser treatment for macular oedema secondary to non-ischaemic BRVO; G-full PRP for neovascular age-related macular degeneration (NVG) secondary to I- BRVO, I-CRVO or PDR; H-laser retinopexy for retinal breaks/ degenerations.

Results:
Mean LogMAR visual acuity for all procedures improved postlaser (p = 0.065), and laser prevented visual loss in 85% eyes. Topical anaesthesia was only required. At mean follow up of 5 months, 72% procedures had a successful clinical outcome. Significantly higher powers were required for PRP using Pascal compared to conventional laser (p = 0.001) in PDR, I-BRVO, I-CRVO and NVG. Sixty-seven per cent of patients (15/20) were successfully treated with single-session 20-ms PRP using a mean 1952 burns. There were no laser-associated adverse effects or ocular complications associated with multi-spot PRP or macular Pascal arrays.

Conclusions:
The clinical efficacy using 10– to 30-ms pulse duration Pascal laser is comparable to conventional standard protocols used for the treatment of vascular retinal disorders. Higher power, 10– to 30-ms pulse duration laser may be safely and effectively used in clinical practice.

Significance:
This retrospective observational study demonstrates the clinical efficacy & safety of Pascal’ s shorter pulse duration & higher power compared to conventional standard protocols used for treatment of various retinal vascular disorders. This study also shows the safety of Pascal’ s macula grid pattern.


Purpose:
To report the safety and incidence of adverse effects, during and after a successful photocoagulation for different pathologies using a Pattern Scan Laser (PASCAL) system and its modified settings.

Methods:
This was a retrospective study. We reviewed the clinical records of all laser sessions performed with PASCAL from November 2007 to July 2008. Where there were any complications, we recorded the laser parameters, type, affected retina region, postoperative interval and treatment if required.

Results:
There were 1301 consecutive cases. Complications included 17 cases of retinal bleeding (1.3%), two cases of choroidal detachment (0.15%) and one case of exudative retinal detachment (0.07%). There was no statistical difference between the laser parameters used in patients with or without complications.

Conclusions:
The laser parameters for PASCAL are safe. The complications and adverse effects encountered in this series are similar to those reported in other studies.

Significance:
Another study showing that the laser parameters for PASCAL are safe, with the rate of complications and adverse effects similar to those reported in other studies.
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Significance:
Another study showing that the laser parameters for PASCAL are safe, with the rate of complications and adverse effects similar to those reported in other studies.
Aim:
To systematically refine and recommend parameter settings of spot size, power, and treatment duration using the PASCAL® photocoagulator, a multi-spot, semi-automated, short-duration laser system.

Materials and Methods:
A retrospective consecutive series with 752 Caucasian eyes and 1242 laser procedures over two years were grouped into, (1) 374 macular focal / grid photocoagulation (FP), (2), 666 panretinal photocoagulation (PRP), and (3) 202 barrage photocoagulation (BP). Parameters for power, duration, spot number, and spot size were recorded for every group.

Results:
Power parameters for all groups showed a non-gaussian distribution; FP group, median 190 mW, range 100 - 950 mW, and PRP group, median 800 mW, range 100 - 2000 mW. On subgroup comparison, for similar spot size, as treatment duration decreased, the power required increased, albeit in a much lesser proportion than that given by energy = power x time. Most frequently used patterns were single spot (89% of cases) in FP, 5 x 5 box (72%) in PRP, and 2 x 2 box (78%) in BP. Spot diameters as high as 700 μm on retina were given in the PRP group. Single session PRP was attempted in six eyes with a median spot count of 3500.

Conclusion:
Overall, due to the small duration of its pulse, the PASCAL® photocoagulator tends to use higher powers, although much lower cumulative energies, than those used in a conventional laser. The consequent lesser heat dissipation, especially lateral, can allow one to use relatively larger spot sizes and give more closely spaced burns, without incurring significant side effects.

Significance:
Paper demonstrating Pascal parameters causes less collateral damage compared to conventional laser.

Purpose:
The purpose of this study was to compare the efficacy, collateral damage, and convenience of panretinal photocoagulation for proliferative diabetic retinopathy or severe nonproliferative diabetic retinopathy using a 532-nm solid-state green laser (GLX) versus a multispot 532-nm pattern scan laser (PASCAL).

Methods:
This study was a prospective randomized clinical trial. Sixty patients with bilaterally symmetrical proliferative diabetic retinopathy or severe nonproliferative diabetic retinopathy participated. Each patient underwent panretinal photocoagulation: one eye with GLX and the other with PASCAL, two sittings per eye. Grade 3 burns with a 200-μm spot size were placed with both modalities. The fluence, pain using the analog scale reading for GLX was 4.6, whereas that for PASCAL was 0.33. Heidelberg retinal angiography images showed the spot spread as being 430 versus 310 μm at 3 months with GLX and PASCAL. The eyes treated with PASCAL showed higher average retinal sensitivity in the central 15 ° and 15 ° to 30 ° zones (25.08 and 22.08 dB, respectively) than the eyes treated with GLX (23.16 and 17.14 dB), respectively.

Conclusion:
Pattern scan laser showed lesser collateral damage and similar regression of retinopathy compared with GLX. Pattern scan laser treatment was less time consuming and less painful for the patient compared with GLX.

