THE ROLE OF SLT IN MANAGING GLAUCOMA

The benefits of early disease detection and minimally invasive treatments can set the stage for slower progression.

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INTRODUCTION

Howard Barnebey, MD: Welcome to this discussion of new trends in the diagnosis and management of glaucoma. Over the past 10 to 15 years, glaucoma specialists have seen a significant acceptance of using selective laser trabeculoplasty (SLT) for both the initial treatment as well as in the long-term management of glaucoma. To that end, we will share some clinical experience with the YC-200 S plus laser by NIDEK. We have also witnessed the introduction of new surgical techniques that are categorized as minimally invasive glaucoma surgery (MIGS). Our discussion will include the importance of a multifactored approach to diagnosing and treating glaucoma in order to provide a better service for our patients.

LET'S TALK ABOUT GLAUCOMA

JENNIFER UNGER, MD

I practice at Valley Eye Associates in Appleton, Wisconsin. I am a comprehensive ophthalmologist who sees a lot of glaucoma patients, and I see new patients daily. In general, these patients need education about their condition, as well as their treatment options. Once I have diagnosed a patient with glaucoma, I say these exact words: "Let's talk about glaucoma." I have a folder that contains some educational materials that I have written, and I have a pamphlet titled "Open Angle of Glaucoma" that lists the treatments that are currently available in my practice. This pamphlet is organized into two pages.

Page 1 of this pamphlet lists eye drops and laser surgery (SLT, ALT, and trans-scleral MicroPulse cyclophotocoagulation [IRIDEX Corp.]). The options on page 2 are types of incisional surgery, including MIGS, as well as traditional approaches such as tube shunts and trabeculectomies. This page also lists injections and oral medications. Patients are usually more interested in the page 1 options, and I describe why I prefer those options for treating glaucoma. I say, "There are no incisions. There is no trip to the operating room. There is very little risk, and they are very effective." Additionally, I like to contrast the approaches of eye drops versus a laser in treating glaucoma. Drops work very quickly, but they require daily application—sometimes up to 4 times per day—and they may impart side effects such as redness, irritation, and/or allergies.

When we treat glaucoma with a laser, on the other hand, results take a couple of weeks, side effects or postoperative symptoms are almost nonexistent, and the patient is required to take very little action to help lower his or her IOP. The results may last years, and in fact, treatment has been successfully repeated.

After this discussion, the patient and I are ready to make a treatment plan. My two most common treatment plans are based on the TMAX, or the highest IOP measured in the patient's eyes. For a pressure of 25 mm Hg or less, I typically schedule SLT. If the individual has not achieved his or her target IOP in 2 to 6 weeks, I will consider prescribing eye drops or another MIGS procedure. If the pressure is 26 mm Hg or higher, I still schedule SLT, but I also start him or her on eye drops (typically, a prostaglandin analogue) to lower the pressure right away. I plan on discontinuing the eye drops 2 to 6 weeks postoperatively.

KEY TAKEAWAYS

- The importance of the early detection and timely treatment of glaucoma
- Clinical cases of SLT treatment and features of the NIDEK YC-200 S plus laser
- Aspects of a multifactorial approach to diagnosing glaucoma
- Minimally invasive treatments and advanced treatment options

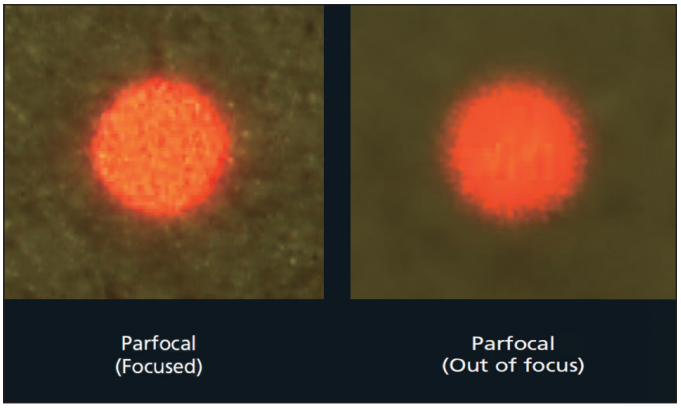

Figure 1. A photo of the aiming beam on the NIDEK YC-200 S plus laser (courtesy of NIDEK). The laser's precise-edge aiming beam enables easier focusing through the contact lens.

