Long term results of diode laser cycloablation in complex glaucoma using the Zeiss Visulas II system

S Ataullah, S Biswas, P H Artes, E O’Donoghue, A E A Ridgway, A F Spencer

Aim: To investigate the safety and efficacy of the Zeiss Visulas II diode laser system in the reduction of intraocular pressure (IOP) in patients with complex glaucoma.

Methods: The authors analysed the medical records of patients who underwent trans-scleral diode laser cycloablation (TDC) at the Manchester Royal Eye Hospital during a 34 month period. 55 eyes of 53 patients with complex glaucoma were followed up for a period of 12–52 months (mean 23.1 months) after initial treatment with the Zeiss Visulas II diode laser system.

Results: Mean pretreatment IOP was 35.8 mm Hg (range 22–64 mm Hg). At the last examination, mean IOP was 17.3 mm Hg (range 0–40 mm Hg). After treatment, 45 eyes (82%) had an IOP between 5 and 22 mm Hg; in 46 eyes (84%) the preoperative IOP had been reduced by 30% or more. The mean number of treatment sessions was 1.7 (range 1–6). At the last follow up appointment, the mean number of glaucoma medications was reduced from 2.1 to 1.6 (p<0.05). In 10 eyes (18%), post-treatment visual acuity (VA) was worse than pretreatment VA by 2 or more lines.

Conclusions: Treatment with the Zeiss Visulas II diode laser system can be safely repeated in order to achieve the target IOP. Treatment outcomes in this study were similar to those from previously published work using the Iris Oculight SLx laser.

Trans-scleral diode laser cycloablation (TDC) is an established treatment for complex glaucoma—that is, glaucoma which is unresponsive to medical therapy and surgical intervention, and for glaucoma where such therapies carry a high risk of failure. TDC selectively destroys the ciliary body pigment epithelium and has a comparatively low rate of complications.

To date, most studies of this treatment have reported on the Oculight SLx diode laser (Iris Medical Instruments, Mountain View, CA, USA) with the contact G-Probe. A previous study on the Zeiss II Visulas system reported on results in a predominantly Oriental group of patients. There are few data available on the efficacy of the Zeiss Visulas II diode laser in white patients.

In this paper, we report on long term results of 55 eyes of 53 predominantly white patients treated at the Manchester Royal Eye Hospital using the Zeiss Visulas II system.

PATIENTS AND METHODS

A retrospective analysis was undertaken of medical records of all patients with complex glaucoma who underwent trans-scleral diode laser cycloablation (TDC) at the Manchester Royal Eye Hospital during a 34 month period.

Indications for TDC were:

(a) medically uncontrolled glaucoma where further surgical treatment carried a high risk of failure, either because of previous failed surgery or a form of glaucoma with an inherently poor response to conventional surgical treatments
(b) intolerance to antiglaucoma medications (in particular systemic carbonic anhydrase inhibitors)
(c) painful blind glaucomatous eyes for which palliative treatment was required.

Patients were excluded from the study if:

(a) any cyclodestructive treatment other than TDC treatment with the Zeiss Visulas II had been applied (14 eyes), or
(b) less than 12 months' follow up data had be collected (n = 1 eye).

Fifty five eyes of 53 patients (23 males, 30 females; 49 white, three Asian Indians, one Afro-Caribbean) met the inclusion criteria. The mean follow up period was 23.1 months (range 12–53 months). The mean age for patients at time of first treatment was 59 years (range 6–90 years). Patients’ eyes were categorised into diagnostic subgroups according to the type of glaucoma. These were primary open angle glaucoma (POAG, n = 5), secondary open angle glaucoma (SOAG, n = 9), aphakic glaucoma (n = 10), chronic angle closure glaucoma (CAGC, n = 5), secondary angle closure glaucoma (SACG, n = 10), rubeotic glaucoma (n = 12), developmental glaucoma (n = 6), uveitic glaucoma (n = 6), and glaucoma after vitrectomy with silicone oil (n = 5). Table 1 shows the number of eyes in each diagnostic subgroup. No eyes underwent therapy other than diode laser, such as tube surgery, at this time.