Significance:
This is the first published peer-reviewed prospective randomised study comparing PASCAL with conventional laser (GLX). The results showed that PASCAL results in similar retinopathy regression while causing less collateral damage, less pain and less time compared to GLX.
The First Truly Pattern Scanning Laser-Evolved

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Results:
Pattern scan laser and GLX required an average fluence of 40.33 vs 191 J/cm2, respectively. Average time required per sitting was 1.43 minutes with PASCAL and 4.53 minutes with GLX. Average visual analog scale reading for GLX was 4.6, whereas that for PASCAL was 0.33. Heidelberg retinal angiography images showed the spread as being 430 versus 310 μm at 3 months with GLX and PASCAL. The eyes treated with PASCAL showed higher average retinal sensitivity in the central 15 ° and 15 ° to 30 ° zones (25.08 and 22.08 dB, respectively) than the eyes treated with GLX (23.16 and 17.14 dB), respectively.

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Purpose:
To evaluate the visual acuity (VA) and optical coherence tomography thickness results of short-duration pattern scanning laser macular photocoagulation in the treatment of clinically significant macular edema because of diabetes.

Methods:
Consecutive retrospective analysis of VA and optical coherence tomographic data from eyes treated in a modified Early Treatment Diabetic Retinopathy Study style using a short-duration pattern scanning laser.

Results:
A total of 100 eyes from 70 patients met study criteria. All subjects were treated with the same PASCAL (pattern scanning laser) photocoagulation unit. Parameters varied according to media and pigmentation status, but typical settings were 100-mm spot size, 10-millisecond pulse duration, 225-mW power, and 29 J/cm² fluence to give a pale but visible lesion. At 4 months posttreatment, there was an average improvement in VA of 0.060 logMAR (an improvement from 20/45 to 20/40, or approximately 3 Early Treatment Diabetic Retinopathy Study letters; P = 0.0007) and a reduction of central optical coherence tomographic thickness of 40 μm and 37 μm (spectral domain and time domain optical coherence tomography groups, respectively), both of which were statistically significant (P = 0.0049 and 0.012, respectively).

Conclusion:
Short-duration PASCAL macular photocoagulation has a biological treatment effect at 4 months for the treatment of clinically significant macular edema. While caution must be used when converting between different VA measurement methods and when using literature-based controls, the observed VA improvement seems equivalent to 3 Early Treatment Diabetic Retinopathy Study letters. These findings are similar to the recently published results from the diabetic retinopathy clinical research network cohort. PASCAL laser photocoagulation for clinically significant macular edema appears safe and effective in the short term and may have significant long-term advantages.
Purpose: To evaluate the effects of Pascal multi-spot panretinal photocoagulation given in a single-session (SS-PRP) vs single-spot multiple-session PRP (MS-PRP) on proliferative diabetic retinopathy (PDR).

Methods: Single-center randomized clinical trial of 40 eyes. Proliferative diabetic retinopathy was treated with a 400-mum spot size in 1500 burns given either as Pascal in 20-millisecond SS-PRP or in 3 sessions (100-millisecond MS-PRP) during a 4-week period. Visual acuity, central subfield retinal thickness (CRT), and 24-2 Swedish interactive threshold algorithm visual fields were recorded at baseline and 4 and 12 weeks. MAIN OUTCOME MEASURES: Central subfield retinal thickness, mean deviation.

Results: There was a significant increase in mean CRT with MS-PRP (22 mum at 4 weeks, 95% CI, -32.25 to -10.75; 20 mum at 12 weeks, 95% CI, -28.75 to -10.82; P < .001) and no significant increase in the SS-PRP group. The mean deviation increased significantly in the SS-PRP group after 4 weeks (0.73 dB, P = .048), with no significant changes in either group at other points. A positive effect on PDR was observed in 74% of eyes in the SS-PRP group vs 53% in the MS-PRP group (P = .31). Mean treatment time for SS-PRP was 5.04 minutes (SD, 1.5 minutes) compared with 59.3 (SD, 12.7 minutes) in the MS-PRP group (P < .001).

Conclusions: There were no adverse outcomes (CRT, visual acuity, or visual field) from using multi-spot SS-PRP vs single-spot MS-PRP at 12 weeks post laser, and treatment times were significantly shorter for multi-spot SS-PRP. Pascal SS-PRP was as effective as MS-PRP in the treatment of PDR.

Significance: SS-PRP may be performed safely and rapidly with same efficacy as MS-PRP with the advantage of significantly shorter treatment time and no increase in mean CRT compared to MS-PRP.

Purpose: To evaluate pain responses following Pascal 20 ms multi-spot and 100 ms single-spot panretinal photocoagulation (PRP).

Methods: Single-centre randomised clinical trial. 40 eyes of 24 patients with treatment-naive proliferative diabetic retinopathy randomised to 20 and 100 ms PRP under topical 0.4% oxybuprocaine. A masked grader used a pain questionnaire within 1 h (numerical pain score (NPS)) and 1 month after treatment (numerical headache score (NHS)). Primary outcome measure was NPS immediately post-PRP. Secondary outcome measures were mean NHS scores and levels of photophobia reported within 4 weeks of primary PRP.

