

Transscleral diode laser cyclophotocoagulation for the treatment of refractory glaucoma secondary to inflammatory eye diseases

Torsten Schlote, Matthias Derse, Manfred Zierhut

Abstract

Background—Inflammatory glaucoma is still a diagnostic and therapeutic dilemma and surgical intervention is always associated with a high risk of failure or reactivation of the inflammatory disease. In this study we prospectively examined the value of transscleral diode laser cyclophotocoagulation (TDLC) for the treatment of refractory inflammatory glaucoma.

Methods—22 eyes of 20 consecutive patients with inflammatory, medically uncontrollable, glaucoma secondary to chronic uveitis/trabeculitis (n = 18), chemical injury (n = 2), episcleritis (n = 1), and necrotising scleritis with inflammation (n = 1) were treated by TDLC. Nine eyes (41%) had had previous failed glaucoma surgery (trabeculectomy, cyclocryocoagulation) and 15 eyes (68.2%) had had previous anterior segment surgery. All patients were followed for 1 year after the initial treatment.

Results—Within 12 months of the first treatment the intraocular pressure was controlled in 77.3% of all eyes (72.2% of those with uveitic glaucoma). No serious side effects such as activation of the inflammatory process, phthisis bulbi or persistent hypotonia were observed, except one patient with a temporary fibrin reaction. More than one treatment was necessary in 63.6% of the patients. The use of systemic carbonic anhydrase inhibitors was reduced from 68.2% before treatment to 27.3% after 1 year.

Conclusion—TDLC seems to be a safe and effective procedure for the treatment of inflammatory glaucoma and may become an alternative to trabeculectomy with antimetabolites in uveitic glaucoma. TDLC may become the surgical procedure of choice in treating secondary glaucoma caused by chemical injury and also in scleritis associated glaucoma, using reduced parameters for application.

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Inflammatory glaucoma is still a diagnostic and therapeutic dilemma. The reliability of diagnostic procedures is often limited and new therapeutic procedures require a relatively long time to be evaluated because inflammatory glaucoma occurs in only a small number of eyes.¹ Furthermore, some antiglaucomatous drugs such as miotics, metipranolol, and latanoprost seem to be contraindicated, not effective, or have not yet been investigated.^{2–5}

Surgical intervention such as trabeculectomy or cyclocryotherapy is always associated with a high risk of failure or activation of the inflammatory disease. Further research is therefore needed on the therapeutic possibilities for inflammatory glaucoma.

Transscleral diode laser cyclophotocoagulation (TDLC) is a relatively new cyclodestructive procedure in the treatment of advanced refractory glaucoma. Although clinical experience is still limited, less severe side effects occur with this method than with cyclocryocoagulation or neodymium:YAG cyclophotocoagulation.^{4–6} Our own observations, as well as those reported in the literature, show that less inflammatory response is induced with cyclophotocoagulation than with cyclocryotherapy. Success rates of 38–85% have been reported with TDLC, regardless of the various differences between these studies.^{4–15} No large or prospective study has investigated the effectiveness and safety of TDLC in inflammatory glaucoma.

The purpose of this prospective study was to determine whether TDLC may be an effective, as well as safe, procedure for lowering intraocular pressure (IOP) in glaucoma caused by inflammatory ocular diseases.

Patients and methods

In January 1997 we initiated a prospective study to evaluate the effectiveness and safety of contact TDLC in cases of advanced glaucoma refractory to medical, surgical, or alternative treatments. Out of 100 consecutive patients, 20 patients (22 eyes) had inflammatory glaucoma without pupillary block and were mostly recruited from the outpatient service for inflammatory eye diseases at the University Eye Hospital, Tuebingen. Because information on the effectiveness of surgical procedures in inflammatory glaucoma is generally limited, we describe and discuss these patients separately.

All patients had inflammatory glaucoma which was uncontrolled despite maximum medical treatment. TDLC was performed if previous glaucoma surgery (trabeculectomy, cyclocryocoagulation) had failed, if there were additional risk factors for trabeculectomy and cyclocryocoagulation were associated with a very high risk of severe side effects (necrotising scleritis). All patients gave informed consent for cyclodiode treatment.

At our hospital subconjunctival anaesthesia was introduced as the standard procedure for TDLC in 1997.⁵ Oxybuprocaine, approximately 4–6 drops, was instilled in the eye and

Department of
General
Ophthalmology and
Experimental
Ophthalmic Surgery,
University Eye
Hospital, Tuebingen,
D-72076, Germany
T Schlote
M Derse
M Zierhut

Correspondence to:
Dr T Schlote
Torsten.Schlote@
med.uni-tuebingen.de

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2.5 ml 2% mepivacaine was then placed beneath the conjunctiva. The needle was carefully placed 6–8 mm from the limbus to avoid bleeding at the injection site near the limbus. The eye was patched for 15 minutes with low pressure. No sedation by oral or intravenous medication was given. Only a 9 year old child and a woman with anterior necrotising scleritis with staphyloma formation were treated under general anaesthesia. The laser energy was delivered through a contact fibreoptic G probe (IRIS Endoprobe) attached to the Oculight SLx semiconductor diode laser (Iris Medical Instruments Inc, CA, USA).

