

Laser Therapy for Glaucoma

For this roundtable discussion, not sponsored by industry, *Glaucoma Today* asked participants to discuss their use of lasers in the treatment of glaucoma and potential future applications of this modality.

PARTICIPANTS



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LASER TRABECULOPLASTY

Preferred Procedure

Lewis: I would like to begin by asking each of you to identify your preferred laser trabeculoplasty procedure, explain why you prefer it to the other alternatives, and describe your parameters.

Kahook: The debate between argon laser trabeculoplasty (ALT) and selective laser trabeculoplasty (SLT) begins with how both of the lasers work. ALT uses blue-green light to treat the trabecular meshwork, usually at the junction between the pigmented and nonpigmented trabecular meshwork. Ophthalmologists began using ALT in 1979, and we have a long track record of success with this procedure. Latina and Park first reported on SLT in 1995.¹ The procedure employs a frequency-doubled Q-switched laser with a wavelength of 532 nm. The pulse duration or

transmission of energy to the trabecular meshwork is much lower—about 1,000 times less—than with ALT. The spot size is 400 μm , so it is easier to apply the energy to the trabecular meshwork. You do not necessarily have to aim the 50- μm beam that you use with ALT at the appropriate spot. Theoretically, SLT is repeatable.

I typically use SLT for many of the reasons I just mentioned. I think the procedure is easier to perform, and it seems to cause less discomfort than ALT, although the latter does not cause patients a great deal of discomfort. I have repeated SLT in several of my patients and found efficacy.

Katz: Repeat ALT is ineffective. It also may be injurious to the patient and cause a persistent elevation in IOP. Experience with ALT indicated a relationship between its success rate and the amount of pigmentation in the angle. Eyes with more pigment seemed to respond more favorably to ALT

than those that did not have much pigment. Mark Latina, MD, used the selective laser to target the melanin granules in the trabecular meshwork. SLT confines most of the heat energy to those pigmented cells and thus seems to limit the amount of thermal injury to the collateral or surrounding tissue. Thermal injury does not seem necessary to achieving a reduction in IOP. The idea of SLT's repeatability is tantalizing but unproven. The procedure's efficacy the first time around seems to be about the same as ALT's.²

There may be some benefit in not destroying the outflow apparatus of the eye. Maybe there will be a more favorable response to certain medications that rely on improving trabecular outflow. Surgeons who perform nonpenetrating surgery or canaloplasty have suggested an advantage of SLT over ALT, in that you are not scarring and obliterating Schlemm's canal, which could jeopardize surgical success.

Currently, I see no downside to SLT compared with ALT, so I prefer the former. The comparative efficacy of MLT (micropulse diode laser trabeculoplasty) versus ALT and SLT is not yet known. The optimal parameters have yet to be established. It is unclear where MLT fits into clinical practice.

Palmberg: I have transitioned to performing SLT primarily, because my patients generally find it less painful than ALT. Particularly in the darkly pigmented eyes of Hispanic or black patients, I have found that ALT can produce extensive peripheral anterior synechiae, even when I am careful to aim the laser beam at the anterior portion of the pigmented trabecular meshwork. I have never seen synechiae form after SLT, so this procedure may have an advantage in certain patient populations. Also, I find SLT much easier to teach to residents than ALT, for which the aiming and spacing of laser spots is more exacting. With SLT, a 400- μ m spot covers the entire trabecular meshwork, and slightly overlapping spots are applied for a confluent treatment. ALT requires that the spot be placed in the midportion of the trabecular meshwork and that the 50- μ m spots be placed about five beam widths apart, a more challenging task.

I believe that the general thinking now is that SLT works by injuring cells that contain pigment. These cells release enzymes that are then able to digest glycosaminoglycans. Five years after treatment, SLT's effect is generally an approximate 20% reduction in IOP, and about 70% of patients achieve a 15% to 20% reduction in pressure. Pseudoexfoliative eyes sometimes experience an enormous drop in IOP, at least after ALT.

I have wondered whether I could perform ALT on an eye for which SLT did not work well. It is unknown if these procedures have totally different mechanisms.

I never use ALT on patients under the age of 40. In my experience, the procedure has not been effective for juvenile open-angle glaucoma. I have not yet tried SLT in these

patients. I found that ALT is not an effective treatment for steroid-induced glaucoma.

Kahook: A recent study assessed the utility of SLT in patients with steroid-response glaucoma after intravitreal injection.³ The investigators reported a decrease in pressure after SLT, but it was not necessarily sustained. SLT's utility in these cases, then, might be that the procedure buys time until the effect of the steroids diminishes and thus may help to avoid more invasive surgery.

Lewis: No one has discussed the diode laser. This unit is portable and useful. Considering that the efficacy of the trabeculoplasty procedures is marginal, why not opt for diode laser treatment (DLT)? It could be argued that the diode laser has multiple applications and is more useful than for just trabeculoplasty.

Kahook: That could be said for the argon laser as well.

Katz: There simply is not enough convincing information in the literature to support switching to DLT. SLT had a strong draw, because it is fairly different from ALT, seems to work as well, and may offer repeatability. DLT does not represent anything strikingly different unless further studies help to distinguish it from the other modalities.

Lewis: For private practitioners looking to acquire a laser, cost may be a big factor. The diode laser and MLT laser (Iridex IQ810; Iridex Corp., Mountain View, CA) are significantly less expensive than the Selecta II Glaucoma Laser System (Lumenis, Inc., Santa Clara, CA) for SLT.