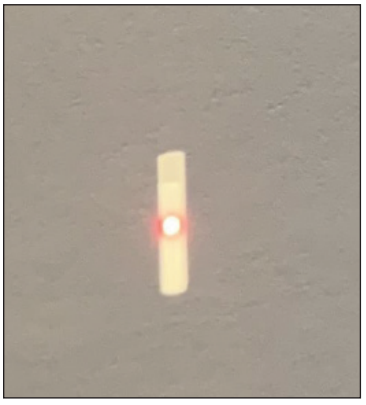

Figure 2. Photo of the aiming beam and the illumination beam of the NIDEK YC-200 S plus laser.

The Benefits of SLT Versus Eye Drops

There are a number of reasons why I prefer using SLT over eye drops to treat glaucoma. First, SLT lowers the IOP by 20% to 25%,[1] making its results equal to that of a prostaglandin analogue.[2] SLT can do this effectively 80% of the time.[2] It is also safe and repeatable, and the results may last 1 to 5 years.[3] I especially like that SLT preserves the anatomy of the angle for future MIGS procedures, should the patient need one. Finally, I have seen very few IOP spikes in my practice using the YC-200 S plus laser and my SLT protocol (*see sidebar*).

My treatment settings are as follows. I start the YC-200 S plus laser at 0.4 mJ, and I gradually increase the power until I observe microbubbles. Then I back off the power 1 notch, which is 0.1 mJ. For most patients, I apply 100 nonoverlapping adjacent treatment spots over 360°. For pigment-dispersion glaucoma patients, I only apply 50 treatment spots for 180°, in an effort to avoid IOP spikes.

There are three particular reasons why I have chosen to use the YC-200 S plus laser. First, I like the crisp edges I see with both the aiming beam (Figure 1) and the illumination beam (Figure 2) on the YC-200 S plus. Figure 2 shows the illumination beam captured through my iPhone. Having a great view of the angle and of the aiming beam means that I can confidently place the laser exactly where I want it. This visibility makes for a very efficient SLT treatment.

Second, I like the larger cone size of the YC-200 S plus. Because the laser strikes a larger area on the cornea, its energy density is lower than that of other lasers (Figures 3A and 3B). A wider cone of laser delivery means that the laser's energy is distributed over an exponentially larger area (Figure 4). This fact makes the YC-200 S plus a kinder, gentler laser.

Finally, I like the control panel on the YC-200 S plus. Its touch screen is easy to use, and it has a feature called SLT-NAVI that allows the surgeon to see the clock hours treated in real time during the procedure.

Summary

Educating patients about glaucoma is a very important part of my practice. I believe that patients deserve to understand their treatment options—even the ones who may never need it (e.g., MIGS, traditional surgery, injections, or acetazolamide). The information presented on the second page of my treatment options brochure helps my patients feel more comfortable with the options on page 1, and it also informs them about what may happen 5 or 10 years down the line when they may need a different type of treatment. Finally, SLT is an integral part of my glaucoma practice, and the NIDEK technology is often my first choice of treatment for these patients.

DR. UNGER'S SLT PROTOCOL

- The YC-200 S plus laser
- Pretreating the eye with proparacaine eye drops
- Using the Latina SLT lens (Ocular Instruments) to complete the procedure
- Postoperatively: a topical NSAID drop, as directed, for 1 week

PERFORMING SLT AFTER CATARACT EXTRACTION AND MIGS IN PATIENTS WITH GLAUCOMA

DANIEL LAROCHE, MD

Glaucoma is the leading cause of irreversible blindness in the world, with an estimated global burden of over 64 million people. That number is projected to increase to 111 million by 2040.[4] Currently, the only modifiable risk factor for glaucoma is IOP,[4] and lowering IOP is the mainstay of treatment to date.[4] The age-related thickening of the crystalline lens is the most identifiable cause of glaucoma. With age, the diameter of the lens stays the same, but its thickness and IOP both increase.[5,6] The mean IOP of a healthy eye is 15 mm Hg, and the mean IOP in untreated glaucoma is 18 mm Hg.[7] So, in eyes with an IOP of 18 mm Hg or higher, it is important to perform gonioscopy, although there are exceptions to this based on corneal thickness and corneal hysteresis.[8] However, eyes with IOP of less than 15 mm Hg do not often show visual field progression. As the IOP increases and corneal hysteresis decreases, progressive visual field deterioration can occur.

