Pain Perception at Laser Treatment of Peripheral Retinal Degenerations With Green and Infrared Wavelengths

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• PURPOSE: **To compare the pain perception at laser treatment of peripheral retinal degenerations with green (532-nm) and infrared (810-nm) wavelengths.**

• DESIGN: **Prospective randomized clinical trial.**

• METHODS: **Sequential patients with indications for photocoagulation of bilateral peripheral retinal degenerations were invited to participate in the study. Thirty patients (60 eyes) were enrolled in the study. Each patient had 1 eye treated with infrared laser (diode, 810-nm wavelength) and the other eye treated with green laser (frequency-doubled solid-state laser, diode-pumped, with 532-nm wavelength). The eyes were randomized to infrared or green wavelengths. The right eye was the first treated in all cases regardless of the wavelength arrangement. Immediately after photocoagulation of each eye, the patient was asked to grade pain perception according to an 11-point (ie, 0–10) numerical rating scale (NRS), with 0 meaning "No pain" and 10 meaning "Pain as bad as you can imagine." The primary outcome was the assessment of pain.**

• RESULTS: **The mean grading of pain perception was 2.80 (SD 1.27; mode and median = 2) to green wavelengths and 5.07 (SD 1.36; mode = 4 and median = 5) to infrared wavelengths ($P < .001$).**

• CONCLUSIONS: **The results showed a statistically and clinically significant difference of pain perception between the 2 groups, with advantage to the green laser group. (Am J Ophthalmol 2010;150:726–730. © 2010 by Elsevier Inc. All rights reserved.)**

RETINAL DEGENERATIONS MAY CAUSE RETINAL DEtachment (RD). Although a limited number of patients with peripheral retinal degenerations (PRD) develop retinal detachment, they are present in 30% of eyes with RD.[1]

Prophylactic treatment of PRD aims to lower the risk of RD. The most frequent indications for treatment are horseshoe tears and dialyses, besides operculated holes and lattice degeneration in symptomatic patients (photopsias) or those with history of retinal disease (RD in the fellow eye, high myopia, or intraocular surgery). Treatment, either by laser retinopexy or by trans-scleral cryotherapy, aims to create a chorioretinal adhesion that will prevent liquid vitreous from passing through the break, thereby causing a retinal detachment. Laser is preferred for several reasons: chorioretinal adhesion occurs faster, causes less breakdown of the blood-retina barrier, has a lower incidence of epiretinal membrane formation, and is less painful.[1]

The most frequently used wavelengths for laser retinopexy are green (argon, 514 nm; or frequency-doubled solid-state laser diode-pumped, 532 nm) and infrared (diode, 810 nm). All these lasers produce a photocoagulative tissue effect by transforming light energy into thermal energy, which produces the desired tissue effect in the photocoagulated tissue or, sometimes, in neighboring tissues by thermal conduction.[1]

The purpose of the study is to compare the pain perception at laser treatment of peripheral retinal degenerations with green (532-nm) and infrared (810-nm) wavelengths.

METHODS

• SUBJECTS AND MEDICAL PROCEDURES: The study was a prospective randomized controlled trial. We compared the pain perception at laser treatment of peripheral retinal degenerations with green and infrared wavelengths.

Sequential patients with indications for photocoagulation of bilateral peripheral retinal degenerations were invited to participate in the study. The indications for treatment were horseshoe tears and dialyses, besides operculated holes and lattice degeneration in symptomatic patients (photopsias) or patients with history of retinal disease (RD in the fellow eye, high myopia, or intraocular surgery). Exclusion criteria for the study were severe liver disease, pregnancy, patients on regular analgesics, previous laser photocoagulation, and age less than 18 years.