Katz: Using scanning electronic microscopy, Robert Noecker, MD, and Scott Fudemberg, MD,⁴ have found that MLT does not cause thermal injury in cadaver eyes, but we do not know if that finding correlates with clinical efficacy.

Lewis: Would you comment on the efficacy demonstrated in your studies of MLT?

Katz: I do not think we have enough experience to allow comment on the efficacy yet. It is all very short term. There is little data in the literature.

Technique

Lewis: Please briefly describe your technique.

Kahook: Before performing SLT, I instill one drop of Alphagan (Allergan, Inc., Irvine, CA) or lolidine (Alcon Laboratories, Inc., Fort Worth, TX). I use an Ocular Latina SLT Gonio Laser Lens (Ocular Instruments, Inc., Bellevue,

WA). Usually, I start at around 1 mJ for lightly pigmented trabecular meshwork and titrate either up or down. In more heavily pigmented trabecular meshwork, my usual starting point is around 0.6 mJ. I almost always treat 360°, except in an eye with a heavily pigmented trabecular meshwork. For example, in a case of pigmentary glaucoma or pseudoexfoliation (PXF), I will usually treat 180° and then treat the remaining 180° at a later time if needed.

Most patients on whom I am currently performing SLT are enrolled in a comparative study in which they are randomized postoperatively to Pred Forte, Acular (both Allergan, Inc.), or artificial tears q.i.d. for 4 days. Thus far, I have not noticed a difference in outcomes, but official analysis has yet to be completed. The patients who are taking Pred Forte are more comfortable in the days following the procedure.

Katz: I also routinely prescribe alpha-agonists in the peri-laser period. IOP spikes may be the only really serious problem with trabeculoplasty. I tend to treat 360° in all eyes except those with pigmentary glaucoma or PXF, in which case I treat 180° or less out of concern about sustained elevations in IOP. In a small case series, three patients with pigmentary glaucoma required filtration surgery after SLT due to sustained increases in IOP.⁵ I also avoid 360° SLT in patients with high IOPs who use multiple drugs and have advanced optic nerve disease or visual field loss. I want to avoid elevated IOP in these individuals.

It is important to recognize that laser machines probably differ in terms of the energy delivered at a given setting. During the Glaucoma Laser Trial, my co-investigators and I used a power meter to check the energy of the different lasers, and there was not really that great a match necessarily with what the dial was saying (personal communication). Based on that experience, I now start with a much lower energy setting than I used originally (0.6 vs 0.8 to 1.0 mJ). I also increase the energy less now during the procedure. Using high magnification, I look for some blanching, cavitation champagne bubbling as my endpoint.

Kahook: What would you do if you were treating a lightly pigmented angle, you were at 1 mJ, and you saw no champagne bubbles?

Katz: If you look very carefully on high magnification, you often do see the cavitation bubbles. I have not been as impressed with the difference in efficacy using the higher energy setting, whereas my partners—like you—feel strongly about going to the higher energy levels.

In an effort to avoid late-night phone calls about red eyes and irritation, I still prescribe an NSAID for 1 to 2 days postoperatively. Jorge Alvarado, MD, and others have argued that the inflammatory cascade is a critical component of

the pressure-lowering effect of SLT.⁶ I have not seen any evidence, however, that using an NSAID for a day or 2 after SLT has changed the ultimate outcome.

Palmberg: Preoperatively, I administer one drop of lolidine before any kind of anterior segment procedure, because I find it markedly reduces the chance of a post-treatment rise in IOP and reduces the chance of the patient's experiencing anterior segment inflammation and discomfort.

I have used a mineral glass lens (Haag-Streit AG, Köniz, Switzerland) for ALT and SLT ever since Robert Stegmann, MD, pointed out to me that the optical properties of a mineral glass lens are far superior to those of a regular lens. With the former, I can go to high magnification without losing definition. I begin with an energy level of 0.8 mJ and work my way up to no more than 1.0 mJ; I look for the minimal energy that causes champagne bubbles to form. I treat 360°, except in eyes with heavy pigmentation or high IOP, as the other panelists have mentioned, in which case treating half the angle at a time may be safer.

The postoperative use of topical steroids does not seem to be necessary with SLT to prevent ocular inflammation (eg, perlimbal flush) and pain, as it was with ALT. My patients continue to use any of their preoperative glaucoma medications, and I see them approximately 2 weeks after the SLT procedure. As with ALT, the full effect of SLT may not be evident for 6 weeks.

Repeat Laser Treatment or Surgical Intervention?

Lewis: There has been a lot of hype about the repeatability of SLT and very little data to support it.

Katz: There is confusion about what the term *repeated treatment* means. Doing 180° and doing another 180° does not mean a repeat to most of us.

Kahook: We do not have good evidence-based medicine illustrating the efficacy of repeated treatments with SLT.

Palmberg: One point that should be made is that it is difficult to assess the actual effectiveness of laser treatment or retreatment, because no one uses a design such as initially treating half of the patients so as to determine what the real response to laser treatment is and what is regression to the mean.

Lewis: If a patient needs another procedure, why would an ophthalmologist repeat laser trabeculoplasty if it was not effective the first time or if its effect only lasted 1 or 2 years? Why not go on to surgery?

HOW DOES LASER TRABECULOPLASTY WORK?