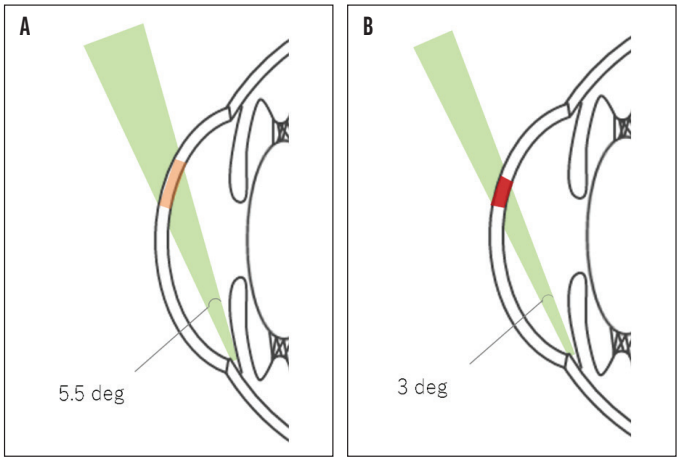

Figure 3. The cone angle on the NIDEK YC-200 S plus laser is 5.5º (A), whereas the cone angle of most other SLT lasers is 3º (B).

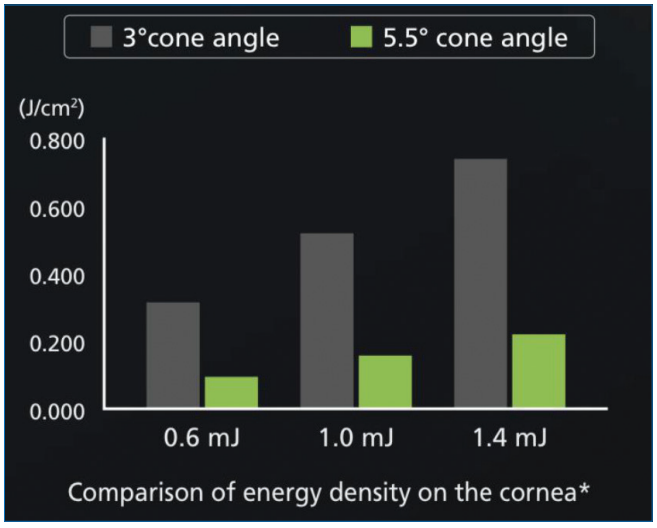

Figure 4. This comparison of energy density on the cornea* shows that a wider cone angle decreases the laser's energy density on the cornea, resulting in less tissue damage. (*Data from theoretical simulations.)

Also, eyes with IOP greater than 18 mm Hg often show increased pigmentation.[7] Figures 5A and 5B show increased pigmentation in the superior angle, but more so in the inferior angle, indicating pigment liberation from the enlarged lens rubbing up against the iris. Also visible is a narrowing of the angle and an obstruction of the trabecular meshwork, which also contributes to angle closure.

In the LiGHT trial,[9] the 6-year data showed that SLT performed better than eye drops for controlling IOP. Of the patients who underwent SLT, 70% were not using eye drops at 6 years. Both groups, however—those who used eye drops and those who underwent SLT—showed some progression of glaucoma; the eye drops group progressed at 26.8%, whereas the SLT patients had progressed by 19.7% in 6 years. The eye drops group required more trabeculectomies: 5.6% compared to 2.4% in the SLT group (almost twice the rate). The eye drops group also needed more cataract surgery: 92 eyes compared to 59 eyes in the SLT group, also nearly twice as much.[9]