Thirty patients (60 eyes) were enrolled in the study (Figure 1). Each patient was randomly assigned to 1 of 2 arms: group 1, right eye treated with infrared laser (diode, 810-nm wavelength) and left eye treated with green laser (frequency-doubled solid-state laser, diode-pumped, with 532-nm wavelength); or group 2, right eye treated with green laser and left eye treated with infrared laser. Block randomization was performed at the time of enrollment

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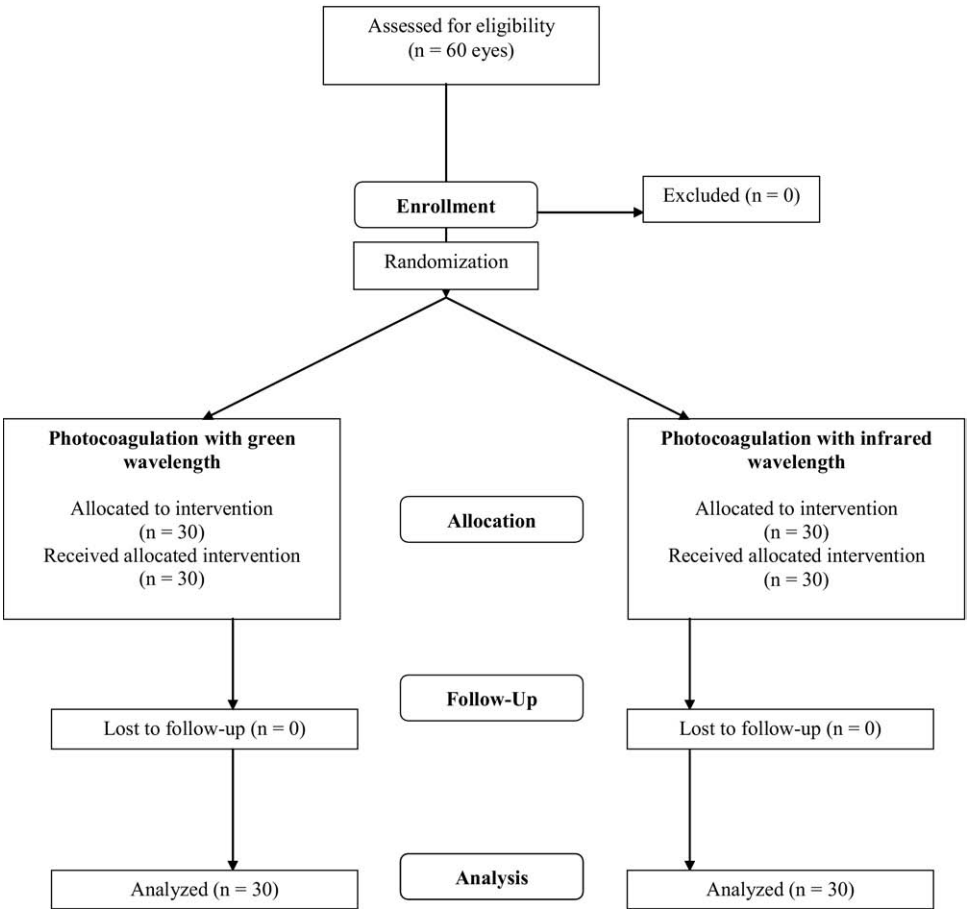

FIGURE 1. CONSORT flow diagram: Pain perception at laser treatment of peripheral retinal degenerations with green and infrared wavelengths.

(blocks of 4 patients; 2 of each group). The right eye was the first treated in all cases regardless of the wavelength arrangement. One ophthalmologist performed the photocoagulation.

The treatment of each eye was standardized as follows: slit-lamp delivery system, total of 200 burns, 250-μm spot size, duration of pulse 0.1 seconds, pulse interval 0.3 seconds, avoiding the horizontal midlines, aiming for a moderately gray burn with green laser (100 to 400 mW) and a light gray burn with infrared laser (200 to 800 mW). Anesthetic drops (proparacaine 0.5%) were used for topical anesthesia before contact lens use.

