

The Effectiveness of Trans-scleral Cyclodiode Treatment

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Abstract

Transcleral cyclodiode laser treatment is increasingly being used in the management of complex glaucoma. This review discusses the literature with reference to the effectiveness of this treatment modality as well as its potential limitations.

Keywords

Glaucoma, cyclodiode, laser

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Historical targeting of the ciliary body to achieve intraocular pressure control was first carried out with the use of cyclodiathermy¹ and cryotherapy² in the first half of the twentieth century but these have now largely been superseded by the use of laser photocoagulation.³ More recently, the neodymium Nd-YAG laser has been largely replaced by the 810 nm semiconductor diode laser which is better absorbed by the pigmented areas of the ciliary body.⁴

Cyclodiode laser treatment is used as a cyclodestructive procedure, where the ciliary body is ablated in order to reduce aqueous production, and is widely used in ophthalmology for the management of refractory glaucoma. In the majority of reported studies, refractory glaucoma has been defined as a condition where satisfactory intraocular pressure (IOP) has not been achieved despite maximum medical and surgical treatment, or where there such management is not tolerated or deemed to be inappropriate.^{5,6} Cyclodiode laser may be applied externally through the scleral coat of the eye or endoscopically under direct visualisation of the ciliary body.

Transcleral cyclodiode therapy is usually applied to the ciliary body with the use of a contact G-probe at the corneoscleral limbus. Treatment can be administered under local or general anaesthetic and transillumination is used by some surgeons to better delineate the position of the pars plicata of the ciliary body. The fibre-optic tip on the contact probe indents the conjunctiva and sclera during treatment, thus enabling more effective laser transmission to the underlying ciliary body. There is no widely accepted standardised treatment protocol for this technique and therefore the number and distribution of laser burns and laser power reported in the literature are highly variable.^{3,5,6} Traditional values for laser application are taken from cadaveric studies that have shown the optimum parameters for contact transcleral diode laser cyclophotocoagulation to be 3 to 4.5 J of energy delivered with the anterior edge of the probe 1.0 to 1.25 mm posterior to the limbus.⁷ Most operators tend to avoid the 3 and 9 o'clock meridian in order to avoid the anterior ciliary arteries and nerves and many glaucoma specialists would avoid the superotemporal segment to preserve the

conjunctival space for any potential glaucoma drainage surgery that may be required.⁶

This review will discuss the effectiveness of transcleral cyclodiode therapy with respect to intraocular pressure control and symptom relief, for different indications as well as its potential impact on vision and its side-effect profile.

Success of Cyclodiode Laser Therapy

The literature reports the success of cyclodiode according to the IOP reduction, the change in medication required for IOP control or reduction in symptoms. The large variation in the results probably reflects the lack of a universally accepted standardised protocol which has resulted in a variety of powers and techniques used, differing patient populations and age ranges and the types of glaucoma included.

The target IOP that is used to define success is highly variable but most studies report a statistically significant reduction in IOP following treatment.^{8–17} Overall cyclodiode laser treatment lowers the mean IOP by at least 33 % with most patients requiring an average of 1.5 treatments.^{8–11} Based on the final IOP achieved the overall success rate is reported as varying from 48 to 88 %.^{8–17} Interestingly eyes with an IOP >30 are more likely to have a >30 % drop in IOP and eyes with an IOP <30 mmHg are more likely to have a final IOP <22 mmHg.¹⁵

Significant reduction in the need for intraocular pressure lowering medication is achieved through the cessation of oral carbonic anhydrase therapy following cyclodiode therapy. Over 80 % patients are able to stop oral carbonic anhydrase treatment after cyclodiode treatment.^{5,9,10,18} If evaluation of the use of oral carbonic anhydrase inhibitors is excluded in the change in medication, then over a longer follow-up the number of medications did not significantly differ prior to and after treatment.¹⁵ Some reports indicate that it is possible to reduce the number of medications by two agents and the need for medication is more significantly reduced in patients undergoing treatment at a higher laser power, compared to those receiving a half power laser treatment.^{17,19}