At age 50, the prevalence of cataracts starts to increase, in addition to a thickening of the crystalline lens.[10] The incidence of glaucoma also starts to increase at this age[4] on all continents (Asia, Africa, Europe, North America, Latin America, and the Caribbean) and in all ethnic groups (European ancestry, African ancestry, Hispanic, and Asian). The ethnic groups with the highest incidence of glaucoma after age 50 tend to be Latin American, Caribbean, and African, because those countries have the least access to cataract surgery.[4] When we examine these patients in the clinic, the presence of pigment on the lens zonules is very suspicious of pigment liberation taking place and contributing to an elevated IOP and possibly glaucoma.

What happens to Schlemm canal and the trabecular meshwork when the crystalline lens thickens with aging and accommodation? During accommodation, the lens enlarges and the iris bows posteriorly, and iridozonular contact increases; the increased pigment liberation can block the trabecular meshwork. With age, these eyes will show an increasing pigmentation of the trabecular meshwork, which can lead the IOP to rise. As glaucoma worsens, we tend to see progressive thickening of the trabecular meshwork and a decreased ability of Schlemm canal to contract. The worse these signs are, the more advanced the glaucoma is likely to be.

My Current Approach to Glaucoma: A New Surgical Algorithm

I believe we practitioners have to rethink our approach to glaucoma. My approach has evolved to a new surgical algorithm with early cataract surgery and MIGS. Removing the cataract opens the angle and eliminates any iridolenticular contact. Implanting a thinner, smaller IOL eliminates any rubbing between the iris and lens or the iris and zonules. Cataract surgery alone can lower an eye's IOP between13% and 73%, and this procedure has been shown to be more effective in correcting angle closure than laser iridotomy.[11] The incidence of angle-closure glaucoma is declining in areas of the world where access to phacoemulsification and cataract surgeries has increased.[12]

In addition to performing cataract surgery earlier in eyes with glaucoma, I like to implant a Hydrus Microstent (Alcon) because it scaffolds Schlemm canal to keep it open and bypasses that pigmented obstruction of the trabecular meshwork to help lower the IOP. A recent study[13] that evaluated the visual field of glaucoma patients 5 years out from cataract surgery showed that those who underwent cataract surgery with implantation of a Hydrus Microstent experienced a 47%

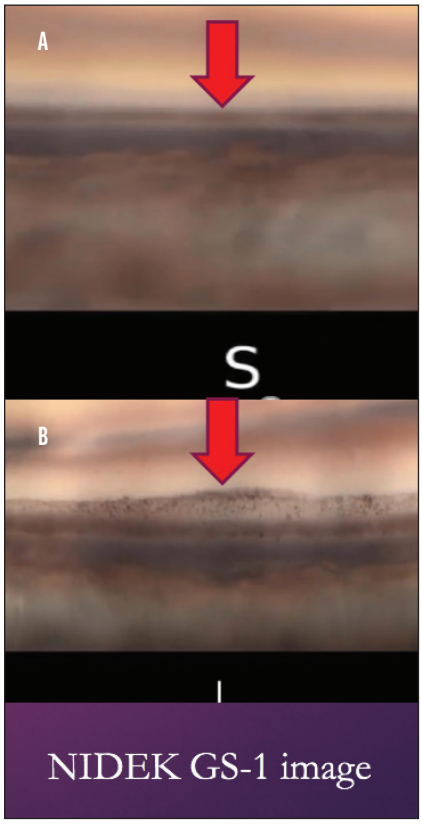

Figure 5. Eyes with IOP greater than 18 mm Hg often show increased pigmentation in both the superior angle (A) but more so in the inferior angle (B). *The GS-1 is not cleared by the FDA for distribution in the United States.

decrease in their visual field progression, with a mean rate of progression of -0.26 dB per year, compared to progression of 0.49 dB in a group that received cataract extraction alone. Furthermore, 66% of the patients implanted with a Hydrus Microstent were medication-free at 5 years, compared to the cataract-alone group. The group that received the Hydrus Microstent also had a lower risk of re-operation; those patients were 2.8 times less likely to undergo glaucoma surgery that required trabeculectomy or tube shunts, compared to the cataract-surgery group alone.[13]

Furthermore, the use of MIGS has increased from 2013 to 2018, and the number of trabeculectomies and glaucoma tube shunts has been decreasing.[14] Data from the US IRIS Registry Analysis between 2013 and 2018 show that MIGS has a very low rate of complications.[14] The most common adverse events we see with MIGS are corneal edema, hyphema, and iridocyclitis, and these events are usually self-limiting within the first to second week postoperatively with steroid treatment and healing.

