Nd:YAG Laser Goniopuncture for Late Bleb Failure After Trabeculectomy With Adjunctive Mitomycin C

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IMPORTANCE There is an increasing need to prolong trabeculectomy success rates with minimally invasive procedures.

OBJECTIVE To investigate the safety and efficacy of Nd:YAG laser goniopuncture (LGP) in lowering intraocular pressure (IOP) in eyes having late bleb failure following trabeculectomy with mitomycin C administration.

DESIGN, SETTING, AND PARTICIPANTS Prospective, noncomparative, interventional cohort at a referral glaucoma practice, including 19 eyes of 19 patients with uncontrolled glaucoma after failed trabeculectomy.

INTERVENTIONS All eyes had ischemic nonfunctioning blebs with patent internal ostia and underwent Nd:YAG LGP, followed by a 5-fluorouracil injection.

MAIN OUTCOMES AND MEASURES The IOP and the number of antiglaucoma medications before and after the procedure, as well as presurgical and postsurgical appearance of the blebs, using the Indiana Bleb Appearance Grading Scale classification.

RESULTS The mean (SD) time of LGP after trabeculectomy was 35.7 (32.3) months, and the mean (SD) follow-up period after LGP was 6.0 (1.1) months (range, 4.4-8.4 months). The mean (SD) IOP had decreased from 20.9 (4.5) mm Hg (range, 15.5-29.0 mm Hg) to 11.9 (4.1) mm Hg (range, 5.0-21.0 mm Hg) (P < .001). The only complications observed after LGP were 2 cases of hypotony, which resolved spontaneously. Compared with baseline Indiana Bleb Appearance Grading Scale classifications, 2 eyes showed an increase in bleb height and 10 eyes showed an increase in bleb extension. None of the eyes had a positive Seidel test result. The mean (SD) number of hypotensive agents per eye had decreased from 0.7 (1.1) to 0.3 (0.7) after the procedure. At the last follow-up visit, 15 eyes (79%) had achieved an IOP of 15 mm Hg or less, with a minimum IOP reduction of 20% from baseline without medication use.

CONCLUSIONS AND RELEVANCE The Nd:YAG LGP is a safe and effective procedure for lowering IOP in eyes with ischemic nonfunctioning blebs and patent trabeculectomy ostia. This is a promising solution to rescue failed trabeculectomies and can potentially prolong trabeculectomy success rates.
The success of trabeculectomy depends on the creation of a filtering bleb. Early and late failure is usually attributable to subconjunctival fibrosis. For late failure, surgical intervention such as needling procedures or surgical revision is usually necessary. Needling is an effective procedure to restore function of encapsulated blebs by mechanical dissection of the subconjunctival scar tissue, and a large proportion of failed or failing blebs can be rescued. With varying definitions of success, rates of 7% to 69% have been reported for needling alone and of 75% to 94% for needling with simultaneous or adjunctive administration of antifibrotic agents (5-fluorouracil or mitomycin C). Complications can occur and may be serious.

Laser goniopuncture (LGP) is most frequently associated with nonpenetrating surgery, as an attempt to augment filtration by converting it to a full-thickness procedure with rupture of the trabeculo-Descemet membrane. The procedure has the benefit of being noninvasive, fast, simple, and inexpensive. It is widely performed after deep sclerectomy, with success rates between 64% and 83%, and has a low complication rate. Numerous investigators have attempted to use the Nd:YAG laser to rescue failing filtering blebs, internally or externally, with reasonable success. However, all these studies included eyes with failed trabeculectomy due to internal ostium obstruction or conjunctival fibrosis. The objective of this study was to investigate the safety and efficacy of Nd:YAG LGP to reopen the pathway from the anterior chamber to the subconjunctival space in ischemic nonfunctioning blebs with patent internal ostia.

**Methods**

**Patient Selection**

In this prospective, noncomparative, interventional cohort, we included patients who underwent LGP at a referral glaucoma practice by a single glaucoma expert (R.S.). This study was approved by the local committee of ethics, was performed in accordance with the tenets of the Declaration of Helsinki, and complied with the Health Insurance Portability and Accountability Act regulations. Written informed consent was obtained from all participants. Patients had late elevation of intraocular pressure (IOP) after trabeculectomy performed with mitomycin C administration (defined as an IOP above individual target pressures), as well as patent internal ostia on gonioscopy and ischemic nonfunctioning blebs (V0 or V1 by the Indiana Bleb Appearance Grading Scale classification). Before and after laser surgery, IOP was measured twice using Goldmann applanation tonometry, with at least a 2-hour difference between measurements. We calculated the mean of the IOP measurements before the procedure and at the last follow-up visit for comparison purposes.