Treatment was defined as successful if the IOP could be reduced to 5–21 mm Hg with or without medication in all eyes with a visual acuity of at least 0.02 or more and in monocular patients. In eyes with a visual acuity of hand movements or less (including blind eyes) TDLC was performed to reduce a very high IOP to less than 30 mm Hg and, additionally, to reduce pain and avoid further complications and enucleation. A further aim of the treatment was reduction of the use of systemic carbonic anhydrase inhibitors in all patients. Normal treatment consisted of 10–15 applications of 2.0 W energy applied for 2 seconds to treat not more than 270° (not more than 180° in patients with glaucoma secondary to chemical injury). The energy level and length of treatment were reduced in cases of thinned sclera such as necrotising scleritis and after the occurrence of pop effects.

After surgery 0.5 ml dexamethasone was applied subconjunctivally. The patients received topical non-steroidal anti-inflammatory medication (diclofenac) five times a day (no cells or cells 1+ in the anterior chamber) or topical corticosteroids (prednisolone acetate 1%, cells >1+). Antiglaucomatous medication was continued and gradually withdrawn during the follow up period. At first, oral carbonic anhydrase inhibitors were withdrawn. If no adequate IOP response was obtained 6 weeks after the first treatment, patients underwent repeated TDLC for a maximum of four treatments.

Baseline information included age, race, sex, underlying inflammatory disease, visual acuity, IOP, medication, slit lamp biomicroscopic appearance, optic nerve head appearance, previous glaucoma, and other surgery.

Follow up examinations were performed on the first day and after 6 weeks, 3 months, 6 months, 9 months, and 12 months. After every TDLC the effect of treatment was monitored after 6 weeks. At each follow up examination the visual acuity, IOP, medication, slit lamp biomicroscopic appearance, and complications were recorded.

Statistical analysis was performed using the paired *t* test to evaluate changes from baseline IOP and number of medications.

Results

Patient characteristics are shown in Table 1. Of the 22 eyes, nine (40.9%) had previous failed glaucoma surgery (trabeculectomy, laser trabeculoplasty, cyclocryocoagulation) and 15

Table 1 Characteristics of patients and diagnosis

Number of patients (all white)	20
Number of eyes	22
Mean (SD) age (years)	50.3 (20.6)
range	9–77
F:M	13:7
Underlying inflammatory eye diseases	
CAU of unknown aetiology	5
Herpes keratouveitis/trabeculitis	6
CAU associated with JCA	3
CAU in Cogan's syndrome	2
Intermediate uveitis of unknown aetiology	1
Panuveitis of unknown aetiology	1
Necrotising scleritis with inflammation and uveitis	1
Episcleritis	1
Chemical injury	2
Previous glaucoma surgery	
Trabeculectomy	5
Cyclocryocoagulation	5
Laser trabeculoplasty	2
Previous other surgery	
Pseudophakic	6
Aphakic	6
Keratoplasty	2
Excision of conjunctival tissue after chemical injury	1

CAU = chronic anterior uveitis, JCA = juvenile chronic arthritis.

(68.2%) had previous anterior segment surgery. In all patients the underlying inflammatory disease was controlled by anti-inflammatory medication before TDLC was performed and remained the same postoperatively.

Only two patients were treated under general anaesthesia: a 60 year old woman with necrotising scleritis with inflammation and staphyloma formation (high risk of perforation) and a 9 year old girl with chronic anterior uveitis associated with juvenile chronic arthritis (JCA). In the remaining 18 patients sufficient anaesthesia was achieved by subconjunctival injection of mepivacaine 2%. During the follow up of 12 months, 44 TDLCs (mean of two treatments per eye) were performed. Eight eyes received a single treatment, seven eyes received two treatments, six eyes received three treatments, and one eye received four treatments. Because no response was seen in the child with JCA associated uveitis and glaucoma, a cyclocryocoagulation was performed 9 months after the initial TDLC. The symptoms in the patient with necrotising scleritis with inflammation were controlled with methotrexate. Because of the circular scleral thinning with staphyloma formation, the total energy for TDLC was reduced to nearly one quarter (12 laser spots, 1 second, 1.25 W). No activation of scleritis or uveitis was seen postoperatively and IOP was controlled.