Results: Mean laser fluence was significantly lower using 20 ms PRP (4.8 J/cm2) compared to 100 ms PRP (11.8 J/cm2; P<0.001). Mean NPS scores for treatment were 2.4 (2.3) (mild) for 20 ms PRP group compared to 4.9 (3.3) (moderate) in 100 ms PRP group- a significant difference (95% CI 4.3 to 0.68; p=0.006). Mean NHS score within 1 month was 1.5 (2.7) in 20 ms PRP group compared to 3.2 (3.5) in the 100 ms PRP group (p<0.05). The median duration of photophobia after 20 ms PRP was 3 h, and significantly less compared to 100 ms PRP after which 72 h of photophobia was reported (p<0.001).

Conclusions: Multi-spot 20 ms PRP was associated with significantly lower levels of anxiety, headache, pain and photophobia compared to 100 ms single-spot PRP treatment. Possible reasons include lower fluence, shorter-pulse duration, and spatial summation of laser nociception with multi-spot Pascal technique.

Significance: 20-ms multi-spot single session Pascal PRP is associated with significantly less pain, headaches & photophobia compared to conventional 100-ms single-spot multiple session PRP.
Purpose: To evaluate the effects of Pascal multi-spot panretinal photocoagulation given in a single-session (SS-PRP) vs single-spot multiple-session PRP (MS-PRP) on proliferative diabetic retinopathy (PDR).

Methods: Single-center, randomized clinical trial of 40 eyes. Proliferative diabetic retinopathy was treated with a 400-mum spot size in 1500 burns given either as Pascal in 20-millisecond SS-PRP or in 3 sessions (100-millisecond MS-PRP) during a 4-week period. Visual acuity, central subfield retinal thickness (CRT), and 24-2 Swedish interactive threshold algorithm visual fields were recorded at baseline and 4 and 12 weeks. MAIN OUTCOME MEASURES: Central subfield retinal thickness, mean deviation.

Results: There was a significant increase in mean CRT with MS-PRP (22 mum at 4 weeks, 95% CI, -32.25 to -10.75; 20 mum at 12 weeks, 95% CI, -28.75 to -10.82; P < .001) and no significant increase in the SS-PRP group. The mean deviation increased significantly in the SS-PRP group after 4 weeks (0.73 DB, P = .048), with no significant changes in either group at other points. A positive effect on PDR was observed in 74% of eyes in the SS-PRP group vs 53% in the MS-PRP group (P = .31). Mean treatment time for SS-PRP was 5.04 minutes (SD, 1.5 minutes) compared with 59.3 (SD, 12.7 minutes) in the MS-PRP group (P < .001).

Conclusions: There were no adverse outcomes (CRT, visual acuity, or visual field) from using multi-spot SS-PRP vs single-spot MS-PRP at 12 weeks post laser, and treatment times were significantly shorter for multi-spot SS-PRP. Pascal SS-PRP was as effective as MS-PRP in the treatment of PDR.

Significance: SS-PRP may be performed safely and rapidly with same efficacy as MS-PRP with the advantage of significantly shorter treatment time and no increase in mean CRT compared to MS-PRP.
The First Truly Pattern Scanning Laser-Evolved

Methods:
A prospective study was performed on 50 patients (100 eyes), in whom proliferative diabetic retinopathy was diagnosed recently. Two eyes of an individual patient were randomly assigned, one for a single session of panretinal photocoagulation using pattern scan laser and the other for multiple sessions of conventional laser.

Results:
Our study confirms that single session is effective and even better than conventional laser in relation to the effect of treatment.

Conclusion:
Complications and the associated pain are less; thus, the patient’s acceptance of PASCAL was high, and single session was well tolerated with topical anaesthesia alone.

Significance:
Study shows that Pascal’s single session PRP obtained better results (less pain, better patient acceptance, less complications) compared to multiple session conventional laser PRP.

Background:
Panretinal photocoagulation remains the gold standard for treatment of proliferative diabetic retinopathy, which can be done in a single session or in multiple sessions. However, because of different reasons, single session is less frequently practiced. We describe the results of a single session of pattern scan laser versus multiple sessions of conventional laser in cases of proliferative diabetic retinopathy.

Aims:
To quantify the 20-ms Pattern Scan Laser (Pascal) panretinal laser photocoagulation (PRP) ablation dosage required for regression of proliferative diabetic retinopathy (PDR), and to explore factors related to long-term regression.

Methods:
We retrospectively studied a cohort of patients who participated in a randomised clinical trial, the Manchester Pascal Study. In all, 36 eyes of 22 patients were investigated over a follow-up period of 18 months. Primary outcome measures included visual acuity (VA) and complete PDR regression. Secondary outcomes included laser burn dosimetry, calculation of retinal PRP ablation areas, and effect of patient-related factors on disease regression. A PDR subgroup analysis was undertaken to assess all factors related to PDR regression according to disease severity. Results: There were no significant changes in logMAR VA for any group over time. In total, 10 eyes (28%) regressed after a single PRP. Following top-up PRP treatment, regression rates varied according to severity: 75% for mild PDR (n=6), 67% for moderate PDR (n=14), and 43% in severe PDR (n=3). To achieve complete disease regression, mild PDR required a mean of 2187 PRP burns and 264 mm² ablation area, moderate PDR required 3998 PRP burns and area 456 mm², and severe PDR needed 6924 PRP laser burns (536 mm²; P<0.05).

Conclusion:
Multiple 20-ms PRP treatments applied over time does not adversely affect visual outcomes, with favourable PDR regression rates and minimal laser burn expansion over 18 months. The average laser dosimetry and retinal ablation areas to achieve complete regression increased significantly with worsening PDR.
Background: Panretinal photocoagulation remains the gold standard for treatment of proliferative diabetic retinopathy, which can be done in a single session or in multiple sessions. However, because of different reasons, single session is less frequently practiced. We describe the results of a single session of pattern scan laser versus multiple sessions of conventional laser in cases of proliferative diabetic retinopathy.

