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CLINICAL STUDY

Pain response and follow-up of patients undergoing panretinal laser photocoagulation with reduced exposure times

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Abstract

Purpose **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.**
Methods **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 a visible grey-white burns, spot size 300 μm. The other hemi-retina 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.**
Results **Seventeen patients had proliferative diabetic retinopathy, two had ischaemic central retinal vein occlusion and one had ocular ischaemic syndrome. The mean response to treatment A was 5.11, compared to 1.40 treatment B, on the visual analogue scale, which was statistically significant ($P = 0.001$). All patients preferred treatment B. Further treatments, if required, were performed with treatment B parameters and long-term follow-up has shown no evidence of undertreatment.**
Conclusions **Shortening exposure time of retinal laser is significantly less painful but equally effective as conventional parameters.**

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Keywords: laser photocoagulation; retina; pain

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Introduction

For over 30 years, it has been known that panretinal laser photocoagulation (PRP) is effective in treating proliferative retinopathy in a wide variety of underlying conditions, of which diabetic retinopathy is the most common indication. The Diabetic Retinopathy Study (DRS) demonstrated that timely laser PRP can reduce the risk of severe visual loss by 50%.[1]

More recently there has been considerable interest and debate as to whether 'quicker more painless' laser photocoagulation can be achieved, and there is evidence that many ophthalmologists no longer use the DRS settings for laser photocoagulation.[2,3]

In addition, new, exciting developments using semi automatic pattern delivery of retinal laser burns have been developed and reported which use much smaller amounts of energy and shorter duration.[4]

The DRS recommended that between 800 and 1600, 500 μm scatter laser burns of blue-green argon laser should be given up to the equator of each eye, and used 0.1 s duration with the laser treatment often applied at a single sitting. The original protocols of the DRS used argon blue-green laser or xenon arc photocoagulation, but

modern techniques use green wavelength laser performed over at least two sessions.[5]

Despite these modifications many patients still find PRP a painful experience, and when this is marked may lead to significant undertreatment.[6] To assist patient compliance during retinal laser photocoagulation, different techniques of anaesthesia and analgesia have been used. These include sharp needle peribulbar or retrobulbar anaesthesia,[6] oral analgesia,[7] topical diclofenac eyedrops,[8] and inhaled entonox.[9] Pain can also be alleviated by using shorter exposure laser burns and avoiding red and infra-red wavelengths which penetrate deeper.

We have used the frequency doubled, neodymium YAG laser, with a wavelength of 532 nm, to perform a study to determine if shorter duration exposures are more comfortable than conventional parameters, while still providing effective uptake. In order to assess whether this constitutes effective treatment, we have also followed up these patients for up to two years afterwards ensure that the treatment is effective.

Patients and methods

A prospective, masked study was performed on twenty consecutive patients undergoing PRP for the first time. Full ethical permission was gained from our local committee and the project was registered with our Trust. All patients underwent scatter PRP using the Volk Transequator contact lens with coupling solution and two drops of oxybuprocaine 0.4%. Informed consent was obtained and patients were informed about the study aims without mentioning that the measurement of pain was the main study outcome. In this way, we attempted to limit bias in the pain scoring (see Discussion.)

Patients were randomly allocated to receive treatment regime A or B first. In treatment A, the superior or inferior retina was treated with approximately 500 shots of scatter laser photocoagulation using 'conventional' laser parameters: spot size 300 μm, exposure 0.1 s, power sufficient to cause blanching of retina. The remaining hemi-retina was treated with treatment B with approximately 500 burns of spot size 300 μm and parameters of higher power but shorter duration (0.02 s) to give a similar visible laser endpoint. Patients were masked as to the order of the treatment regime and the initial site of treatment (superior or inferior) was chosen at random. At the end of the session patients were asked to mark on a visual analogue scale the severity of the pain experienced for the two regimes with 0 = no pain to ten is the most pain ever experienced.[10]

Retinal photography was performed to ensure that laser reactions were comparable between the two treatment regimes. The results were presented in terms of mean pain scores and analysed in terms of standard deviations.

Following the laser treatment for this study, if indicated further panretinal laser photocoagulation was given using the modified settings under treatment B. All 20 study participants were followed up after the completion of laser treatment for a period of time, from 6 to 45 months. If further laser treatment was required this was performed with treatment B parameters. For the purposes of this study, effective treatment was defined as regression of abnormal new vessels.

