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CASE REPORT

Dilated pupils and loss of accommodation following diode panretinal photocoagulation with sub-tenon local anaesthetic in four cases

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Abstract

Aim **To describe pupillary abnormalities associated with diode laser photocoagulation with subTenon's local anaesthetic.**
Methods **We describe four cases of tonic pupils following diabetic panretinal photocoagulation with subTenon's local anaesthetic.**
Results **Six pupils of four patients became dilated and sustained loss of accommodation with denervation hypersensitivity with 0.1% pilocarpine after undergoing panretinal photocoagulation with a subTenon's local anaesthetic. The numbers of burns were not excessive and in one patient it even occurred after only 1200 laser burns.**
Conclusion **Diode laser causes histological changes deeper in the retina and the choroid than in Argon laser. Intense diode laser burns may cause damage to the short ciliary nerves traversing the choroid. In the unanaesthetised patient, pain arises when the laser burn hits these nerves and so may protect the eye from excess damage to the nerves. When the eye is anaesthetised with a subTenon's, local anaesthetic damage to the choroidal nerves may occur without the laser operator being aware that the burns are too intense.**
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Introduction

Dilated pupils and loss of accommodation is a rare complication of panretinal photocoagulation (PRP) for diabetic retinopathy, which may either be a transient or long-term effect.[1–6] It has been seen in patients both with and without periocular anaesthesia. It has been suggested that thermal injury to the parasympathetic motor nerves running in the short ciliary nerves anteriorly through the choroid and suprachoroidal space could explain this complication.[2,5,7,8] We have seen this in four cases following diode PRP with subTenon's local anaesthetic injection given as described by Stevens.[9] The cases are presented and the possible causes discussed.

Case 1

A 21-year-old female with insulin-dependent diabetes for 16 years developed right proliferative retinopathy. She was treated with pan-retinal photocoagulation with a subTenon's injection of local anaesthetic. Two thousand three hundred burns of Diode laser were applied with sufficient power to just blanch the retina. After the treatment the right pupil remained dilated and was commented upon by friends and family. Her vision had deteriorated to 3/60 right and 1/60 left from severe maculopathy. The pupil remained enlarged. However she was asymptomatic because her vision was poor (see Table 1). Figure 1 shows the pupil responses under

Table 1 Laser treatment to the right eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
	Diode	2300	SubTenon's	Dilated
Total		2300		

different testing conditions including denervation hypersensitivity testing using 0.1% pilocarpine. A positive test is confirmed if the pupil constricts at this concentration of pilocarpine. The right pupil demonstrated a positive test result and also a moderate (++) degree of iris vermiform movements was noted.

Case 2

A 49-year-old female with insulin-dependent diabetes for 21 years developed right disc new vessels and underwent 2001 burns of Diode laser panretinal photocoagulation with subTenon local anaesthetic injection. After the first treatment the right pupil remained dilated. The right eye was subsequently treated with a further 2000 burns. The right pupil gradually reduced in size over a 9-month period but it did not return to normal.

The left eye was treated with 1200 burns of Diode laser panretinal photocoagulation with subTenon's local anaesthetic injection. The pupil remained dilated and only minimally improved over a 6-month period.

Now she finds bright lights 'blinding' and uses darkly tinted glasses with sidepieces or G. pilocarpine 1% when she is outdoors. She has great difficulty in adapting quickly to both dark and bright conditions. Her vision is 6/9 right and 6/5 left with correction (see Tables 2 and 3). Figure 2 shows the pupil size changes seen in different testing conditions including pre and post pilocarpine 0.1%. Both pupils showed positive denervation hypersensitivity based on the pilocarpine test and also showed mild (+) vermiform movements.

Table 2 Laser treatment to the right eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
1st laser session	Diode	2001	SubTenon's	Dilated
2nd laser session (1 month later)	Diode	1004	Topical	No worse
3rd laser session (2 months later)	Diode	1000	SubTenon's	No worse
Total	4005			

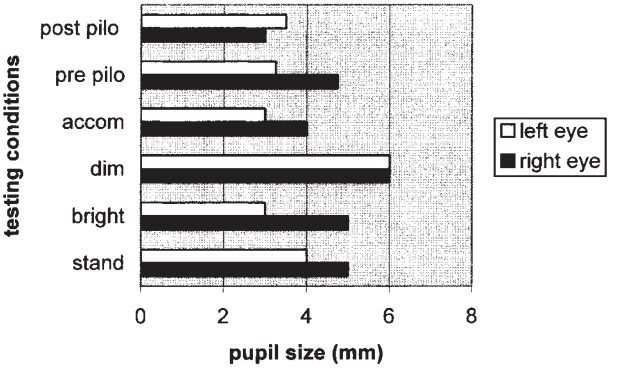

Figure 1 Pupil changes for Case 1. Stand = standard light; bright = bright light; dim = dim light; accom = accommodation; pre pilo = pre 0.1% pilocarpine; post pilo = post 0.1% pilocarpine.