Methods: A prospective study was performed on 50 patients (100 eyes), in whom proliferative diabetic retinopathy was diagnosed recently. Two eyes of an individual patient were randomly assigned, one for a single session of panretinal photocoagulation using pattern scan laser and the other for multiple sessions of conventional laser.

Results: Our study confirms that single session is effective and even better than conventional laser in relation to the effect of treatment.

Conclusion: Complications and the associated pain are less; thus, the patient’s acceptance of PASCAL was high, and single session was well tolerated with topical anesthesia alone.

Significance: Study shows that Pascal’s single session PRP obtained better results (less pain, better patient acceptance, less complications) compared to multiple session conventional laser PRP.
Objective: To report the evolution of pattern scanning laser (PASCAL) photocoagulation burns in the treatment of diabetic retinopathy, using Fourier-Domain optical coherence tomography (FD-OCT) and fundus autofluorescence (AF), and to evaluate these characteristics with clinically visible alterations in outer retina (OR) and retinal pigment epithelium (RPE).

Methods: Standard red-free and colour fundus photography (FP), FD-OCT, and fundus camera-based AF were performed in 17 eyes of 11 patients following macular and panretinal photocoagulation (PRP).

Conclusions: Using high-resolution FD-OCT and AF, ophthalmoscopically invisible and threshold PASCAL burns within outer retina and RPE may be accurately localized and mapped by AF and FD-OCT.

Significance: Another study showing limited collateral damage with PASCAL burns while even invisible burns were easily located with AF & FD-OCT.

Results: Morphologic changes secondary to grid laser treatment.

Participants: Thirteen treatment-naïve patients with clinically significant macular edema in type 2 diabetes.

Methods: Patients were treated with focal macular photocoagulation. Changes in the localization of hyperreflective foci were analyzed by spectral domain (SD) optical coherence tomography (OCT) during follow-up at day 1, week 1, and months 1, 2, 3, and 4 in defined areas. Further, fundus photography and infrared imaging were performed at all visits and findings were correlated to OCT results. Main Outcome Measures: Changes in retinal morphologic features detected in OCT.

Results: A dynamic change in the distribution pattern of hyperreflective foci was observed over 4 months after the photocoagulation. With the decrease of retinal thickness, the dots either resolved completely or became confluent at the apical border of the outer nuclear layer, and finally formed ophthalmoscopically detectable hard exudates during extended follow-up. In the event of retinal thickening despite laser treatment, the hyperreflective dots maintained their previous distribution throughout all retinal layers. As a fourth response, dissemination of plaques of hard exudates into multiple, separate, hyperreflective foci were detected.

Significance: Hyperreflective foci in the retina seem to represent precursors or components of hard exudates. Their specific localization depends greatly on the presence of microvascular extravasation and intraretinal fluid accumulation. Retinal photocoagulation has a major impact on retinal edema and subsequently on the distribution of intraretinal lipid deposits.

Conclusions: Study using SD-OCT showed impact of Pascal lasering on lipid exudates in diabetic macular edema patients.

Purpose: To analyze immediate in vivo intraretinal morphologic changes secondary to standardized grid photocoagulation using spectral domain optical coherence tomography (SD OCT).

Participants: 13 consecutive patients with treatment-naïve clinically significant diabetic macular edema (DME).

Methods: Before and 1 day after standardized grid photocoagulation using the PASCAL system, Spectralis OCT examinations based on an eye-tracking system, infrared fundus imaging, color fundus photography, and biomicroscopy were performed. A standardized visual acuity assessment (ETDRS protocol) and fluorescein angiography were performed at baseline.

Main Outcome Measures: Morphologic changes secondary to grid laser treatment.

Results: One day after laser therapy, immediate morphologic alterations of only the retinal pigment epithelium (RPE), the photoreceptor layer (PRL), and the outer nuclear layer (ONL), were observed. The shape of the laser-induced lesions did not show a sagittal alteration pattern throughout all 3 of the layers, however, but rather seemed to follow an oblique pathway throughout the ONL, changing direction at the level of the external limiting membrane and proceeding sagittally through the PRL and RPE. These morphologic changes also induced biometric changes, such as a decrease in central retinal thickness combined with local thickening at the lesion site, especially in the PRL.

Conclusions: Spectral domain optical coherence tomography provides new insight into the immediate morphologic changes after laser treatment using the PASCAL laser system. Standardized grid photocoagulation induces characteristic homogenous alteration in the neurosensory retinal layers. Biometric changes, indicating an immediate effect, were observed within 1 day after treatment.

Significance: This is the first study that analyse the immediate in vivo morphologic retinal changes secondary to standardized grid photocoagulation using SD-OCT. This is also a first study to show the unique burns morphology post-grid photocoagulation with the PASCAL grid arrays patterns.
Methods:
Thirteen treatment-naïve patients with clinically significant macular edema in type 2 diabetes.

Purpose:
To study the changes in the distribution and morphologic features of intraretinal microexudates after macular photocoagulation.

Participants:
Thirteen treatment-naïve patients with clinically significant macular edema in type 2 diabetes.