By Malik Y. Kahook, MD, and Joshua D. Stein, MD, MS

Wise and Witter introduced argon laser trabeculoplasty (ALT) as a relatively safe and frequently effective method of lowering IOP.¹ Later, other methods of treating the trabecular meshwork were introduced, including selective laser trabeculoplasty (SLT) and, more recently, micropulse laser trabeculoplasty.^{2,3} The actual mechanism of IOP lowering resulting from trabeculoplasty has been extensively studied and debated for decades. Three potential mechanisms are outlined herein.

MECHANICAL

This possible mechanism results from the energy applied directly to the trabecular meshwork in the form of heat from ALT. The thermal burn causes scarring at the application site. The scar tissue produces contraction of the collagen beams, resulting in widening of the adjacent trabecular meshwork tissue. As a result, more fluid is able to enter Schlemm's canal, leading to a decrease in IOP. Although some studies have demonstrated changes in the architecture of the treated trabecular meshwork, other studies have failed to show such an effect. Additionally, SLT does not cause thermal damage at the site of treatment and has not been shown to alter the architecture of the targeted tissues. The mechanical theory would therefore only apply to ALT and potentially to micropulse laser trabeculoplasty.

BIOLOGICAL

The recruitment of macrophages and induction of cytokine release form the backbone of this theory. Laser energy applied to the trabecular meshwork has been reported to induce the recruitment of macrophages and the subsequent remodeling of the extracellular matrix in the conventional outflow system.

Additionally, IL-1 and other cytokine levels have been shown to increase following ALT and SLT, potentially leading to the induction of matrix metalloproteinases and remodeling of the extracellular matrix. These changes may produce a decrease in IOP after treatment.

REPOPULATION

This mechanism involves the induction of DNA replication, cellular division, and cellular migration over the treated areas in the trabecular meshwork. These changes may lead to a rejuvenation of the trabecular meshwork and a potential drop in IOP.

CONCLUSION

All of the aforementioned theories may play a role in decreasing IOP after laser trabeculoplasty and are not necessarily mutually exclusive. Further studies related to these mechanisms could result in methods of treating open-angle glaucoma that are more efficacious and safe.

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Further Reading

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Palmberg: I would go on to surgery, particularly in cases of advanced glaucomatous damage, because these patients should not be exposed to the risk of having badly uncontrolled glaucoma for several months between visits. I have seen patients who had PXF go from having controlled pressure after repeat ALT to an IOP of 40 mm Hg in just 3 months.

Katz: Dr. Palmberg is right that every case is different. Let's say the patient underwent a trabeculectomy in one eye and experienced complications and a permanent loss of vision. Ultimately, you would talk to the patient about treatment options for the other eye. Do you want to try laser therapy again or go to surgery or additional medication? Many patients who have repeat laser treatment have sur-

gery eventually, but laser trabeculoplasty may be a worthwhile venture, because it may delay the need for filtration surgery with all of its attendant risks.

In my experience, about half of my patients who initially responded to SLT achieved a reduction in IOP when the procedure was repeated.

Kahook: If a patient returns 3 or 6 months after SLT and his IOP is going back up, do I repeat the procedure? No, it would not buy the patient much time. If he comes back 1 year or 18 months later in the scenario that Dr. Katz described, he is worried about surgery, and he underwent SLT initially because of poor compliance, or other social issues, then I think repeat laser treatment might have a benefit.

Primary Therapy

Lewis: Laser trabeculoplasty has been demonstrated to be an appropriate first-line therapy in patients. Why don't surgeons use this modality as a primary treatment more often?

Palmberg: When thinking about laser trabeculoplasty as a primary therapy, we need to ask whether or not it is at all likely to lower the pressure enough to achieve the visual field stability we now know we can achieve in most eyes with adequate IOP control. I am convinced by data from the Collaborative Initial Glaucoma Treatment Study⁷ that a 35% reduction in IOP is really what we are looking for in somebody with initially diagnosed glaucoma and definite field loss (eg, a mean deviation of -5 dB). For more advanced cases (eg, a mean deviation of -10 dB), data from the Advanced Glaucoma Intervention Study⁸ suggest to me that we should be seeking to reach a target IOP of less than 15 mm Hg. Paul Chandler, MD,⁹ said that in 1959, but it is only in the last decade that we have adequate data to confirm that approach.

I just do not find that ALT or SLT alone reduces IOP sufficiently in very many cases, but laser trabeculoplasty is an option that some patients will bring up or that I will occasionally broach with a patient. For example, the procedure may be a reasonable choice for primary therapy in a patient who has a history of not adhering to medical therapy for other conditions and who refuses surgery. At least you will lower the IOP somewhat and slow the damage. Laser trabeculoplasty may also deserve a try as primary therapy for certain patients who cannot afford other treatment.

Katz: I think we are all old school. Traditionally, laser therapy does not come first. The Glaucoma Laser Trial compared ALT and medication as frontline therapy, and it certainly came out fine compared with timolol.¹⁰ An outpouring of editorials condemning ALT as a first-line procedure ensued. Why?

Surgeons are creatures of habit, and the leadership in glaucoma does not support laser therapy as first-line treatment. Moreover, nobody wants to be audited for performing too many laser treatments or to be thought of as a "cowboy." In addition, laser therapy's level of acceptance among patients is not necessarily high, partly because of the unfamiliarity of the technique. In most cases, you will opt for the path of least resistance with patients, especially when you have other viable alternatives with medications.