The mean pretreatment IOP for all eyes (except the child with cyclocryocoagulation after 9 months) was 30.7 (SD7.3) mm Hg and significantly decreased to 21.5 (7.8) mm Hg after 6 weeks ($p = 0.0002$), 21.98 (7.6) mm Hg after 3 months ($p = 0.0003$), 18.7 (7.5) mm Hg after 6 months ($p < 0.0001$), 17.8 (7.6) mm Hg after 9 months ($p < 0.0001$), and to 19.4 (8.9) mm Hg at 12 months ($p < 0.0001$). Successful lowering of IOP as defined above was achieved in 17 eyes (77.3%). The use of systemic carbonic anhydrase inhibitors was reduced from 68.2% before treatment to 27.3% after 1 year. The

Table 2 Complications after TDLC in 22 eyes with inflammatory glaucoma

Complications/side effects	No of eyes (%)
During CPC	
Pop effects	2 (9)
Conjunctival burns	1 (4.5)
First day postoperatively	
Cells and flare	12 (54.5)
Fibrin clot	1 (4.5)
Erosio corneae	1 (4.5)
Within 12 months after first CPC	
Decreased visual acuity	8 (38.1)
Hypotonia (<5 mm Hg)	0
Phthisis	0

CPC = cyclophotocoagulation.

Table 3 Visual acuity before cyclophotocoagulation (n = 22) and after 1 year (n = 21) of follow up

Visual acuity	Preoperatively	After 1 year
20/16–20/20	2	3
20/25–20/32	4	2
20/40–20/50	2	2
20/63–20/100	2	3
20/400–20/200	5	5
HM	4	2
LP	1	3
NLP	1	1

NLP = no light perception, LP = light perception, HM = hand movements.

The 9 year old child with JCA received cyclocryocoagulation 9 months after initial TDLC and was excluded. The decrease in visual acuity in eight patients was caused by cataract progression in two eyes, increased corneal opacification in two, and glaucoma progression in four eyes.

average number of topical antiglaucomatous drugs used was 2.55 (1.5) before surgery and 2.0 (1.2) after 12 months follow up ($p = 0.08$).

The procedure failed in five eyes with uveitic glaucoma so the success rate in 18 eyes with uveitic glaucoma was 72.2%. Fifteen cyclophotocoagulations were performed in these five eyes. Two of the five eyes were aphakic; three had previous failed cyclocryocoagulation (including the child with JCA associated uveitis) and two a previous failed trabeculectomy.

In all 22 eyes no serious complications occurred during the 12 months following the initial treatment (Table 2). Nearly half of the patients had mild anterior uveitis on the first postoperative day. Only one female patient with secondary glaucoma after herpes kerato-uveitis and perforating keratoplasty had a fibrin reaction in the anterior chamber. Using subconjunctival dexamethasone and topical prednisolone acetate, the fibrin reaction disappeared after three days. No reactivation of the underlying inflammatory disease was seen.

Visual acuity remained the same in eight eyes (38.1%), improved in five (23.8%), and decreased in eight eyes (38.1%) (Table 3). The decrease in visual acuity in eight patients was caused by cataract progression in two eyes, increased corneal opacification/scarring in two (chemical injury, keratouveitis), and progression of glaucomatous optic neuropathy in four eyes.

Discussion

The results of our study indicate that TDLC can be successfully performed with a low risk for complications in inflammatory glaucoma. There were no cases of phthisis, hypotonia, or marked activation of the underlying inflamma-

tory disease except in one patient with a fibrin reaction. The overall success rate of 77.3% is comparable to that found in other studies on the use of TDLC in patients with heterogeneous glaucoma.^{4–15} However, in contrast to other studies, we found that repeated treatments were often necessary (63.6%).

In this study TDLC was successful in 72.2% of 18 eyes with uveitic glaucoma. Our results are in accordance with the recently published analysis by Spencer and Vernon⁷ who reported on nine eyes with uveitic glaucoma out of 58 eyes with different types of glaucoma. Their results were comparable to other types of glaucoma (aphakic glaucoma, primary open angle glaucoma) and no phthisis or marked activation of the underlying inflammatory disease was observed. In the largest study on the treatment of refractory glaucoma by TDLC, nine out of 210 eyes had uveitic glaucoma.⁶ The inflammatory reaction after treatment did not differ from that found in other types of glaucoma. Similar findings were also reported by Brancato *et al*,⁴ although they found that TDLC was successful in only two of five eyes. Several reports on non-contact neodymium:YAG laser cyclophotocoagulation include a limited number of eyes with uveitic glaucoma and also report a good outcome with no increase in complications compared with those found with other types of glaucoma.^{16–18}

The results obtained with TDLC have to be discussed in comparison with other surgical procedures such as trabeculectomy, Molteno implantation, and cyclocryocoagulation. It is known that trabeculectomy in patients with uveitis or previous surgery is associated with a relatively high risk of failure.¹⁹ Using antimetabolites, the results of trabeculectomy improved, although a significant risk of side effects (bleb related side effects such as prolonged hypotonia and corneal toxicity) exists.²⁰ In uveitic glaucoma trabeculectomy with 5-fluorouracil (5-FU) was successfully performed in 65–85% of eyes.^{21–23} However, Patitsas *et al*²⁴ found a high risk of cataract progression (90%) and failure in aphakic and pseudophakic eyes (45%) after trabeculectomy with 5-FU in uveitic glaucoma.