Methods:
Patients were treated with focal macular photocoagulation. Changes in the localization of hyperreflective foci were analyzed by spectral domain (SD) optical coherence tomography (OCT) during follow-up at day 1, week 1, and months 1, 2, 3, and 4 in defined areas. Further, fundus photography and infrared imaging were performed at all visits and findings were correlated to OCT results. Main Outcome Measures: Changes in retinal morphologic features detected in OCT.

Results:
A dynamic change in the distribution pattern of hyperreflective foci was observed over 4 months after the photocoagulation. With the decrease of retinal thickness, the dots either resolved completely or became confluent at the apical border of the outer nuclear layer, and finally formed ophthalmoscopically detectable hard exudates during extended follow-up. In the event of retinal thickening despite laser treatment, the hyperreflective dots maintained their previous distribution throughout all retinal layers. As a fourth response, dissemination of plaques of hard exudates into multiple, separate, hyperreflective foci were detected.

Significance:
Hyperreflective foci in the retina seem to represent precursors or components of hard exudates. Their specific localization depends greatly on the presence of microvascular extravasation and intraretinal fluid accumulation. Retinal photocoagulation has a major impact on retinal edema and subsequently on the distribution of intraretinal lipid deposits.

Conclusions:
Study using SD-OCT showed impact of Pascal lasering on lipid exudates in diabetic macular edema patients.

Participants:
13 consecutive patients with treatment-naïve clinically significant diabetic macular edema (DME).

Methods:
Before and 1 day after standardized grid photocoagulation using the PASCAL system, Spectralis OCT examinations based on an eye-tracking system, infrared fundus imaging, color fundus photography, and biomicroscopy were performed. A standardized visual acuity assessment (ETDRS protocol) and fluorescein angiography were performed at baseline.

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Spectral domain optical coherence tomography provides new insight into the immediate morphologic changes after laser treatment using the PASCAL laser system. Standardized grid photocoagulation induces characteristic homogenous alteration in the neurosensory retinal layers. Biometric changes, indicating an immediate effect, were observed within 1 day after treatment.

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This is the first study that analyse the immediate in vivo morphologic retinal changes secondary to standardized grid photocoagulation using SD-OCT. This is also a first study to show the unique burns morphology post-grid photocoagulation with the PASCAL grid arrays patterns.
The First Truly Pattern Scanning Laser-Evolved Methods: coherence tomography (FD OCT) and fundus autofluorescence (AF).

Objectives: To compare in vivo burn morphologic features and healing responses of Pascal 20- and 100-millisecond panretinal photocoagulation (PRP) burns in proliferative diabetic retinopathy.

Design: Prospective randomized controlled trial with 24 eyes assigned to either 20- or 100-millisecond Pascal PRP. Fundus autofluorescence and Fourier domain coherence tomography (FD-OCT) were performed 1 hour and 2 and 4 weeks after treatment. Main outcome measures included burn morphologic features on FD-OCT and greatest liner diameter (GLD) of laser burns as evaluated in 6 standard ETDRS photographic field using autofluorescence.

Results: The contemporaneous increase in autofluorescence is observed with increasing pulse duration. Differences in mean GLD between 100- and 20-millisecond burns were 63μm at 1 hour and 198μm at 4 weeks (P<0.001 for both). At 4 weeks, all burns corresponded to defects at the junction of inner and outer segments of photoreceptors (JIOSP) and apical retinal pigment epithelium. After 4 weeks, the GLD of 20-millisecond burns reduced significantly by 35% (P<0.001), with no changes in the 100-millisecond burns.

Conclusions: All burns initially appear as equivalent square-edged, columnar foci of hyper reflectivity in the outer retina. Pascal 20-millisecond burns progressively reduce in size, and this suggests a novel healing response localized to the JI/OSP and apical retinal pigment epithelium. The higher fluence 200-millisecond burns developed larger defects due to thermal blooming and collateral damage.

Significance: This is the first time a study shows that PASCAL’s parameters allow retinal tissue healing with reduction in laser lesion (up to 35%) which may not occur with conventional laser burns.

Results: At 1 hour after treatment, burns were visualized partially with clinical biomicroscopy. AF demonstrated spots lacking autofluorescence that confirmed effective laser uptake within the Pascal arrays. Sequential changes in hyperreflectivity on FD OCT correlated with morphologic alterations seen on AF. Burns became increasingly hyperautofluorescent between 2 and 4 weeks. There were significant reductions in the retinal thickness within treated sectors on FD OCT at 2 weeks (26 ± 32 μm; P = 0.012) and 3 months after laser (20 ± 21 μm; P = 0.02) compared with baseline. Clinical biomicroscopic reduction of DME was the most common finding in 80%.

Conclusions: Barely visible 10-millisecond Pascal laser seems to produce an effect at the level of the inner and outer photoreceptor segments and apical retinal pigment epithelium, with minimal axial and lateral spread of burns. FD OCT confirmed spatial localization of AF signal changes that correlated with laser burn–tissue interactions over 3 months. The technique of lower fluence barely visible 10-millisecond laser may reduce retinal edema within affected sectors and effectively treat DME with minimization of scar formation.

Significance: Barely visible burns with Pascal produced highly localized lesions while retaining effective treatment outcomes for DME patients.

Purpose: To investigate the clinical effects and safety of targeted pattern scan laser (Pascal) retinal photocoagulation in proliferative diabetic retinopathy (PDR).