The conventional definition of complete success described in the literature to this sample was applied. It is defined as an IOP of 15 mm Hg or less, with a minimum IOP reduction of 20% from baseline at the last follow-up visit without medication use.

**Technique**

Laser goniopuncture was performed with an Nd:YAG laser (YC-1600; Nidek) attached to a slitlamp and using a laser lens (Magna View Gonio; Ocular Instruments, Inc.). The laser beam was focused as deep as possible into the ostium, and 10 to 20 single shots were applied with energy levels between 7 and 8 mJ. Bubble formation was seen, and enlargement of the ostium was observed in approximately half of cases. On the same day of the LGP, 5 mg of 5-fluorouracil (50 mg/mL) was injected in the inferior conjunctival fornix. If the IOP after the procedure was 8 mm Hg or higher, the patient was instructed to digitally press the eye for 10 seconds 3 times a day for 3 days. After the procedure, topical prednisolone, 1%, was prescribed for administration every hour during the first postoperative day, every 2 hours for the next 2 days, and every 8 hours for the following 20 days (Video).

Given a normal distribution of the sample statistics, comparison of means was performed using paired t test. Statistical analyses were performed with available software (STATA version 10.0; StataCorp LP). The α level (type I error) was set at .05 (2-tailed).

**Results**

We included 19 eyes of 19 patients, among whom 58% (11 patients) were female, while 84% (16 patients) were of white race/ethnicity and 16% (3 patients) were Asian. The mean (SD) time of LGP after trabeculectomy was 35.7 (32.3) months.

The mean (SD) IOP before laser surgery was 20.9 (4.75) mm Hg (range, 15.5-29.0 mm Hg) and had significantly decreased to 5.8 (2.9) mm Hg immediately after LGP (range, 0.0-11.0 mm Hg) (P < .001). On the day after LGP, the mean (SD) IOP was 9.3 (4.3) mm Hg (range, 2.0-17.0 mm Hg). At a mean (SD) of 6.0 (1.1) months (range, 4.4-8.4 months) after LGP, the mean (SD) IOP had decreased to 11.9 (4.1) mm Hg (range, 5.0-21.0 mm Hg) (P < .001). The mean (SD) reduction was −9.0 (6.3) mm Hg (range, −19.5 to 0.5 mm Hg), or −40.5% (24.0%) (range, −68.8% to 3.2%).

The mean (SD) number of hypotensive agents per eye was 0.7 (1.1) at baseline. At the last follow-up visit, the mean (SD) number of hypotensive agents per eye was 0.3 (0.7). Medication use was not increased in any of the eyes between baseline and the last follow-up visit.

At the last follow-up visit, 15 eyes (79%) had achieved an IOP of 15 mm Hg or less, with a minimum IOP reduction of 20% from baseline without medication use (Figure 1). Compared with baseline Indiana Bleb Appearance Grading Scale classifications, 2 eyes showed an increase in bleb height, and 10 eyes showed an increase in bleb extension. None of the eyes had a positive Seidel test result. Figure 2 shows the preoperative and postoperative bleb appearance of the case shown in the Video. Despite the ischemic bleb appearance, the surrounding conjunctiva was elevated regardless of preexisting tissue scarring.

We observed 2 cases of hypotony (IOP < 5 mm Hg) after LGP. On the first day after LGP, both eyes had IOPs of 2 mm Hg. One of the eyes showed a peripheral choroidal detachment, which resolved spontaneously within 1 week, and no eye developed...
hypotony maculopathy. At the last follow-up visit, both eyes had an IOP of 10 mm Hg.

Discussion

In some eyes with failed trabeculectomies but no visible obstruction to the internal ostium and an ischemic bleb, we have shown that LGP may break the source of increased resistance that is impairing aqueous flow from the anterior chamber to the subconjunctival space. The procedure was successful in 79% (15 of 19 eyes) of our cases at the last follow-up visit, with an average IOP reduction of 41% from baseline.