Cyclodiode laser is highly effective in providing symptom relief in blind glaucomatous eyes, with 96.7 % patients obtaining relief of ocular discomfort after cyclodiode treatment. All had moderate or severe pain prior to cyclodiode laser and 73 % patients required one session of treatment only.²⁰

One of the disadvantages of cyclodiode treatment appears to be the need for repeated treatments. The re-treatment rate can vary from approximately 30 to 48 %. The number of treatment sessions is approximately two if long and short term studies are examined, with a higher re-treatment rate for younger patients, post-traumatic glaucoma and glaucoma after vitreo-retinal surgery.^{8,10,11,14,15,19-21}

Effectiveness of Cyclodiode Laser in Complex Glaucoma

It is apparent that the success of cyclodiode is related to the subtype of glaucoma. This can influence the IOP reduction achieved, the complication rate and the need for re-treatment and highlights the difficulty in comparing reports on cyclodiode outcomes from the literature as these will be affected by the population inclusion criteria for the study. Cyclodiode laser has been used to treat endstage primary glaucoma as well as secondary glaucoma following vitreo-retinal surgery using silicone oil, glaucoma in pregnancy, paediatric glaucoma, neovascular glaucoma, uveitic glaucoma and malignant glaucoma.²²⁻²⁶

The greatest drop in IOP is seen in secondary glaucoma, such as eyes with neovascular glaucoma, silicone oil and uveitic eyes. These eyes often have the highest re-treatment rate. Eyes with uveitis tend to be very sensitive to cyclodiode and therefore less treatment is needed and it is imperative to avoid hypotony.^{9,10} Previous therapy can also influence the success rate as demonstrated by Grueb et al. found that previous ocular surgery significantly reduced the effectiveness of cyclodiode treatment.²⁷

Although the success may be lower than in eyes without previous surgery, cyclodiode can be a useful therapy in these eyes. It may provide additional IOP-lowering in eyes where glaucoma drainage tube surgery has been inadequate.²⁹ Cyclodiode can also help lower IOP and medication requirement in 44–82 % eyes with chronic IOP elevation following the use of silicone oil as part of a vitreoretinal procedure. In these cases, removal of silicone oil or glaucoma filtering surgery are often not viable options.²²⁻²⁴ An interesting application of cyclodiode is described in the management of malignant glaucoma or aqueous misdirection, which can develop as a post-operative complication in eyes with angle closure.^{25,28} Although describing a small series, Stumpf et al. found that cyclodiode applied to two quadrants of the eye was effective in managing aqueous misdirection in these patients with only transient side effects.²⁵

It is apparent that in paediatric cases, more re-treatment is required with a mean number of 2.3 sessions per eye.^{21,31} Although many studies will differentiate between adult and paediatric cases, this is not always the case and should be borne in mind. Twenty-two per cent of patients needed subsequent tube drainage surgery while cyclodiode was useful as a temporising measure in these often complex cases.²¹

Once refractory glaucoma has developed, treatment options are limited with the main options often being cyclodiode laser or glaucoma drainage surgery. Although the cyclodiode is easier to perform, with a shorter recovery, the surgical and qualified success was greater with surgery and

with less visual deterioration.^{12,32} Some series however have reported up to an 81 % success with cyclodiode laser and this can lead to cyclodiode being the preferred treatment in these complex cases.¹⁵

Influence of Laser Power on Cyclodiode Therapy Outcomes

At present there is no universally accepted standardised protocol for the cyclodiode. Different approaches are used, with some surgeons opting for a more aggressive approach with higher powers, while others used lower powers with greater re-treatment. In a survey of 510 ophthalmologists in the UK it was found that the initial median dose settings used were 1,500 and 2,000 ms and on average 26 applications were administered per treatment.³ The coexistence of uveitis often led to a lower power setting while many increased the energy level for blind eyes.⁶

A few studies have specifically investigated whether the dose has an effect on the effectiveness of lowering IOP. Both prospective and retrospective studies have found no significant difference in the final mean IOP, change in IOP or percentage of eyes with a specified reduction in IOP when a full power dosing schedule has been compared to a lesser power schedule or if the number of laser applications is varied.^{8,12,30} Where a greater effect is seen from an increased power used, the results may reflect bias in the treatment dose selected for higher risk glaucoma where the complication rate is high and the IOP is less likely to respond without multiple laser applications.¹⁹

The lack of a dose-response relationship makes it difficult to titrate cyclodiode laser therapy based on individual patient characteristics and also highlight the complexity of developing an optimal treatment protocol. Complications appear to be less frequent with a lower energy and therefore repeated treatments may be more suitable in high risk patients to avoid complications.