Methods: Prospective and non-randomized study of 28 eyes with treatment-naive proliferative diabetic retinopathy (PDR). Single-session 20-ms-Pascal TRP strategy applied 1500 burns to zones of retinal capillary non-perfusion and intermediate retinal ischaemia guided by wide-field fluorescein angiography (Optos). Main outcome measures at 12 and 24 weeks included; PDR grade (assessed by two masked retina specialists); central retinal thickness (CRT); mean deviation (MD) using 24-2 Swedish interactive threshold algorithm (SITA)-standard visual fields (VF); and ETDRS visual acuity (VA).

Results: Following primary TRP, there was PDR regression in 76% of patients at 12 weeks (κ = 0.70; p < 0.001). No laser re-treatment was required at 4 weeks, and 10 eyes underwent repeat TRP at 12 weeks. Wide-field Optos angiography at 24 weeks showed complete disease regression in 37% and partial regression in 33%. Additional panretinal laser photocoagulation (PRP) was planned for active PDR in 30%. There were significant reductions in CRT over time (10.4 μm at 12-weeks, p = 0.007, 12.1 μm at 24-weeks, p = 0.0003). The MD on VFs improved after 12 weeks (+1.25 dB; p = 0.015) and 24 weeks (+1.26 dB, p = 0.01). The VA increased by +3 letters at 24 weeks (95% CI, 1.74–5.01; p < 0.0001).

Conclusions: This pilot study reports that Optos-guided Pascal 20-ms TRP using 1500 burns for treatment-naive PDR is a promising procedure with favourable safety profile.
The First Truly Pattern Scanning Laser-Evolved Coherence Tomography (FD OCT) and Fundus Autofluorescence (AF) Corporation) photocoagulation burns in diabetic macular edema (DME) using Fourier-domain optical to investigate the morphologic features and clinical efficacy of barely visible Pascal (Optimedica Corporation) photocoagulation burns in proliferative diabetic retinopathy. Objective: To compare in vivo burn morphologic features and healing responses of Pascal 20- and 100-millisecond panretinal photocoagulation (PRP) burns in proliferative diabetic retinopathy. Design: Prospective randomized controlled trial with 24 eyes assigned to either 20- or 100-millisecond Pascal PRP. Fundus autofluorescence and fourier domain coherence tomography (FD-OCT) were performed 1 hour and 2 and 4 weeks after treatment. Main outcome measures included burn morphologic features on FD-OCT and greatest linear diameter (GLD) of laser burns as evaluated in 6 standard ETDRS photographic field using autofluorescence. Results: The contemporaneous increase in autofluorescence is observed with increasing pulse duration. Differences in mean GLD between 100- and 20-millisecond burns were 63um at 1 hour and 198um at 4 weeks (P<0.001 for both). At 4 weeks, all burns corresponded to defects at the junction of inner and outer segments of photoreceptors (J/OSP) and apical retinal pigment epithelium. After 4 weeks, the GLD of 20-millisecond burns reduced significantly by 35% (P<0.001), with no changes in the 100-millisecond burns. Conclusions: All burns initially appear as equivalent square-edged, columnar foci of hyper reflectivity in the outer retina. Pascal 20-millisecond burns progressively reduce in size, and this suggests a novel healing response localized to the J/OSP and apical retinal pigment epithelium. The higher fluence 100-millisecond burns developed larger defects due to thermal blooming and collateral damage. Significance: This is the first time a study show that PASCAL’s parameters allow retinal tissue healing with reduction in laser lesion (up to 35%) which may not occur with conventional laser burns. Purpose: To investigate the clinical effects and safety of targeted pattern scan laser (Pascal) retinal photocoagulation (TRP) in proliferative diabetic retinopathy (PDR). Methods: Prospective and non-randomized study of 28 eyes with treatment-naive proliferative diabetic retinopathy (PDR). Single-session 20-ms-Pascal TRP strategy applied 1500 burns to zones of retinal capillary non-perfusion and intermediate retina ischaemia guided by wide-field fluorescein angiography (Optos). Main outcome measures at 12 and 24 weeks included; PDR grade (assessed by two masked retina specialists); central retinal thickness (CRT); mean deviation (MD) using 24-2 Swedish interactive threshold algorithm (SITA)-standard visual fields (VF); and ETDRS visual acuity (VA). Results: Following primary TRP, there was PDR regression in 76% of patients at 12 weeks (κ = 0.70; p < 0.001). No laser re-treatment was required at 4 weeks, and 10 eyes underwent repeat TRP at 12 weeks. Wide-field Optos angiography at 24 weeks showed complete disease regression in 37% and partial regression in 33%. Additional panretinal laser photocoagulation (PRP) was planned for active PDR in 30%. There were significant reductions in CRT over time (10.4 μm at 12-weeks, p = 0.007, 12.1 μm at 24-weeks, p = 0.0003). The MD on VFs improved after 12 weeks (+1.25 dB; p = 0.015) and 24 weeks (+1.26 dB; p = 0.01). The VA increased by +3 letters at 24 weeks (95% CI, 1.74-5.01; p < 0.0001). Conclusions: This pilot study reports that Optos-guided Pascal 20-ms TRP using 1500 burns for treatment-naive PDR is a promising procedure with favourable safety profile.


# Abstracts


**Background:**
A novel computer-guided laser treatment for open-angle glaucoma, called patterned laser trabeculoplasty, and its preliminary clinical evaluation is described.