Palmberg: A few patients will say they really do not want to use medication, which is a good opening for a conversation about laser therapy.

Katz: Approximately 10% to 20% of my patients prefer laser trabeculoplasty as the initial therapy for open-angle glaucoma. Some are economically strapped. Others do not believe in taking medication. Many are executives who see no downside to undergoing laser treatment first. Interestingly, I find that ophthalmologists who frequently perform first-line laser trabeculoplasty rarely advocate this approach to other surgeons, but about half of them would have the procedure first if they themselves were diagnosed with glaucoma.

Kahook: I use SLT as primary therapy not infrequently. In the quest that Dr. Palmberg mentioned to reach a 35% reduction in IOP, you are going to need more than one medication most of the time. The more medications patients are prescribed, the poorer their adherence becomes. In published studies, when patients are prescribed a second medication, they are much less likely to fill their prescriptions on time, a finding that hints at poor adherence to therapy.¹¹ Approximately 40% of my patients whom I monitor electronically do not use their drops half the time. For these reasons, when I diagnose glaucoma, I offer medication and laser therapy to patients. When I choose SLT as primary therapy, I see about a 30% decrease in IOP in many patients.

LASER IRIDOTOMY

Indications

Lewis: Please describe your indications for laser iridotomy.

Palmberg: I look for appositional angle closure or some peripheral anterior synechiae. If there is no elevation in IOP and only a narrow angle, and there are no signs or symptoms of previous attacks, I will educate the patient regarding the symptoms of an angle-closure attack and where to come if one occurs. I will then repeat gonioscopy every 6 months. If the patient would be unable to seek prompt attention in the case of an angle-closure attack because of senility or a plan to live in a remote location, I would make an exception and perform laser iridotomies. Also, if glaucomatous damage were present and the angle were narrow, I would perform laser iridotomies to eliminate a possible contributing mechanism.

Laser iridotomy is highly successful, but I do think it leads to the formation of cataracts. It certainly causes posterior synechiae to form that can make cataract surgery more difficult. I perform laser iridotomy less often now than in the past. I used to treat any slit angle, but now I require closure for at least a clock hour or two. I find that it is rare for anyone to go on to frank closure in a decade or more.

Tips I would offer on making the diagnosis of angle clo-

sure are to perform gonioscopy in the dark and to use a narrow, short beam of light that does not enter the pupil, conditions that accentuate relative pupillary block. I also believe that anterior segment imaging technologies are going to be helpful for confirming the diagnosis, as detailed in a recent editorial.¹²

Lewis: Indentation gonioscopy alters the angle. When we image the angle, however, we may use a dark or light room. I am not convinced that we are always seeing the same thing with imaging that we do with gonioscopy, although I do think that imaging will ultimately be important.

What are your indications for laser iridotomy?

Katz: I agree that the technology has to advance.

My indications for laser iridotomy do not differ much from Dr. Palmberg's. The age of the patient influences my recommendation. I am less worried about a 95-year-old patient who has a narrow angle with no peripheral anterior synechiae than a 40-year-old with +8.00 D of hyperopia. The question is, How do you look at the angle? David Friedman, MD, MPH, PhD, and others have shown that the angle may become narrower in low light.¹³ Standardized anterior segment imaging with stable lighting conditions could therefore prove to be helpful.

Unfortunately, a lot of physicians do not perform indentation gonioscopy, which is the only way that I think you can really evaluate a narrow angle appropriately.

Technique

Palmberg: I apply a drop of lolidine and of proparacaine. To constrict the pupil and allow a very peripheral iridotomy, I either apply a drop of 1% pilocarpine or widen the slit-lamp beam. I use either an Abraham or a Wise lens. First, I place a 0.5-second, 500- μ m spot with the argon laser set at about 0.18 W (brown iris) to 0.22 W (blue iris) in order to get a heat shrink spot. Then, I penetrate with a YAG laser at 5 mJ right in the middle of the argon spot. The argon treatment closes blood vessels and compacts the iris stroma so that there is no bleeding and the iris stroma does not fragment. At penetration, I want to see a burst of fluid demonstrating a release of pigment. Then, I push in and out on the iridotomy lens several times. I liken this process to swishing your teeth after you brush them. The idea is to disperse the pigment to have a clear view that I am all the way through and to ensure that no adjacent iris tissue is going to rotate into and plug the hole.¹⁴

I keep patients for observation for approximately 1 hour. I use gonioscopy to ensure that the angle is open and watch for a spike in IOP from the released pigment. Postoperatively, patients use Pred Forte q.i.d. for 4 days.

Lewis: What part of the iris are you treating?

Palmberg: I place the iridotomy at the 12-o'clock position, as long as the eyelid will cover it enough that the meniscus of the tear film of the upper eyelid will not be right over the hole. If light passes through the meniscus of tears and through the iridotomy, it is prismatically focused as a line of light on the retina and creates a blue line across the patient's field of vision when he is walking down a dark hall and there is light at the other end. That blue line is really bothersome. If the upper eyelid will not completely cover the iridotomy, I use the temporal iris, because it rarely causes problems. Because I have seen patients who have experienced glare after a temporal laser iridotomy, however, I still try to position the hole superiorly if the eyelid will cover it.

The hole created by the YAG laser through iris tissue pretreated with the argon laser is really quite small. I have not had a patient complain of glare in years. I used to see unhappy patients frequently, when surgeons placed the iridotomy at the 1-o'clock position, which is right where the tear meniscus is.