Bearing in mind that most of our patients had had previous anterior segment surgery, which is an additional risk factor for trabeculectomy, TDLC may become a comparable alternative to filtration surgery with antimetabolites. However, further information is needed about the long term outcome of TDLC in uveitic glaucoma as well as a direct comparison with trabeculectomy.

Molteno implantation may be another effective procedure but is associated with a relatively high incidence of complications (hyphaema, Tenon cyst formation, phthisis, choroidal effusion, and severe postoperative uveitis).^{25,26} Surprisingly good results were reported by Hill *et al*²⁷ who compared trabeculectomy without antimetabolites with Molteno implantation in patients with inflammatory glaucoma and found a 1 year and 2 year life table success rate of 81% and 73% for trabeculectomy and 79% and 79% for Molteno

implantation. Välimäki *et al*²⁸ evaluated the outcome of Molteno implantation in secondary glaucoma associated with JCA associated uveitis and achieved a successful outcome in 89% of eyes (mean follow up 40 months). However, intraoperative complications were seen in 26% of the patients and postoperative complications in 30%.

The high complication rate (phthisis, macular oedema, severe prolonged uveitis) associated with cyclocryotherapy with all types of glaucoma limits its use to the surgical procedure of last choice.^{29,30} Little is known about the efficacy and risks in inflammatory glaucoma. Some authors observed no increased rate of severe complications compared with other types of glaucoma.^{31,32} However, in a study of three eyes with inflammatory glaucoma and previous intraocular surgery treated with cyclocryocoagulation, Wesley and Kielar³³ reported that all three eyes developed hypotonia postoperatively. TDLC acts selectively by melanin absorption and therefore the inflammatory reaction may be less intense than with cyclocryotherapy. Because the incidence of severe complications is lower with TDLC, it should be preferred.

Scleritis associated and episcleritis associated glaucoma are rare secondary glaucomas. Only single reports can be found regarding the successful use of trabeculectomy.^{34,35} Because filtering surgery in scleritis may be associated with an increased risk of sclera melting and because scleritis itself is a potentially destructive disease, the adjuvant use of antimetabolites seems to be contraindicated. Cyclocryotherapy in scleritis may result in a marked activation of the inflammatory process and may additionally result in perforation or further scleral atrophy and thinning. Cyclocryotherapy should therefore only be performed if all other medical and surgical interventions (including cyclophotocoagulation) have failed to reduce the high IOP. In contrast, the normal sclera is usually not affected by cyclophotocoagulation.⁴ Only one case of perforation in an area of thinned sclera has been reported after TDLC with normal parameters (1.75 W, 2 seconds).⁸ Using TDLC we successfully treated a patient with necrotising scleritis with staphylococcal formation and secondary glaucoma. Because the need for energy adjustment in eyes with abnormal scleral thinning has been demonstrated experimentally, we reduced the applied total energy to nearly one quarter.³⁶

Information on the surgical management of secondary glaucoma resulting from severe chemical injury is also limited. Trabeculectomy has been successfully performed in a few cases in which the conjunctiva was less affected.³⁷ Nothing is known about the use of antimetabolites. The risk of cornea, sclera, and bleb related complications may be markedly increased and antimetabolites are therefore probably contraindicated. Cyclocryotherapy may induce a severe inflammatory response and cause further damage to the sclera. It remains the procedure of last choice. In 1988 Zaidman and Wandel³⁸ were the first to treat successfully an eye with uncontrollable glau-

coma after a severe alkali burn without complications using non-contact transscleral neodymium:YAG cyclophotocoagulation. We successfully treated two eyes with severe glaucoma after chemical injury by TDLC over 180°. No serious side effects occurred. Because usually no further scleral or conjunctival damage will be induced by TDLC, it should be preferred to cyclocryotherapy.

In conclusion, TDLC seems to be a safe and effective procedure for the treatment of inflammatory glaucoma. In uveitic glaucoma a direct comparison of TDLC and trabeculectomy with antimetabolites is needed. TDLC may become the surgical procedure of choice in treating secondary glaucoma resulting from chemical injury and also in scleritis associated glaucoma (using reduced parameters for application), because the risk of complications is probably lower than with other procedures. Nevertheless, further information is required, especially on the long term effects of TDLC.

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