**Methods:**
Forty-seven eyes of 25 patients with open-angle glaucoma received 532-nm laser treatment with 100-μm spots. Power was titrated for trabecular meshwork blanching at 10 ms and sub-visible treatment was applied with 5-ms pulses. The arc patterns of 66 spots rotated automatically after each laser application so that the new pattern was applied at an untreated position.

**Results:**
Approximately 1,100 laser spots were placed per eye in 16 steps, covering 360 ° of trabecular meshwork. The intraocular pressure decreased from the pretreatment level of 21.9 ± 4.1 to 16.0 ± 2.3 mm Hg at 1 month (n = 41) and remained stable around 15.5 ± 2.7 mm Hg during 6 months of follow-up (n = 30).

**Conclusions:**
Patterned laser trabeculoplasty provides rapid, precise, and minimally traumatic (sub-visible) computer-guided treatment with exact abutment of the patterns, exhibiting a 24% reduction in intraocular pressure during 6 months of follow-up (P < .01).

**Significance:**
First PLT study demonstrating IOP reduction similar to SLT.

**Purpose:**
To evaluate the safety, selectivity, and healing of retinal lesions created using a continuous line scanning laser.

**Methods:**
A 532 nm Nd:YAG laser (PASCAL) with retinal beam diameters of 40 and 66 μm was applied to 60 eyes of 30 Dutch-Belted rabbits. Retinal exposure duration varied from 15 to 60 μs. Lesions were acutely assessed by ophthalmoscopy and fluorescein angiography (FA). RPE flatmounts were evaluated with live-dead fluorescent assay (LD). Histological analysis was performed at 7 time points from 1 hour to 2 months.

**Results:**
The ratios of the threshold of rupture and of OV to FA visibility (measures of safety and selectivity) increased with decreasing duration and beam diameter. FA and LD yielded similar thresholds of RPE damage. Above the OV threshold, histology showed focal RPE damage and photoreceptor loss at one day, without inner retinal effects. By one week, photoreceptor and RPE continuity was restored. By 1 month, photoreceptors appeared normal.

**Conclusions:**
Retinal therapy with a fast scanning continuous laser achieves selective targeting of the RPE and, at higher power, of the photoreceptors without permanent scarring or inner retinal damage. Continuous scanning laser can treat large retinal areas within standard eye fixation time.

**Significance:**
Experimental study using Pascal to achieve microsecond pulse burns by fast scanning continuous line scanning method resulting in selective targeting of RPE & photoreceptors while leaving no permanent scarring & intact inner retinal layers.

**Introduction:**
We performed a study of laser panretinal photocoagulation in 20 patients with proliferative retinopathy. We compared short exposure, high-energy laser settings with conventional settings, using a 532 nm, frequency doubled, Neodymium–Yag laser and assessed the patients in terms of pain experienced and effectiveness of treatment.

**Method:**
Twenty patients having panretinal photocoagulation for the first time underwent random allocation to treatment of the superior and inferior hemi-retina. Treatment A used ‘conventional’ parameters: exposure time 0.1 s, power sufficient to produce visible grey-white burns, spot size 300 μm. The other hemiretina was treated with treatment B using exposure 0.02 s, 300 μm and sufficient power to have similar endpoint. All patients were asked to evaluate severity of pain on a visual analogue scale. (0 = no pain, 10 = most severe pain). All patients were masked as to the type of treatment and the order of carrying out the treatment on each patient was randomised. Patients underwent fundus photography and were followed up for 6–45 months.

**Conclusion:**
Shortening exposure time of retinal laser is significantly less painful but equally effective as conventional parameters.

**Significance:**
Study using 20 ms pulse duration showed significantly less pain compared to conventional laser’ s 100 ms pulse duration.
Abstracts


Background:
A novel computer-guided laser treatment for open-angle glaucoma, called patterned laser trabeculoplasty, and its preliminary clinical evaluation is described.

Methods:
Forty-seven eyes of 25 patients with open-angle glaucoma received 532-nm laser treatment with 100-μm spots. Power was titrated for trabecular meshwork blanching at 10 ms and sub-visible treatment was applied with 5-ms pulses. The arc patterns of 66 spots rotated automatically after each laser application so that the new pattern was applied at an untreated position.

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Approximately 1,100 laser spots were placed per eye in 16 steps, covering 360 ° of trabecular meshwork. The intraocular pressure decreased from the pretreatment level of 21.9 ± 4.1 to 16.0 ± 2.3 mm Hg at 1 month (n = 41) and remained stable around 15.5 ± 2.7 mm Hg during 6 months of follow-up (n = 30).

Conclusions:
Patterned laser trabeculoplasty provides rapid, precise, and minimally traumatic (sub-visible) computer-guided treatment with exact abutment of the patterns, exhibiting a 24% reduction in intraocular pressure during 6 months of follow-up (P < .01).

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Shortening exposure time of retinal laser is significantly less painful but equally effective as conventional parameters.

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Study using 20 ms pulse duration showed significantly less pain compared to conventional laser’s 100 ms pulse duration.
Abstracts


Objective:
To compare the effectiveness of “light” versus “classic” laser photocoagulation in diabetic patients with clinically significant macular oedema (CSMO).