I think the unresolved question is whether or not to perform an iridotomy when there has not been an attack in either eye and the angle is just very narrow. Is it worthwhile to treat 19 patients unnecessarily with a laser iridotomy to prevent acute angle closure in the 20th patient? Is the procedure sufficiently benign compared with catastrophic acute angle closure? It is a gray area. After an acute attack, the patient may not regain his vision (see *Pearls for Managing an Acute Angle-Closure Attack*). He may have a blown pupil for the rest of his life and may rapidly develop a cataract. I try to engage the patient when making these borderline decisions.

Katz: I find that administering a miotic allows me to place the laser iridotomy as peripherally as possible. I generally do not use an argon laser in preparation, because I usually can get through the tissue, especially blue irides, pretty easily with the YAG laser alone. If there is a concern about a really thick iris, preparing a taut iris with an argon-laser pretreatment bed may be a good idea. It is then easier to get through the pretreated iris with the YAG laser. Also there are a number of people who are on anticoagulation, and again in those I think it is a good idea to use argon-laser pretreatment as a prophylaxis against significant intraocular bleeding.

Kahook: I use pilocarpine to constrict the pupil and prevent the trampoline effect noted when applying laser energy to the iris. The YAG laser works best for lightly pigmented irides, whereas the argon laser is effective for pigmented tissue. I rarely use both in one eye and find that the YAG works in almost all eyes as a standalone laser.

PEARLS FOR MANAGING AN ACUTE ANGLE-CLOSURE ATTACK

PAUL F. PALMBERG, MD, PhD

I would like to share a pearl for managing an acute attack with 30-gauge needle paracentesis. First, the eye is prepared with a drop of povidone (Alcon Laboratories, Inc., Fort Worth, TX) followed in 30 seconds or so by a drop of proparacaine. Next, I apply a drop of Betadine solution 0.5% (The Purdue Frederick Company, Stamford, CT) for 2 minutes, as I would in the OR, and rinse it out.

At the slit lamp, I place a solid bladed speculum to hold the eyelids open and the eyelashes out of the way. I then grasp a 30-gauge, 0.5-inch needle by the hub (no syringe) between my thumb and forefinger. I place my other three fingers on the temporal side of the patient's cheek and perform a paracentesis. The entry into the far peripheral cornea should be inferotemporal (the 4-o'clock position in a left eye), with the needle angled toward the 6-o'clock position (Figure 1) so that it cannot hit the crystalline lens. The needle's track should be about halfway between the iris parallel and the corneal parallel in order to be long enough to seal itself. You can tell that the needle's tip has entered the anterior chamber when it begins to gleam.

I hold the needle in place for about 10 seconds. When I pull it out, I find that the IOP is invariably about 12 ± 2 mm Hg, because it apparently takes that much pressure to force fluid through the needle. This technique reduces the IOP in a controlled manner with no risk of a flat anterior chamber or, so far, suprachoroidal hemorrhage. The cornea will be clearer (Figure 1), and the patient will be more comfortable, changes that facilitate

laser iridotomy.

I have performed this procedure for angle closure and other indications hundreds of times without a single case of infection. The only complication at my institution with this approach occurred when a surgeon passed the needle straight in toward the center of the pupil—instead of angling it toward 6 o'clock—and hit the lens. You cannot hit the lens if you go in at the correct angle.

I favor this intervention over a pharmaceutical approach with oral osmotics or intravenous mannitol, which risk causing congestive heart failure or a subdural hematoma in elderly patients and take a long time to work. I also prefer to perform a paracentesis over the fairly brutal practice of pushing firmly on the cornea with a muscle hook or gonioscope to try to force the angle open and decompress the eye. The latter technique increases the pressure and the pain and may rough up the corneal epithelium. Why put a patient through that?

RICHARD A. LEWIS, MD

When patients are in pain and violently sick during an acute attack, it may not be possible for them to sit upright for an examination or treatment. They may be unable to use oral medications due to nausea. I have found a retrobulbar block very useful in this setting. Administering 3 to 4 mL of 1% lidocaine in the examination room almost instantly alleviates their pain. Patients are then comfortable and cooperative for additional treatment and the laser iridotomy.



(Courtesy of Paul F. Palmberg, MD, PhD.)

Figure 1. To manage an acute angle-closure attack, the surgeon enters the peripheral cornea with a 30-gauge, 0.5-inch needle (A). The path is longer than the iris (B). Upon the needle's extraction, the cornea will be clear, and the IOP will be around 12 mm Hg (C). The surgeon can then perform a laser iridotomy.

Laser Iridotomy or Removal of the Lens?

Lewis: When a patient is referred to you for chronic angle closure and has not received an iridotomy, removing the cataract can resolve the glaucoma, improve his vision, and prevent a long-term problem. When would you remove the cataract or crystalline lens rather than perform an iridotomy?

Palmberg: If a patient is at the point of needing the cataract extracted and there is mostly appositional rather than synechial closure of the angle, I will remove the cataract instead of performing a laser iridotomy.