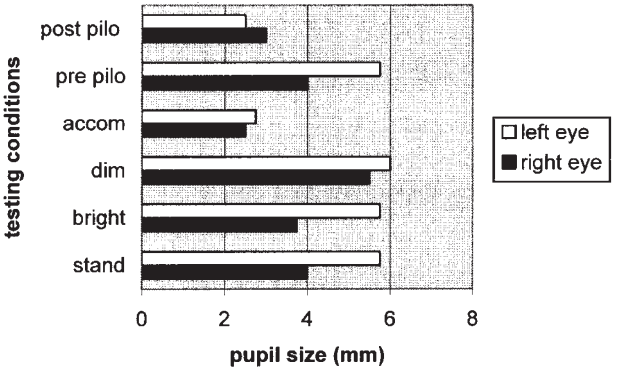

Figure 2 Pupil changes for Case 2. Abbreviations as in Figure 1.

Case 3

A 63-year-old man with insulin-dependent diabetes for 27 years developed proliferative diabetic retinopathy in his right eye and he suffered from recurrent vitreous haemorrhages. He was treated with PRP on five occasions over a year to the right eye. After a subTenon's local anaesthetic injection, the pupil became slightly larger but he suffered no visual symptoms.

Later proliferative disease was noted in his left eye. He was treated three times without periocular anaesthetic and the fourth PRP was done with a subTenon's injection after which the left pupil remained dilated. He developed left vitreous haemorrhage and was treated with a further 1200 argon laser burns with topical anaesthesia alone.

Eighteen months later the left pupil remained dilated, larger than the right, although it did improve a

Table 3 Laser treatment to the left eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
	Diode	1200	SubTenon's	Dilated
Total		1200		

Table 4 Laser to the right eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
1st laser session	Argon	1000	Topical	None
2nd laser session (2 months later)	Diode	1000	Topical	None
3rd laser session (5 months later)	Diode	1000	Topical	None
4th laser session (2 months later)	Diode	1300	SubTenon's	Slightly dilated
Subtotal		4300		
5th laser session (5 months later)	Argon	1000	Topical	No worse
Total		5300		

little. He found bright lights difficult especially on sunny days. Adaptation from light to dark was slow. Reading and distance vision was satisfactory. His vision in bright sunshine was greatly improved with G. pilocarpine 1% to both eyes (see Tables 4 and 5). Both pupils showed positive denervation hypersensitivity based on the pilocarpine test (see Figure 3) and in the right eye there was also mild (+) vermiform movements whereas there were moderate (++) vermiform movements in the left eye.

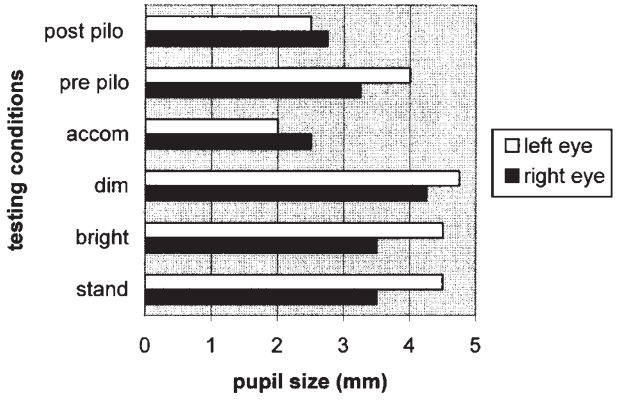

Figure 3 Pupil changes for Case 3. Abbreviations as in Figure 1.

Table 5 Laser to the left eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
1st laser session	Diode	1000	Topical	None
2nd laser session (1 month later)	Diode	2000	Topical	None
3rd laser session (5 months later)	Diode	1277	SubTenon's	Dilated
Subtotal		4277		
4th laser session (5 months later)	Argon	1000	Topical	No worse
Total		5277		

Case 4

A 20-year-old male with insulin-dependent diabetes, since the age of 2, developed bilateral NVD and NVE with a corrected visual acuity of right 6/5 and left 6/6. He was treated with Diode panretinal photocoagulation to both eyes. He found the treatments quite painful so the second PRP was done with a subTenon's injection of lignocaine and bupivacaine.