Standalone MIGS procedures, performed independently of cataract extraction, are much more likely to fail.[14] In the US IRIS Registry Analysis, 25% of eyes that received standalone MIGS required reoperation after 2 years. Therefore, it's important to remove the enlarged crystalline lens in eyes with glaucoma, when possible, to increase the success rate of MIGS. The analysis also found that black patients with moderate-to-advanced glaucoma and higher baseline IOPs are more likely to require secondary surgery after MIGS.[14] We need to catch this population as early as possible to help improve their success rate of cataract extraction and MIGS.

A recent study by Okuda et al[15] showed the association between the prolonged use of antiglaucoma medications and the surgical failure of ab interno microhook trabeculotomy. Patients who had been on medications for more than 4.5 years had the lowest success rate of ab interno trabeculotomy (MIGS). These data reveal that it is best to intervene as early as possible in glaucoma patients to preserve the anatomy of Schlemm canal, the trabecular meshwork, and the eye's dynamic activity to pump aqueous of the eye.

We also have data on SLT. A study by Shazly et al[16] looked at the effect of prior cataract surgery on long-term outcomes of SLT. Performing SLT after cataract surgery and MIGS can induce as much as a 26% reduction of IOP at 30 months postoperatively. Another small study by De Keyser et al[17] of 38 patients who underwent cataract surgery alone had a preoperative baseline IOP of 13.51 mm Hg and IOP of 10.05 mm Hg by 12 months postoperatively. At baseline, this group's average medication load was 1.71, and at 12 months it had decreased to 0.41—a threefold decrease in medication usage.

Now, we are starting to see some data on the application of SLT after cataract surgery and MIGS. Siedlecki et al[18] performed a retrospective electronic medical record review of the iStent procedure (Glaukos) performed

"SLT IS VERY EFFECTIVE AT REDUCING IOP BEFORE AND AFTER CATARACT EXTRACTION AND ISTENT. SLT CAN REDUCE BOTH MEDICATION BURDEN AND IOP AFTER CATARACT EXTRACTION ALONE, AND AFTER CATARACT EXTRACTION WITH ISTENT."

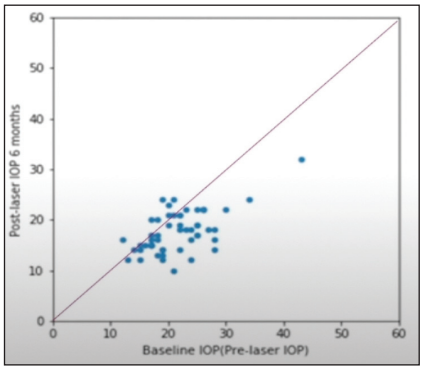

Figure 6. A scatter plot of the change in IOP from preoperative baseline to 6 months postoperatively in Dr. Barnebey's first treatment cohort with the NIDEK YC-200 S plus laser. IOP is measured in mm Hg.