Immediately after photocoagulation, the patient was asked to grade pain perception according to an 11-point (ie, 0–10) numerical rating scale (NRS),[2,3] accompanied by the instructions "Please rate your pain by indicating the number that best describes it." This NRS is represented as a straight line (10 cm in length). The numbers between 0 and 10 are spaced at regular intervals along the line; at either end of the line are 2 poles that are defined as the extreme limits of the response to be measured, with 0 meaning "No pain" and 10 meaning "Pain as bad as you can imagine."

The interval between the treatment of the first and the second eye was 1 week. After grading of pain perception the patient was offered a single dose of a short-action painkiller (paracetamol 750 mg). In case of intolerable pain, the patient received peribulbar anesthesia. In case of persistent pain, the patient would be assisted by an anesthetist (fortunately, no patients needed such assistance). Patients were offered the option to suspend treatment after first eye. Although pain relief was not offered for the second eye, all patients completed the treatment of both eyes.

• **DATA COLLECTION AND OUTCOMES:** Data were collected by a standardized form that included gender, age, eye, pain perception, mean time to apply treatment, laser power, and wavelength, completed by the physician at the time of preoperative medical examination. Pain perception and complications of laser photocoagulation were recorded on a standardized form by a member of the medical staff. One of the study's researchers reviewed the relevant medical records in order to determine whether 1 of the study's definitions was

TABLE. Pain Perception at Laser Treatment of Peripheral Retinal Degenerations With Green and Infrared Wavelengths: Summary of Patient Data

Patient	Group[a]	Gender	Age (Years)	Eye	Laser Wavelength[b]	Power (mW)	Pain (NRS[c])	Time (s[d])
1	2	Male	38	Right	Green	300	1	105
				Left	Infrared	600	4	110
2	1	Male	22	Left	Green	250	3	113
				Right	Infrared	500	4	107
3	2	Female	21	Right	Green	300	2	125
				Left	Infrared	550	4	114
				Right	Infrared	600	6	121
5	1	Female	30	Left	Green	300	2	99
				Right	Infrared	500	4	100
6	2	Male	18	Right	Green	350	4	132
				Left	Infrared	650	6	102
7	1	Male	22	Left	Green	300	3	115
				Right	Infrared	550	4	118
8	2	Male	24	Right	Green	350	4	110
				Left	Infrared	650	6	104
9	2	Male	54	Right	Green	300	2	102
				Left	Infrared	650	4	99
10	2	Female	50	Right	Green	350	5	113
				Left	Infrared	700	6	116
11	1	Female	40	Left	Green	300	2	127
				Right	Infrared	650	4	110
12	1	Female	19	Left	Green	300	3	102
				Right	Infrared	600	6	109
13	2	Male	19	Right	Green	300	1	110
				Left	Infrared	600	4	100
14	1	Female	27	Left	Green	300	2	141
				Right	Infrared	650	6	120
15	1	Female	23	Left	Green	350	5	121
				Right	Infrared	600	8	111
16	1	Female	33	Left	Green	300	3	104
				Right	Infrared	600	6	127
17	2	Male	44	Right	Green	300	2	109
				Left	Infrared	650	4	102
18	2	Male	19	Right	Green	250	3	98
				Left	Infrared	600	6	123
19	2	Male	23	Right	Green	250	2	133
				Left	Infrared	500	4	140
20	1	Female	31	Left	Green	300	4	124
				Right	Infrared	600	4	119
21	1	Female	31	Left	Green	300	2	130
				Right	Infrared	550	2	124
22	2	Male	28	Right	Green	300	6	100
				Left	Infrared	650	8	101
23	1	Male	21	Left	Green	300	2	114
				Right	Infrared	650	6	112
24	2	Female	42	Right	Green	300	2	99
				Left	Infrared	550	4	101
25	2	Female	35	Right	Green	350	5	98
				Left	Infrared	650	6	104
26	1	Male	20	Left	Green	300	3	115
				Right	Infrared	550	6	110
27	1	Male	40	Left	Green	250	1	111
				Right	Infrared	550	6	112