One week later he returned complaining of blurred vision and a large pupil on the right side. His distance vision was 6/6 with glasses but he was unable to read and the pupil was dilated with no reaction to light and accommodation. He required a +2.00 DS lens to read. Two weeks after the treatment the pupil had recovered a little. He was lost to follow-up. Eighteen months later the pupil was still enlarged and he was still symptomatic. Unfortunately he was not available for examination and there were no more details (see Tables 6 and 7)

Discussion

A tonic pupil (dilated with loss of accommodation) is a recognised complication of PRP, which may either be

Table 6 Laser treatment to the right eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
1st laser session	Diode	1002	Topical	None
2nd laser session (2 months later)	Diode	2136	SubTenon's	Dilation
Total		3136		

Table 7 Laser treatment to the left eye

	Laser	*Number of burns*	*Anaesthetic*	*Effect on pupil*
	Diode	1002	Topical	None
Total		1002		

transient or permanent. Its incidence may be under reported, as most patients in retinal clinics are seen after their pupils have been dilated and patients may not notice small amounts of anisocoria. To our knowledge it has not been previously described following diode laser or a subTenon's anaesthetic. However Schiodte has reported its occurrence in patients treated with either argon or xenon photocoagulation with retrobulbar anaesthesia.[4]

Parasympathetic fibres supply the ciliary body for accommodation and the sphincter muscle in the iris to constrict the pupil. The nerves synapse in the ciliary ganglion and continue as the short ciliary nerves, which penetrate the sclera around the optic nerve and run forward in the suprachoroidal space to the ciliary body and iris.[10]

The site of the lesion in our patients is postganglionic, ie either in the short ciliary nerves or in the ciliary ganglion as the lesion produced is very similar to a tonic Adie's pupil with pupil dilatation, poor reaction to light, loss of accommodation and positive denervation supersensitivity to 0.1% pilocarpine. All three patients available for examination exhibited denervation supersensitivity to 0.1% pilocarpine.

Kaufman performing horizontal retinal meridian photocoagulation on the monkey eye, showed that the parasympathetic nerve fibres run primarily if not exclusively with the numerous short posterior ciliary nerves.[8] Hence full (scatter) PRP could interrupt them at any anterior-posterior level peripheral to the immediate area of the disc and macula.

There are many papers on subTenon's local anaesthetic (LA) for intraocular surgery and laser treatment including: Fukusaku using this technique in 3000 cataract operations,[11] Steven in 12 patients,[12] and Freiberg in 36 patients[13] using subTenon's anaesthetic for PRP in diabetics. None have reported ciliary nerve damage. The injection is into the inferonasal quadrant and the ciliary ganglion lies in the inferotemporal quadrant. The LA spreads around the globe in the subTenon's space.[9] Theoretically the volume of fluid could damage the short ciliary nerves. However we think this is unlikely as tens of thousands of subTenon's LA have been given for cataract surgery and it has never been reported in the literature.

Schiodte suggested that damage occurs to the short ciliary nerves by the laser as they traverse the suprachoroidal space having left the ciliary ganglion on their way to the ciliary body and iris.[4] This would seem a likely explanation as pupil dilation may occur after PRP without periocular anaesthetic.[5,6,14] Histopathological comparisons of diode and argon lesions in the rabbit retina showed that the diode affects the outer retina, RPE and choroids, closer to these nerves, than does the argon, which characteristically affects the inner and outer retina including RPE.[15] Kaufman in his work on monkeys showed that the severity of the morphological changes in the nerves passing through the choroids depended directly on the intensity of the laser burn and the proximity of the nerve to the burn.[8]

A patient anaesthetized with a subTenon's injection for diode photocoagulation will allow the operator to apply more treatment in one session, which may result in greater nerve damage. The unanaesthetized patient may be more protected from excess damage to the nerves because of the perceived discomfort.

Patients with diabetes mellitus, as part of the disease process, may experience a decrease in accommodative amplitude probably secondary to an autonomic neuropathy.[16] However PRP by itself also has a statistically significant effect on further reducing these amplitudes.[16]

A combination of factors may have occurred in our cases. An underlying vulnerability secondary to an autonomic neuropathy may exist. This becomes clinically significant after diode laser burns which are able to penetrate to the deeper layers inducing greater parasympathetic fibre damage in a patient anaesthetized by a subTenon's injection. Damage to the pupils occurred after as little as 1200 burns, which is not excessive treatment. The range of total number of burns before pupil dilation developed was 1200–4300. In these four cases the pupil dilation developed after diode and subTenon's anaesthetic injection, not after diode alone or argon laser therapy.

Conclusion

We have presented four cases of persistent pupil dilation following diode laser pan-retinal photocoagulation with subTenon's local anaesthetic. Short ciliary nerve damage may be more likely with the diode laser as it penetrates the retina and choroid more deeply than argon laser. SubTenon's LA injection allows more treatment to be applied at one session so the combination of diode laser PRP and subTenon's LA may increase the risk of this complication.

More research is needed to see if this new

complication is associated with diode laser or with a subTenon's anaesthetic. Pilocarpine 1% prn gave symptomatic relief in both patients who used it and so a trial of therapy is suggested in symptomatic patients.

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