Kahook: The approach depends on the situation. If a patient presents with chronic angle closure and a cataract,

LASER IRIDOPLASTY

By Paul F. Palmberg, MD, PhD

Laser iridoplasty is an effective treatment for plateau iris syndrome, a condition found to be responsible for 2.7% of the eyes with angle closure that undergo laser iridotomy at the Bascom Palmer Eye Institute.¹ The condition may present acutely, when residual appositional angle closure is evident after laser iridotomy, or it can occur years after the procedure. For that reason, as Robert Ritch, MD, pointed out to me years ago and I can confirm, if the angle does not open to at least grade 2 after laser iridotomy, the surgeon should look for a prominent last roll of the iris. Indentation gonioscopy is useful to accentuate this roll, because the iris will drape back over the lens' periphery but be held forward in the periphery by the underlying, forward-rolled ciliary body processes that are responsible for this mechanism of angle closure. If the angle is narrowed but open in the presence of a plateau configuration, the clinician should see the patient every 6 to 12 months. The angle may become progressively narrower and close even 5 or 10 years later due to a slowly increasing forward rotation of the ciliary processes.

The iridoplasty procedure that Dr. Ritch described heat shrinks the far peripheral iris with 24 to 36 applications of a 500- μ m spot size for 0.5 to 1.0-second.² Although highly successful,

the treatment may have to be repeated years later, so patients require continued observation.³

Iridoplasty is also quite useful in cases of pseudoplateau iris syndrome, which occurs due to an acute forward rotation of the ciliary body processes caused by uveal congestion. As an example, I provide this typical scenario. A patient who had an IOP of 12 mm Hg in the afternoon undergoes pupillary dilation and returns in the evening with an acute attack of angle closure and an IOP of 70 mm Hg. Surprisingly, after a perfectly performed laser iridotomy and some medical therapy, the IOP remains 40 mm Hg with continued appositional closure. The eye has a swollen ciliary body that has rotated forward, and iridoplasty will open that angle.

Angle closure caused by congestion of the ciliary body also used to occur after an overly aggressive panretinal photocoagulation in one session or an overly tight scleral buckling procedure, but retina specialists soon learned to avoid this situation.

1. Palmberg P. Laser iridoplasty. Paper presented at: The AAO Annual Meeting; October 1988; Las Vegas, NV.

2. Ritch R. Argon laser treatment for medically unresponsive attacks of angle-closure glaucoma. *Am J Ophthalmol*. 1982;94(2):197-204.

3. Ritch R, Tham CC, Lam DS. Long-term success of argon laser peripheral iridoplasty in the management of plateau iris syndrome. *Ophthalmology*. 2004;111(1):104-108.

you can perform cataract surgery and goniosynechiolysis at the same time, which will improve visual acuity and decrease the IOP in most cases.

Lewis: In that procedure, what would you do for goniosynechiolysis?

Kahook: I perform cataract surgery per my routine without any changes. After removing the lens and implanting an IOL, I use a microforceps to tease the iris away from the angle. I do so by gently grabbing the peripheral iris and moving it away from the angle in a downward fashion. I have had great success doing this after seeing what Iqbal Iqbal Ahmed, MD,¹⁵ and other surgeons have presented at national meetings.

Katz: I would like to add that not everybody is as skilled at phacoemulsification as Drs. Ahmed and Kahook. During an acute attack when the cornea is cloudy, the situation can go from bad to worse very quickly in the hands of someone who is not as skilled at phacoemulsification surgery. Many ophthalmologists dilate the pupil preoperatively. Occasionally, an acute attack occurs in the preoperative holding area in the midst of dilation among patients with a narrow angle. Finally, if you are attempting to reduce high

IOP by removing the crystalline lens, a suprachoroidal hemorrhage can occur during phacoemulsification.

CYCLOPHOTOCOAGULATION

Lewis: What role does cyclophotocoagulation (CPC) play in your practice?

Kahook: I have a transscleral diode laser with a G-probe. I usually reserve transscleral diode CPC for patients in whom previous medical and surgical therapy has failed. One example is the patient who has undergone trabeculectomy and one or two glaucoma drainage implant procedures and who does not have sufficient conjunctiva to support a repeat penetrating procedure. I always perform a limited treatment of 270°. I usually start at 2 seconds and 2 W and then titrate the energy downward accordingly after hearing an audible pop, which signifies overtreatment of the ciliary body.

Another example of patients on whom I perform transscleral CPC is those postpenetrating keratoplasty with a history of glaucoma drainage device implantation. I find that a limited treatment of 270° works well for these patients rather than the placement of a second device. Again, I always reserve the option of going back in and completing the treatment to decrease the IOP further.

For me, endoscopic cyclophotocoagulation (ECP) has largely taken the place of transscleral CPC. The Endoscopy System (Endo Optiks, Little Silver, NJ) features an 810-nm diode laser on a 19-gauge endoscopic probe. The benefit of this system is that you are targeting the tissue that you are going after. You can titrate the energy at the target tissue by looking for shrinking and whitening of the tissue (Figure 1). You also have the option of going through two incisions and treating 360°. My colleagues and I have shown that going through two different incisions and treating the subincisional ciliary processes is highly efficacious; ECP decreased IOP by up to 40% in eyes that required lower pressure.¹⁶ In my experience, patients do well after ECP. I think the procedure carries a stigma due to its association with transscleral CPC. With ECP, you do not damage the sclera and ciliary body stroma while trying to reach the nonpigmented epithelium in the ciliary processes, as occurs with the transscleral method. As a result, the incidence of hypotony is very low in my experience. I have not had a case of long-term hypotony after ECP.