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TABLE. Pain Perception at Laser Treatment of Peripheral Retinal Degenerations With Green and Infrared Wavelengths: Summary of Patient Data *(Continued)*

Patient	Group[a]	Gender	Age (Years)	Eye	Laser Wavelength[b]	Power (mW)	Pain (NRS[c])	Time (s[d])
28	2	Male	34	Right	Green	300	2	97
				Left	Infrared	550	6	104
29	2	Female	24	Right	Green	300	3	101
				Left	Infrared	600	4	103
30	1	Male	25	Left	Green	300	2	112
				Right	Infrared	550	4	105

[a]Group 1: right eye treated with infrared laser and left eye treated with green laser; group 2: right eye treated with green laser and left eye treated with infrared laser.

[b]Laser wavelength: green = 532 nm, infrared = 810 nm.

[c]Pain (NRS): numerical rating scale (0–10).

[d]Mean time to apply treatment (seconds).

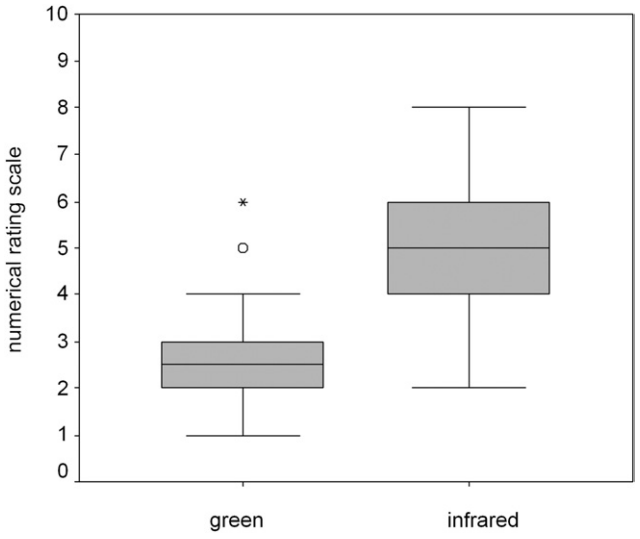

FIGURE 2. Box plot graph: Grading of pain perception (numerical rating scale) at laser treatment of peripheral retinal degenerations with green (532-nm) and infrared (810-nm) wavelengths.

met. These reviewers were not informed of the study-group assignment of the patients.

The primary outcome of the study was the assessment of pain immediately after photocoagulation. The secondary outcome was complications of laser photocoagulation (vasovagal episode, break in Bruch membrane, choroidal effusion, and vitreous hemorrhage).[4]

• **SAMPLE SIZE AND STATISTICAL ANALYSIS:** A sample size of 30 patients (total of 60 eyes; 30 eyes in each group) was planned. With an assumption of a mean pain perception of 2.5 (NRS) in the green-wavelength group, this sample size provided an 80% probability of detecting a difference as small as 2 (NRS) of pain perception in the infrared-wavelength group. Results of these analyses were considered statistically significant when the P values were $< .05$. For continuous variables, 1-way analysis of variance (ANOVA) tables were used.

RESULTS

THIRTY PATIENTS (60 EYES) WERE RECRUITED FOR THE study between January 10, 2009 and December 10, 2009 (Table). None were excluded. Each group in the study thus had 30 eyes. Sixteen patients (53.3%) were male and 14 (46.7%) were female. There were no statistically significant differences in mean age between genders (male 28.2 [SD 10.5] years; female 30.7 [SD 8.6] years, $P < .317$).