Results

Twenty patients participated in the study and their characteristics are summarised in Table 1.

For treatment regime A, with exposure time 0.1 s, the mean power required for an adequate reaction was 0.178 W with a mean pain score of 5.11 on the visual analogue scale. For treatment B, with exposure 0.02 s, mean power settings were 0.49 W and 1.41 on the pain scale. This difference in pain response was statistically highly significant, $P < 0.001$. Comparison between the two regimes of treatment is shown on the graph in Table 2.

Retinal photography of treatments A and B immediately following laser treatment showed no appreciable difference in visible photocoagulation reactions and this is shown in Figures 1 and 2.

Follow-up of laser patients is given in Table 3. In all cases, if further laser was required, this was completed with the settings as in treatment B. Resolution of neovascularization on and around the optic disc (NVD) and new vessels elsewhere (NVE) occurred in 18 of the 20 patients with follow-up ranging from 6 to 45 months.

Table 1 Patient characteristics

Patient characteristics	*Number*
Number of patients	20
Mean age in years	62 (range 26–76)
Caucasians	17
Asians	03
Diagnosis	
PDR	17
CRVO	02
Ocular ischaemia	01
Iris colour	
Blue	9
Brown	7
Mixed	4

Table 2 Treatment specification

	Treatment A (0.1 s)	*Treatment B (0.02 s)*
Burn no.	486.45	518
Spot size (Trans equator)	300	300
Power (W)	0.178	0.489
Pain response (cm on the visual analogue scale)	5.11*	1.405*
	SD (2.861)	SD (0.951)

*$P < 0.001$.

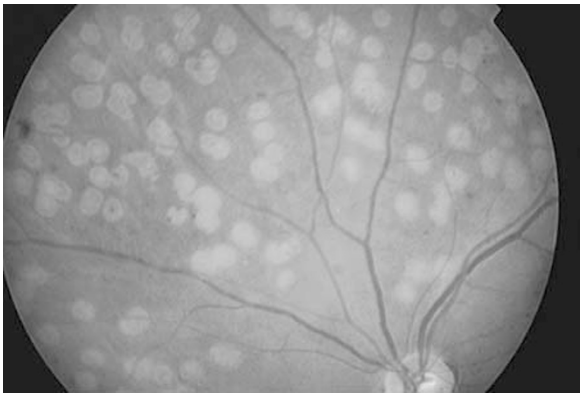

Figure 1 Superior retina treated. Laser parameters: exposure time: 0.1 s, power: 0.18 W.

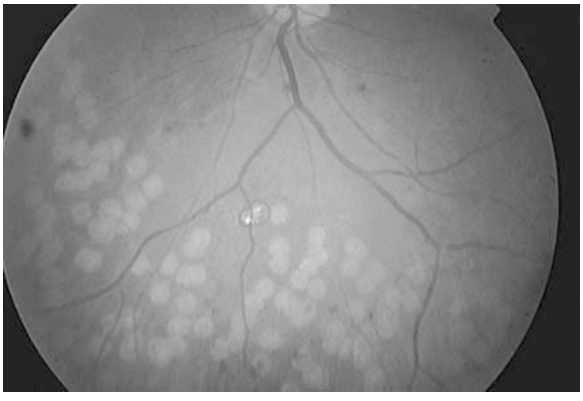

Figure 2 Inferior retina treated with laser parameters: exposure time: 0.02 s, power: 0.5 W.

The two exceptions were case 3, which was a case of central retinal vein occlusion that developed vitreous haemorrhage that prevented further laser treatment and case 16 in which there were no initial NVD/NVE but aggressive pre-proliferative retinopathy.

Discussion

Laser PRP can be a painful experience for the patient, which may be so uncomfortable that there is a risk of inadequate treatment being applied or perhaps the patient may even default from attendance.

Strategies to make the treatment more comfortable include changing the laser parameters[11] and the results of this small study clearly show that patients found the shorter exposure, higher power, laser treatment much more comfortable than conventional settings with no apparent reduction in visible endpoint. The visual analogue pain scale is a well-tested, accurate means of measuring pain as an endpoint, but a potential source of bias for this study is that patients may have been inadvertently informed during the consent that the laser treatment with short duration was expected to be less painful. To try and minimise this, we deliberately explained to the patients that the study was aimed to determine which laser regime was most effective as a whole, rather than emphasing the pain assessment as the main endpoint of the study.