Lewis: Do you recommend ECP in pseudophakes as a primary or as a supplemental treatment of glaucoma.

Kahook: I have performed ECP combined with cataract surgery on patients who are taking one or two medications to decrease their IOP. Typically, I reserve ECP for individuals who have a pressure under 35 mm Hg. I will not perform the procedure if the IOP is much higher, as I have not found it to be effective, likely because ECP does not target enough of the nonpigmented epithelium that can be found in the spaces between processes. I have also used ECP for pseudophakic patients who have a glaucoma drainage device but an IOP that is not quite as low as I would like. ECP can achieve that reduction in pressure. I have also performed the procedure on pseudophakic patients in whom trabeculectomy has failed rather than repeat the trabeculectomy or place a tube. My colleagues and I demonstrated a statistically significant decrease in IOP in pseudophakic patients who underwent ECP alone, although the reduction

in IOP was less than in those undergoing combined cataract extraction and ECP.¹⁷

Lewis: Where is the advantage of ECP over CPC?

Kahook: I think ECP is worth it in the appropriate patient. I think the appeal of performing the procedure when considering cycloablation becomes clear when you look at reports comparing histology after treatment with ECP versus CPC. My colleagues and I reported on the changes in ex vivo eyes after treatment with CPC and ECP and compared these findings to an untreated eye. We found a great amount of collateral damage with CPC that was not seen in the ECP-treated eyes. While the CPC-treated eyes appeared to have severe disorganization of the architecture surrounding the ciliary processes, the ECP-treated eyes had only localized tissue effects at the site of the ciliary processes. The targeted treatment seen with ECP makes it more appealing in my opinion.¹⁸

Katz: ECP is much more elegant than transscleral CPC. We specialists think of glaucoma as a disease of outflow, however, not a disease of inflow. For that reason, it has always rubbed us the wrong way to consider CPC before outflow procedures (such as laser trabeculoplasty, a tube shunt, trabeculectomy) in eyes undergoing cataract surgery or pseudophakic eyes with good visual acuity. We believe that aqueous is produced not just to regulate IOP, but also to transport nutrients and remove toxins. That said, we do suppress aqueous flow pharmacologically, but that is transient if you stop the drug. Nevertheless, I think our mindset favors outflow surgeries as opposed to ablation of the ciliary body.

Ophthalmologists who perform a lot of glaucoma surgery will feel comfortable executing a trabeculectomy and

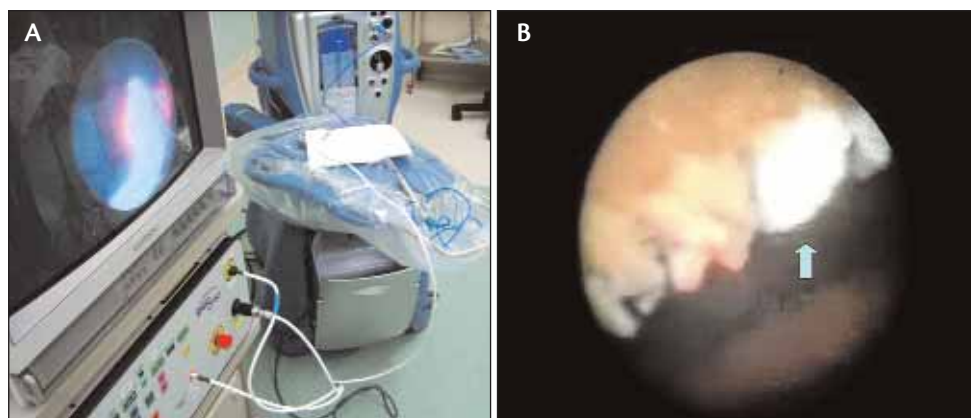


Figure 1. ECP is often performed with phacoemulsification, and the machines for both procedure can be set up side by side (A). An endoscopic view of the ciliary processes reveals shrinkage and whitening of the treated tissue (arrow) (B).

(Courtesy of Malik Y. Kahook, MD.)

placing a tube shunt. Others who perform cataract surgery for a glaucoma patient may be uncomfortable about doing a filtration procedure. They may very well achieve better outcomes and fewer catastrophes by performing ECP for their patients.

I still believe that we should augment outflow rather than reduce inflow. In certain cases, as described by Dr. Kahook, I will perform ECP. If the eye has poor vision and I do not want to penetrate the globe, I will perform transscleral CPC.

Lewis: At the slit lamp?

Katz: I perform all the laser CPC cases, both diode external CPC and ECP, in the OR.

Palmberg: I guess I have the same bias against destructive procedures. I remember a patient in whom I had placed a Baerveldt glaucoma implant (Advanced Medical Optics, Inc., Santa Ana, CA) in one eye. His other eye had no light perception, and it was a general policy at the Bascom Palmer Eye Institute not to perform invasive procedures on such eyes due to the risk of sympathetic ophthalmia. I therefore used a G-probe to perform transscleral CPC. The procedure was terribly painful, and the IOP rose again in 1 month. I repeated the procedure. When he returned for a third time with elevated IOP, he said, "Please put one of those tubes in my eye. Don't make me miserable again." I would rather place a Baerveldt glaucoma implant in such a case than choose a cyclodestructive procedure. The results are great, the patient is comfortable, and I would think that the risk of sympathetic ophthalmia would be minimal.