In 1977, Ticho and Ivry first reported on the use of laser surgery to break the resistance in failing trabeculectomies. They used argon laser and a gonioprism to puncture pigmented membranes over the internal ostium. Other authors obtained similar success with pigmented membranes but concluded that the procedure did not work on nonpigmented membranes. For nonpigmented membranes, Cohn et al showed that in 32% of cases the Nd:YAG laser was useful to reopen filtration fistulas, with a mean sustained IOP reduction of 9.8 mm Hg. In subsequent years, attempts were made with argon and Nd:YAG lasers and through internal or transconjunctival approaches, with varied success rates.*

Most of the above studies involved visible membranes, vitreous, iris, or debris obstructing the inner ostium. In our patients, no obstruction to the sclerectomy site was visible, and all blebs had an ischemic appearance. In addition, most of the previous studies were performed when the use of antifibrotic agents (5-fluorouracil and mitomycin C) was not standard practice in trabeculectomy. Success rates of trabeculectomy increased considerably after mitomycin C was introduced. However, complication rates associated with ischemic and avascular blebs also increased, including hypotony and scleral melting at the site of surgery. Therefore, we hypothesize that exposure to antifibrotic agents may have facilitated reopening of the ostium due to increased fragility of the sclera. In our sample, it was unclear what the exact cause of resistance was. It is possible that the laser application promoted holes in the scleral flap, which had been weakened by the use of mitomycin C.

Success rates (of varying definitions) of 7% to 69% have been reported for needling alone and of 75% to 94% for needling...
duling with simultaneous or adjunctive 5-fluorouracil injection and mitomycin C administration. However, multiple needlings are frequently necessary, and complications such as hyphema and shallow anterior chamber may occur. Serous choroidal detachment, bleb leakage, encapsulated bleb, and vitreous hemorrhage, punctate keratopathy, corneal edema, blebitis, suprachoroidal hemorrhage, and endophthalmitis have also been reported.

In contrast, goniopuncture is noninvasive and has been widely used after deep sclerectomy, with low complication rates. In previous studies using LGP to reopen failed trabeculectomies, the most common complication was elevation of IOP in the unsuccessful cases. Moreover, hypotony, hyphema, anterior synechiae, iris prolapse, and choroidal detachment have been described. In our study, we observed temporary hypotony in only 2 cases. However, the few cases and the short postoperative follow-up period after LGP are limitations of this study. Yet, the current paradigm of glaucoma treatment is to postpone more invasive and potentially sight-threatening procedures (such as additional trabeculectomies, tube implants, and cyclophotocoagulation) until they become required.

Our study showed promising results, with a mean reduction in IOP of 9 mm Hg even in patients with low IOP at baseline. Using the Indiana Bleb Appearance Grading Scale classification, we observed that bleb height and bleb extension increased after LGP. However, some questions remain, and further studies should identify factors that are associated with higher success rates. Previous studies showed that all successful cases had developed functioning blebs at some point before the laser procedure, whereas those in which failure occurred earlier with no bleb formation tended to have more unsuccessful outcomes. However, there are controversial results regarding the influence of the time of trabeculectomy failure on the outcomes of LGP (ie, early vs late failure). These differences may be associated with the scleral strain or with the strength of the scarring tissue at different times after the surgery. Furthermore, these factors may behave differently in eyes exposed to antifibrotic agents such as mitomycin C. Similar findings were reported in a study that described ab interno trephination for bleb rescue, in which flat, scarred, or thickened blebs did not respond to trephination, whereas those exposed to mitomycin C (with cystic blebs and more mobile conjunctiva) showed better response. It is possible that in our sample the laser application promoted holes in the scleral flap, weakened by the use of mitomycin C; those who failed to show IOP reduction could potentially have had more resistant scleral flap, despite use of the antifibrotic agent.

In any failed trabeculectomy, it is difficult to ascertain the site of greatest resistance to outflow because it can result from fibrosis at the scleral flap and at the subconjunctival space. We performed LGP only in patients whose IOP elevation was not assumed to be due to conjunctival fibrosis or cystic blebs. Our results may not be applicable to additional types of blebs, and further studies should explore other possible indications for the procedure.

In conclusion, the Nd:YAG LPG is a simple, safe, and effective procedure to rescue late ischemic bleb failure in cases with a patent internal ostium and in which trabeculectomy was performed with adjunctive mitomycin C administration. This can potentially postpone the performance of invasive, higher-risk procedures and preserve the patient’s vision.

ARTICLE INFORMATION
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REFERENCES

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