Pain experienced by patients during laser retinal photocoagulation is very variable and is dependent on a number of factors including pigmentation of the fundus, laser re-treatment, and patient anxiety. It is thought in many cases to result from photocoagulation of the ciliary nerves running in the suprachoroidal space and generally patients experience more pain when treated anteriorly and in the horizontal meridians.[5] Laser burn intensity is directly proportional to the burn duration and power setting and inversely proportional to the spot size. Shorter duration laser burns may be less painful due to the thermal effect on treated tissue because they rapidly cool off compared to the longer duration where adjacent tissues become heated.[12] The newer generation frequency-doubled YAG lasers, which are more energy efficient than argon gas lasers allow much shorter durations of laser exposures to be used with, as we have demonstrated, less pain.

Various documented strategies have been attempted to increase patient comfort with laser photocoagulation but all have potential drawbacks. Sharp needle or subtenon anaesthesia for laser PRP is effective but carries the risk of globe trauma and may require additional personnel and monitoring of the patient.[6,13] Pre-emptive analgesia with paracetamol did not significantly reduce pain associated with panretinal photocoagulation.[7] Topical diclofenac may have to be applied over 2 h before laser treatment to be effective and this may cause obvious difficulties in a busy clinic.[8] Entonox is given by inhalation through a disposable mouthpiece or mask during laser treatment and while it has good safety record, the effect of using it on patients and staff in the closed confines of a laser room are unknown.[9]

If laser exposures are shortened to microseconds, the so-called micropulse delivery, less pain has been reported and less damage occurs to the visual function. In theory, this mode of delivery looks promising either with a diode infrared laser or frequency doubled YAG

Table 3 Follow-up of 20 study participants

Patient number	*Diagnosis*	*Laser burns in total (to nearest 50)*	*Outcome*	*Length of follow-up months*
1	CRVO and rubeosis	1850	Rubeosis disappeared	9
2	Diabetes PDR/NVE	2900	NVE inactive and fibrosed	18
3	CRVO and vit haemorrhage	750	Vit haem failed to clear	24
4	Diabetes PDR/NVD	4000	NVD resolved	38
5	Diabetes PDR/NVD	3700	NVD resolved	12
6	Diabetes PDR/NVE	1300	NVE resolved	18
7	Diabetes PDR/NVE/NVD	6600	NVE/NVD resolved	24
8	Diabetes PDR/NVE	2700	NVE resolved	27
9	Diabetes PRP/NVE	3200	NVE resolved	12
10	Diabetes PRP/NVD/NVE	2900	NVE resolved	10
11	Diabetes PRP/NVD	2700	NVD resolved	8
12	Diabetes PRP/NVE	3700	NVE resolved	22
13	Diabetes PRP/NVE	1800	NVE resolved	6
14	Diabetes PRP/NVD	2100	NVD fibrosed	6
15	Ocular ischaemic/NVD	3100	NVD resolved	6
16	Diabetes Pre proliferative	1900	No NVE/NVD developed	26
17	Diabetes PRP/NVE	2600	NVE resolved	8
18	Diabetes PRP/NVE	3700	NVE resolved	20
19	Diabetes PRP/NVE/NVD	2800	NVD/NVE resolved	45
20	Diabetes PRP/NVE	1800	NVE resolved	6

CRVO = central retinal vein occlusion; NVD = new vessels on optic disc; NVE = new vessels elsewhere in fundus; PDR = proliferative diabetic retinopathy; PRP = pan-retinal photocoagulation.

and early results look promising.[14–16] Meanwhile, by simply reducing the exposure time and increasing the power of conventional laser machines, effective laser PRP can be achieved with a more comfortable experience for the patient.

Conclusion

Pain threshold during laser photocoagulation is variable among patients but discomfort experienced remains an important cause of unsatisfactory treatment sessions for both patient and doctor. Our study, which as far as we are aware, has not been performed before, confirms that reducing the exposure time and increasing the laser power can reduce pain significantly without compromising the long-term results of the treatment.

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