Surgeons I know who advocate ECP usually point to the patient whose IOP is approximately 18 mm Hg when you would like it to be 15 mm Hg. He is using three medications, and you would like it to be two. A 180° ECP treatment at the time of cataract surgery can reduce the IOP by 10% to 15%, an effect that will last at least 3 years. Until today, I had not heard that a 360° ECP treatment could produce a 3- to 5-year reduction in IOP of 40%.

Lewis: We talked earlier about how the effect of laser trabeculoplasty wears off. Do you find that the effect of ECP in healthy, seeing eyes wanes in time?

Kahook: The trabeculectomy is still the best procedure available for lowering IOP, at least in my hands. ECP's effect fades for a couple of reasons. One is that the treatment might not have been full, so substantial nonpigmented epithelium may remain untreated. Another reason is that, after ECP, the tissue may become reinvigorat-

ed due to persistent blood flow to the ciliary processes. These are the likely reasons why the IOP increases in most cases.

Lewis: CPC has two potential applications: the functional, seeing eye and the blind, painful eye.

Palmberg: If a patient has an ugly, painful, blind eye, I prefer enucleation to CPC and/or retrobulbar injections of Thorazine (GlaxoSmithKline, Research Triangle, NC) or alcohol, because pain is relieved more reliably and the eye is no longer ugly. The prostheses available today are excellent, so enucleation and a prosthetic device are really the answer in such cases, particularly if the patient is young.

Lewis: You do not perform CPC?

Palmberg: I have performed the procedure maybe once in the past 4 years.

Lewis: I still think it plays a role in the treatment of certain blind, painful eyes. Enucleation scares a lot of patients. Transscleral CPC can decrease the IOP, maybe not to the target, but to a comfortable level.

Palmberg: The biggest mistake I ever made was to perform a cyclodestructive procedure on a blind eye with an IOP of 60 mm Hg that was not causing the patient pain. I was sure that the eye would become painful and that the cornea would decompensate. The procedure made her eye permanently uncomfortable. At the time, my business card listed my home phone number. The patient used to call me at 3 AM and say, "I can't sleep, and I don't want you to, either."

My advice is, Do not do something painful to somebody who is not currently in pain.

Katz: Sympathetic ophthalmia is a published rare complication of laser CPC.¹⁹

NEW LASER APPLICATIONS

Lewis: Let's end by discussing new laser applications in the treatment of glaucoma.

Katz: Michael Berlin, MD, is working with excimer laser trabeculostomy, which is a relatively new technique. Using a 500-μm probe with a 200-μm fiber, the surgeon creates anywhere from five to 10 openings into Schlemm's canal with an ab interno gonioscopic approach. Dr. Berlin and his co-investigators have presented data showing an IOP reduction lasting up to 18 months after excimer laser trabeculostomy.²⁰

Lewis: Suture lysis is a nice application for lasers.

Palmberg: I have found that a red laser (Novus Omni; Coherent, Palo Alto, CA) is best for suture lysis. An argon laser can burn the tissue and produce an adhesion of the bleb to the underlying sclera. As the bleb grows, the adhesion can result in a hole in the bleb. Three years after suture lysis, the hole is visible between the two cut ends of the nylon below it. This has not occurred with the red laser, because energy seems to pass through the overlying tissue without burns and is very effective at cutting the black nylon sutures. If you have to use an argon laser, use a 100- μ m spot size, because the longer length of nylon heated allows a lower power density to be used with less chance of producing a burn.

Lewis: I have not used nylon for scleral sutures in a long time, just for that reason. I use Vicryl (Ethicon Inc., Somerville, NJ).

Palmberg: With mitomycin C (MMC)?

Lewis: Yes.

Palmberg: I am afraid that using Vicryl sutures in the scleral flap and applying MMC would result in a lot of cases of hypotony when the Vicryl melts in several weeks. Nylon will last for 5 years or more and creates a more durable resistance. I am aware of a well-known glaucoma specialist who advocated using Vicryl sutures in the scleral flap and, 1 year later, bemoaned that using MMC had led to hypotony in far too many of his cases.

Katz: As an aside, because the argon laser is disappearing and not many ophthalmologists have a red-wavelength laser, we typically use releasable sutures that can be removed at the slit lamp without a laser.

Lewis: I have used low-powered laser cautery with a large spot size to gently shrink tissue at the base of a large bleb. The technique alleviated some of the patient's dellen-like symptoms. Has anyone ever tried this?

Katz: Years ago, Mary Lynch, MD, talked about using the thermal mode on the YAG laser to try to shrink certain blebs, but she had only modest success.²¹

Palmberg: I have used an Optemp handheld cautery (Alcon Laboratories, Inc.) held near the limbus to shrink the collagen of a bleb in order to reduce its height when I did not think a large decrease was needed. In the case of a painful bleb due to a dellen or bubble dysesthesia, however,

a compression stitch can really do a great job. Compression stitches are rarely helpful for uncomfortable circumferential blebs. Instead, you can use a handheld hot cautery to make punctures in the lateral and inferior limbal parts of the bleb that you do not need.

Every kind of painful bleb can be made comfortable with these simple slit-lamp or minor OR procedures except a big Tenon's cyst. It is rare that you need to revise a bleb for pain. Between compression sutures and cautery puncture, you can solve these problems without the risk of bleb failure that surgical revision entails.²²

Lewis: Laser treatment for glaucoma is valuable and growing in applications. It has become an essential tool for managing our patients. My thanks to the panelists for sharing their ideas. □

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