The Zeiss Visulas II system uses a probe with a glass ball tip to focus the laser beam (wavelength 810 nm) to a 740 µm spot, 2.1 mm beyond the ball tip. Laser energy is delivered trans-conjunctivally via a fibre optic cable attached to the probe. The probe is reusable and the glass ball tip is sterilised between use. The laser energy output of the fibre optic cable is checked regularly to confirm it is undamaged.

The anterior margin of the 3.0 mm diameter probe was placed along the surgical limbus, perpendicular to the sclera, so that the centre of the focusing tip was positioned 1.5 mm posterior to the limbus. Transillumination was used to ascertain the position of the ciliary body and the probe position was adjusted accordingly.

Laser settings were fixed at 1500 mW of power applied for 1500 ms, as initially recommended by Zeiss. The number of applications ranged from 12 to 30 (median number of applications 24) delivered over 180–360 degrees. Fewer applications were used on occasion where there was concern not to induce phthisis, more applications where required to treat a full 360 degrees.

Local anaesthesia was administered to all patients with the exception of six paediatric patients who underwent TDC under general anaesthesia. Local anaesthetic was delivered as a peribulbar, retrobulbar, or sub-Tenon infiltration (3–5 ml of a 50/50 mixture of 2% lignocaine and 0.25% bupivacaine, or 3–5 ml of 3% prilocaine). Immediately after treatment, a subconjunctival injection of 4 mg of betamethasone was administered and patients continued their usual antiglaucoma medication. Topical steroid drops were administered for 1 week and
talled off thereafter, according to the degree of post-surgical inflammation. Glaucoma medications were withdrawn as dictated by the IOP response.

The data recorded at baseline (preoperative evaluation) included VA, IOP number of medications, slit lamp biomicroscopy appearance, and funduscopy. The same data were recorded from post-surgical evaluations performed at 1 day, 1 week, 1 month, 6 months, and 12 months following the first TDC. A final set of data was obtained from the most recent follow-up visit. Additional data recorded at each follow-up included the presence of any complications.

A numerical value of 1 to 12 was assigned to each grade of visual acuity from 6/6 on the Snellen chart (assigned a numerical value of 1) to no perception of light (assigned a numerical value of 12). This enabled us to include the lower grades of acuity (count fingers, hand movement, perception of light, and no perception of light) in the statistical analysis.

Previous reports have used different criteria to define the success of treatment. To provide data for comparison, we applied three different criteria for treatment success. Treatment success was defined as:

(a) post-treatment IOP between 5 and 22 mm Hg
(b) post-treatment IOP between 5 and 17 mm Hg
(c) a reduction in IOP of 30% compared with pretreatment IOP

RESULTS

The mean preoperative IOP was 35.8 mm Hg (SD 9.7, range 22–64). At 12 months after the first treatment mean IOP was 18.3 mm Hg (SD 8.3, range 1–42). At the last review (12–53 months after first treatment) mean IOP was 17.3 mm Hg (SD 7.7, range 0–40).

Longitudinal data of the group as a whole show a definite decline in IOP over the follow-up period, from 21.75 (SD 10.2) mm Hg at 1 week to 17.8 (SD 7.7) mm Hg by 12 months and to 17.4 (SD 7.7) mm Hg at final follow-up.

Figure 1 compares pretreatment IOP with IOP recorded at the last examination. Using our criteria for success:

(a) 45 eyes (82%) had an IOP between 5 and 22 mm Hg
(b) 30 eyes (54%) had an IOP between 5 and 17 mm Hg
(c) 46 eyes (84%) had an IOP reduction of 30% or more, compared with pretreatment IOP.

Fifty one eyes (93%) received TDC in order to achieve better IOP control and four eyes (7%) received TDC in order to relieve pain. Although all four eyes treated for pain relief had a satisfactory reduction in IOP (46–86% reduction in pretreatment IOP), one eye remained painful and eventually required enucleation.