Influence of Cyclodiode Laser on Visual Acuity

Reports of visual deterioration after cyclodiode laser range from seven to 64.3 % eyes and it is suggested that visual loss may be more common with repeated cyclodiode treatment.^{5,9,16,18,19,29} The effects on vision appear to increase with time. Over a 5-year period, the visual acuity reduced by one or more Snellen lines in 61 % patients and by two Snellen lines in 30 % patients.¹⁸ These findings should be interpreted in the context of the fact that cyclodiode laser has often been reserved for eyes with poor visual potential. Cataract progression and the natural history of advanced glaucoma are possible causative factors and it is hard to differentiate between those who had a decline in visual acuity due to the treatment and an inevitable decline which the cyclodiode failed to halt.⁵ Where the pre-treatment visual acuity is better than 20/60, the average visual acuity is unchanged.^{5,18} Egbert found in a prospective study that while 23 % subjects had reduced visual acuity following treatment, only 5 % of patients with vision better than 20/60 lost vision. Where visual decline was noted, the visual acuity in the fellow untreated eye reduced at the same rate as the treated eye, suggesting other factors external to the cyclodiode laser alone.

Reduction in visual acuity was unrelated to the laser dose used, number of treatments, the initial acuity or IOP level, suggesting that cyclodiode may not have a worse outcome for those with better visual acuity. In addition, since the reported effects are similar to visual reduction following tube (32 %) or trabeculectomy (33 %) surgery, cyclodiode laser is becoming an increasingly attractive alternative in the management of less advanced glaucoma with good visual potential.¹⁸

Complications of Cyclodiode Laser Therapy

A range of complications have been reported in various studies, including choroidal detachment, retinal detachment, conjunctival burns, uveitis, phthisis bulbi, corneal graft decompensation, hypotony and pain.^{11,13,17,31,33} The incidence of these complications varies widely and probably reflects the varying treatment schedules applied in each reported series. The incidence of reported hypotony and phthisis bulbi varies widely.^{11,18,19} Some studies have reported a correlation between high power and higher rates of hypotony.^{5,19} Nevertheless a clear relationship between laser energy and IOP response has not yet been demonstrated. Despite this it seems that protocols using more than 60 J per session are more likely to cause hypotony and phthisis which are rarely seen in protocols using less than 60 J per treatment session. It has been suggested that multiple treatments using the cyclodiode at a lower power may be better at minimising the complications.³⁴ The subtype of glaucoma can also predispose to hypotony, the incidence of glaucoma being rare in chronic open angle eyes.²⁷ Neovascular glaucoma is a particular risk factor, where 75 % eyes may develop hypotony.¹¹ Furthermore the highest rates of hypotony were reported in series where neovascular glaucoma was the predominant diagnosis.

Conclusion

The literature clearly establishes the role of cyclodiode in the armamentarium we have for managing glaucoma. Cyclodiode laser is an effective treatment in lowering IOP and reducing the need for medication. It is a simple, quick, non-invasive therapy which is worth considering before complex surgical interventions. While cyclodiode laser has been historically used in eyes with poor vision it is now gaining wider acceptance for use in eyes with good vision. Where there is poor visual potential, cyclodiode laser may allow globe preservation in eyes with neovascular glaucoma or symptom relief from intractable pain.

Further work is required in this field to establish methods we can use to titrate the laser therapy and to determine how we can increase the long term effectiveness of therapy without needing re-treatment. Hopefully we can establish a standardised treatment protocol and determine whether repeated lower power treatments are more beneficial in the long term, particularly with respect to the effects on vision and prevention of significant complications. ■

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