It was necessary a mean laser power of 300 mW (SD 29, range 250–350) in the green-wavelength group and 595 mW (SD 53, range 500–700) in the infrared group ($P < .001$). The mean grading of pain perception was 2.80 (SD 1.27, range 1–6) in the green-wavelength group and 5.07 (SD 1.36, range 2–8) in the infrared-wavelength group ($P < .001$) (Figure 2). Two patients reported intolerable pain with topical anesthesia, and they received perbulbar anesthesia. Patients were offered the option to suspend treatment after first eye. Although pain relief was not offered for the second eye, all patients completed the treatment of both eyes. No complications of laser photocoagulation were reported in either group. The mean time to apply treatment was 113 seconds (SD 12) in the green-wavelength group and 111 seconds (SD 10) in the infrared group ($P < .477$).

The right eye was the first treated in all cases. Half of the patients had the right eye treated with infrared wavelength (group 1) and the other half (group 2) with green. The results of subgroup analysis were not statistically different from the overall sample. The mean grading of pain perception in group 1 was 2.67 (SD 0.98, range 1–5) for green wavelengths and 5.07 (SD 1.49, range 2–8) for infrared wavelengths ($P < .001$) and the mean grading of pain perception in group 2 was 2.93 (SD 1.53, range 1–6) for green wavelengths and 5.07 (SD 1.28, range 4–8) for infrared wavelengths ($P < .001$).

DISCUSSION

PAIN PERCEPTION AT LASER RETINOPEXY IS A PERSONAL experience for each individual. Many factors can influence the perception of pain, including sex difference, cultural differences, past experiences, and anxiety levels.[5] Although the treatment of peripheral retinal degenerations with infrared laser appeared to be well tolerated by the majority of the patients, it was more painful than with green wavelengths.

The green laser used nearly half the laser power of the infrared because to obtain the goal of visible burns, different wavelengths need different power, which is a specific characteristic of each laser. The different pain perception is probably related to the deeper tissue penetration of the infrared laser. The green wavelengths are the first choice for the vast majority of retinal and choroidal diseases. These wavelengths are fairly well absorbed by hemoglobin and therefore permit direct closure of vascular anomalies. Most of the energy is absorbed by melanin of the retinal pigment epithelium, causing less pain. The treatment is well tolerated with topical anesthesia.[1]

The infrared laser is cheaper and more useful in treatment of choroidal neovascularization and retinopathy of prematurity and in vitreoretinal surgeries. Greater sparing of the inner retinal layers is achieved.[4] These wavelengths are poorly absorbed by hemoglobin and are the most effective in the presence of vitreous hemorrhage. These lasers are also better able to penetrate cataractous lenses. However, longer wavelengths penetrate deeper into the choroid than green lasers and may therefore be more painful. In general, topical anesthesia is adequate, but periocular anesthetic injection may be necessary in particularly sensitive patients.[1]

Clinical trials to evaluate perception of pain during photocoagulation are scarce.[4–8] We are unaware of previous clinical trial reports comparing pain perception at laser treatment of peripheral retinal degenerations with green and infrared wavelengths, and we could find no reference to it in a computerized search at PubMed. The results showed statistically and clinically significant differences in pain perception between the 2 groups, with advantage to the green laser group. These data can be used as a baseline for future, larger studies to target pain associated with retina photocoagulation.

THE AUTHORS REPORT NO FUNDING AND NO COMMERCIAL OR PROPRIETARY INTEREST IN THE PRODUCT OR COMPANY. THE authors certify that they do not have any affiliations with or involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the manuscript (eg, employment, consultancies, stock ownership, honoraria, speakers bureau, expert testimony). Involved in design and conduct of the study (R.P.C.L., M.A.N., C.E.L.A., K.M.C., V.B.S.); collection, management, analysis, and interpretation of the data (R.P.C.L., M.A.N., C.E.L.A., K.M.C., V.B.S.); and preparation, review, or approval of the manuscript (R.P.C.L., M.A.N., C.E.L.A., K.M.C., V.B.S.). Ethics committee approval was obtained and all participants gave informed consent (CONEP–National Committee for Research Ethics, Brazil, 0065.0.172.172-07). The study was registered at www.clinicaltrials.gov (protocol #CT01033968).

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Biosketch

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