Methods:
A prospective randomised pilot clinical trial in which 29 eyes of 24 diabetic patients with mild to moderate non-proliferative diabetic retinopathy (NPDR) and CSMO were randomised to either “classic” or “light” Nd:YAG 532 nm (frequency doubled) green laser. “Light” laser treatment differed from conventional (“classic”) photocoagulation in that the energy employed was the lowest capable to produce barely visible burns at the level of the retinal pigment epithelium. Primary outcome measure was the change in foveal retinal thickness as measured by optical coherence tomography (OCT); secondary outcomes were the reduction/elimination of macular oedema on contact lens biomicroscopy and fluorescein angiography, change in visual acuity, contrast sensitivity, and mean deviation in the central 10˚ visual field. Examiners were masked to patients’ treatment.

Conclusions:
“Light” photocoagulation for CSMO may be as effective as “classic” laser treatment.


Objective:
We wanted to verify whether a panretinal photocoagulation (PRP) performed using low levels of ARGON laser energy (light PRP) has the same efficacy as a PRP performed in a conventional fashion using argon green wavelengths (classic PRP) in eyes with high-risk proliferative diabetic retinopathy (HRPDR). Furthermore, we wanted to compare the session number performed and the side effects produced by the two techniques.

Methods:
Sixty-five eyes with HRPDR of 50 consecutive patients were enrolled in a prospective randomized controlled trial. In eyes selected for light PRP, a very light biomicroscopic effect on the retina was obtained for each spot. In eyes assigned to classic PRP, each spot produced a white yellow biomicroscopic effect. Mean follow-up was 22.4 months ±9.7 in the light PRP and 21.6 months ±9.3 in the classic PRP group (p = 0.727).

Conclusions:
The efficacy of Light PRP is similar to that of classic Light PRP in eyes with HRPDR. Light PRP is associated with fewer complications and allows the reduction of the number of treatment sessions.

Significance:
“Light” PRP has same efficacy in HPDR compared to heavier “classic” PRP burns.


Background:
To compare the effects of single-sitting vs 4-sitting panretinal photocoagulation (PRP) on macular edema in subjects with severe nonproliferative or early proliferative diabetic retinopathy with relatively good visual acuity and no or mild center-involved macular edema.

Methods:
Subjects were treated with 1 sitting or 4 sittings of PRP in a nonrandomized, prospective, multicentered clinical trial.

Conclusions:
Our results suggest that clinically meaningful differences are unlikely in OCT thickness or visual acuity following application of PRP in 1 sitting compared with 4 sittings in subjects in this cohort. More definitive results would require a large randomized trial.

Significance:
These results suggest PRP costs to some patients in terms of travel and lost productivity as well as to eye care providers could be reduced with single session treatment.
Objective: To compare the effectiveness of “light” versus “classic” laser photocoagulation in diabetic patients with clinically significant macular oedema (CSMO).

Methods: A prospective randomised pilot clinical trial in which 29 eyes of 24 diabetic patients with mild to moderate non-proliferative diabetic retinopathy (NPDR) and CSMO were randomised to either “classic” or “light” Nd:YAG 532 nm (frequency doubled) green laser. “Light” laser treatment differed from conventional (“classic”) photocoagulation in that the energy employed was the lowest capable to produce barely visible burns at the level of the retinal pigment epithelium. Primary outcome measure was the change in foveal retinal thickness as measured by optical coherence tomography (OCT); secondary outcomes were the reduction/elimination of macular oedema on contact lens biomicroscopy and fluorescein angiography, change in visual acuity, contrast sensitivity, and mean deviation in the central 10˚ visual field. Examiners were masked to patients’ treatment.

Conclusions: “Light” photocoagulation for CSMO may be as effective as “classic” laser treatment.

Background: To compare the effects of single-sitting vs 4-sitting panretinal photocoagulation (PRP) on macular edema in subjects with severe nonproliferative or early proliferative diabetic retinopathy with relatively good visual acuity and no or mild center-involved macular edema.

Methods: Subjects were treated with 1 sitting or 4 sittings of PRP in a nonrandomized, prospective, multicentered clinical trial.

Conclusions: Our results suggest that clinically meaningful differences are unlikely in OCT thickness or visual acuity following application of PRP in 1 sitting compared with 4 sittings in subjects in this cohort. More definitive results would require a large randomized trial.

Significance: These results suggest PRP costs to some patients in terms of travel and lost productivity as well as to eye care providers could be reduced with single session treatment.

Objective: We wanted to verify whether a panretinal photocoagulation (PRP) performed using low levels of ARGON laser energy (light PRP) has the same efficacy as a PRP performed in a conventional fashion using argon green wavelengths (classic PRP) in eyes with high-risk proliferative diabetic retinopathy (HRPDR). Furthermore, we wanted to compare the session number performed and the side effects produced by the two techniques.

Methods: Sixty-five eyes with HRPDR of 50 consecutive patients were enrolled in a prospective randomized controlled trial. In eyes selected for light PRP, a very light biomicroscopic effect on the retina was obtained for each spot. In eyes assigned to classic PRP, each spot produced a white yellow biomicroscopic effect. Mean follow-up was 22.4 months ±9.7 in the light PRP and 21.6 months ±9.3 in the classic PRP group (p = 0.727).

Conclusions: The efficacy of Light PRP is similar to that of classic Light PRP in eyes with HRPDR. Light PRP is associated with fewer complications and allows the reduction of the number of treatment sessions.

Significance: “Light” PRP has same efficacy in HPDR compared to heavier “classic” PRP burns.
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