Table 1 shows the mean pretreatment and post-treatment IOP for each diagnostic subgroup. Patients with rubeotic glaucoma had a significantly higher pretreatment IOP than patients in other diagnostic groups (Kruskall-Wallis non-parametric analysis of variance by ranks, p<0.05). The differences in IOP between the groups were no longer statistically significant at the last examination (Kruskall-Wallis, p = 0.34). The median number of applications was 24 (range 12–30).

The mean energy applied at each treatment was 52 J (range 27–68 J). Twenty eight eyes (51%) required repeat treatment of TDC and the mean total energy applied per eye was 91 J (range 34–281 J). There was no significant difference in the mean energy applied between the diagnostic subgroups (Kruskall-Wallis, p = 0.16).

The total number of TDC sessions per eye ranged from 1 to 6 (mean 1.7). Twenty seven eyes (49%) had a single TDC session, 19 eyes (34%) underwent two sessions, seven eyes (13%) underwent three sessions, one eye (2%) had four treatments, and one eye (2%) required six sessions. The total number of treatments required was not related to preoperative IOP (Kruskall-Wallis ANOVA, p=0.66). There was a tendency for patients with aphakic glaucoma to require more treatment sessions than the other groups (mean number of sessions 2.7, range 1–6, p = 0.074).

The eyes that required re-treatment had a significantly higher IOP at 1 month (before any additional diode laser thus reflecting the initial effect of the diode laser) than eyes that did not require re-treatment (mean 25.9 mm Hg compared with 19.8 mm Hg; p<0.05).

![Figure 1](https://www.bjophthalmol.com)

**Figure 1** Preoperative IOP versus postoperative IOP at last examination. Solid line at 22 mm Hg. Dotted line at 17 mm Hg. Broken line represents 30% IOP reduction. (The numeral 2 next to data point indicates that two individuals are at this data point.)

![Figure 2](https://www.bjophthalmol.com)

**Figure 2** Preoperative VA versus postoperative VA at last examination. Solid line represents no change in VA. Broken lines represent a change of two grades of VA. (Two eyes are excluded, VA was unmeasurable because of learning disability.)
The mean total number of medications required at baseline was 2.1 (range 0–6). This was reduced to 1.6 (range 0–4) at the last review (Wilcoxon signed ranks test, p<0.05). Moreover, the requirement for oral acetazolamide was substantially reduced. Seventeen patients (32%) required oral acetazolamide before TDC; only four (8%) were still taking it at their last examination (p<0.005).

Table 2 summarises the probable causes of this change.

<table>
<thead>
<tr>
<th>Case no</th>
<th>Preop VA</th>
<th>VA at last exam</th>
<th>Diagnosis</th>
<th>Cause of altered visual acuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6/24 HM</td>
<td>POAG</td>
<td></td>
<td>Presumed progression of visual field loss</td>
</tr>
<tr>
<td>2</td>
<td>HM NPL</td>
<td>SOAG</td>
<td></td>
<td>Bacterial keratitis and glaucoma progression</td>
</tr>
<tr>
<td>3</td>
<td>CF PL</td>
<td>SOAG</td>
<td></td>
<td>Failure: glaucoma progression due to refractory rise in IOP after 2nd TDC</td>
</tr>
<tr>
<td>4</td>
<td>6/60 HM</td>
<td>SOAG</td>
<td></td>
<td>Retinal detachment 8 months postoperatively</td>
</tr>
<tr>
<td>5</td>
<td>6/36 HM</td>
<td>SACG</td>
<td></td>
<td>Glaucoma progression due to widely fluctuating IOP in between TDC sessions</td>
</tr>
<tr>
<td>6</td>
<td>6/60 HM</td>
<td>Aphakic</td>
<td></td>
<td>Failure: high IOP and glaucoma progression</td>
</tr>
<tr>
<td>7</td>
<td>6/60 NPL</td>
<td>Rubecotic (ocular ischaemic syndrome)</td>
<td></td>
<td>Ischaemic visual loss</td>
</tr>
<tr>
<td>8</td>
<td>HM NPL</td>
<td>Rubecotic (CRVO)</td>
<td></td>
<td>Failure: high IOP and ischaemic loss</td>
</tr>
<tr>
<td>9</td>
<td>6/18 CF</td>
<td>Developmental</td>
<td></td>
<td>Presumed progression of visual field loss</td>
</tr>
<tr>
<td>10</td>
<td>CF PL</td>
<td>Developmental</td>
<td></td>
<td>Retinal detachment 7 months postoperatively</td>
</tr>
<tr>
<td>11</td>
<td>HM 6/36</td>
<td>Rubecotic</td>
<td></td>
<td>Resolution of vitreous haemorrhage</td>
</tr>
<tr>
<td>12</td>
<td>CF 6/60</td>
<td>SOAG</td>
<td></td>
<td>Resolution of corneal oedema</td>
</tr>
<tr>
<td>13</td>
<td>3/60 6/36</td>
<td>SOAG</td>
<td></td>
<td>Resolution of corneal oedema</td>
</tr>
</tbody>
</table>

POAG = primary open angle glaucoma, SACG = secondary angle closure glaucoma, SOAG = secondary open angle glaucoma, CRVO = central retinal vein occlusion.

DISCUSSION

Current treatments available for complex glaucomas include the insertion of drainage tubes and cyclodestructive procedures, such as TDC. TDC is less invasive than the insertion of drainage tubes and is associated with lower rates of postoperative hypotony. Alternative cyclodestructive procedures (cyclocryocoagulation and Nd:YAG laser cycloablation) are associated with greater rates of postoperative inflammation and hypotony than TDC. Diode laser (810 nm wavelength) is better absorbed by the ciliary body pigment epithelium than Nd:YAG laser (1064 nm). This, together with its portability, durability, and reduced maintenance requirements, makes diode laser the cyclodestructive treatment of choice for complex glaucomas.

Most studies reporting on the efficacy of TDC have used the Oculight SLx with the fiberoptic G-probe delivery system (Iris Medical Instruments, Inc, Mountain View, CA, USA). The purpose of our study was to ascertain the safety and efficacy of TDC using an alternative system that delivers energy through a focusing glass ball tip at the end of a fiberoptic cable (Zeiss Visulas II, Carl Zeiss, Jena, Germany).

Wong et al reported on results with the Zeiss Visulas probe in 33 predominantly oriental patients. The mean follow up period of this study was 9.4 months, and 50% of their patients had treatment for rubeotic glaucoma, compared to only 15% in our study. In contrast, most of the 53 patients reported on in our research were white; they had a wider range of pathologies and were followed for a longer period (mean 23.1 months). The different ethnic backgrounds and diagnostic case mix in the study by Wong et al hinder direct comparisons with the other studies using the Oculight SLx system. Moreover, their criteria for re-treatment (IOP above 28 mm Hg) resulted in a lower re-treatment rate (24% vs 51% in our study) and a higher mean postoperative IOP (24.4 mm Hg). Probably as a result of lower re-treatment rates, their overall success rate of 38% (IOP 2–21 mm Hg) is lower than that reported in this paper (82% of eyes in our study).

We demonstrated a significant reduction in the mean total number of medications required from 2.1 before to 1.6 after treatment. Of note was the reduced requirement for oral acetazolamide (32% before treatment compared with 7% after treatment) which is associated with a wide range of systemic side effects and is often poorly tolerated.

Significant postoperative visual loss has been associated with cyclodestructive procedures. VA reduction has been reported in between 30% and 70% of eyes following...
undertaken. A slight upward trend in the mean IOP was noted. We therefore recommend that TDC can safely be repeated until the target IOP has been achieved. No eyes were retreated before 4 weeks post TDC (24% of treated eyes achieved a maximal IOP reduction 4 weeks post-treatment). At 1 month follow up a slight upward trend in the mean IOP was noted. We therefore recommend allowing this period to elapse before any re-treatment is undertaken.

REFERENCES

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