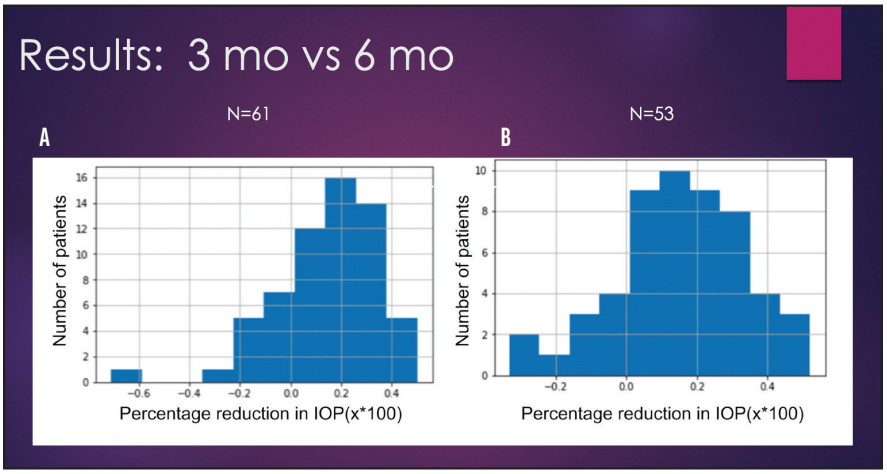

Figure 7. The percentage of IOP reduction from 3 months postoperatively (A) to 6 months postoperatively (B) in Dr. Barnebey's initial YC-200 S plus laser cohort. Zero represents no change, 0.2 equals a 20% reduction in IOP, and 0.4 indicates a 40% reduction in IOP. Likewise, -0.2 would equal a 20% increase in IOP.

after cataract surgery in 48 eyes of 28 patients. The pre-SLT IOP was 15.94 mm Hg, and the post-SLT IOP was 13.71 mm Hg. The medication usage reduced from 1.67 preoperatively to 0.73 postoperatively.

At the 2021 meeting of the American Society of Cataract & Refractive Surgery, Richard Lehrer, MD, presented his clinic's data on approximately 50 eyes that received SLT after undergoing phacoemulsification followed by iStent implantation.[19] At 12 months after SLT, the IOPs were reduced approximately 22.7% in eyes with medications and by 24.2% in eyes without medications. The mean time for adding a medication after the SLT procedure was about 12 months. Even after cataract extraction and MIGS, some of these patients will still need additional treatment, for which SLT works very well. Lehrer also found that SLT can be performed more than once: he repeated SLT in 7 eyes, with a 71.4% success rate.

The conclusion of these findings is that we can consider performing cataract surgery/refractive lensectomy and MIGS earlier to enhance the success rate of these procedures. The longer a patient is on medical therapy, the more it may reduce success with MIGS. SLT is very effective at reducing IOP before and after cataract extraction and iStent. SLT can reduce both medication burden and IOP after cataract extraction alone, and after cataract extraction with iStent. Further studies are needed as we continue to progress in this new MIGS environment.

WHY ANOTHER LASER?

HOWARD BARNEBEY, MD

I would like to share my initial clinical experience with the YC-200 S plus laser. Prior to owning this laser, I wondered if my clinic needed another SLT laser. Was it going to be the same as others on the market, or would it have some differences or enhancements that would make this particular laser and its design and functionality more appealing to me and my fellow practitioners?

I evaluate a new laser for its engineering and for its features that might benefit me and my staff in surgery. Specifically, I consider whether a laser is going to provide greater precision, better control, and improved functionality of the applications my staff and I are familiar with. It is important that a laser deliver energy evenly on the tissues we're treating. We'd like a control panel that is easy to operate and lets us make changes on the fly, as we often need to do during treatment. Do the optics allow me to see the ocular structures easily? I appreciate a well-designed, ergonomic delivery platform that is easy to use. Finally, we want a laser to have a stable platform, something that requires minimal upkeep and is well built.

Engineering, Optics, and Ergonomics

The optics on the NIDEK YC-200 S plus laser are superb and what I would expect from a high-quality slit lamp. The laser has an adjustable illumination tower that helps us visualize structures. I find the control panel on the YC-200 S plus laser to be very intuitive. It features safeguards that let me know I am delivering the right amount of energy at the right settings. Ideally, the ergonomics of the laser should make the procedure comfortable for us to perform and as comfortable as possible for the patient to receive.

Using an SLT laser means treating with a 400-µm spot size. We are treating the entire trabecular meshwork with contiguous laser application. Considering the average cornea's width and the average circumference of the trabecular meshwork, then the average SLT laser application is between 95 and 100 applications.

First Clinical Experience With the YC-200 S plus Laser

In our initial experience treating patients with the YC-200 S plus laser,

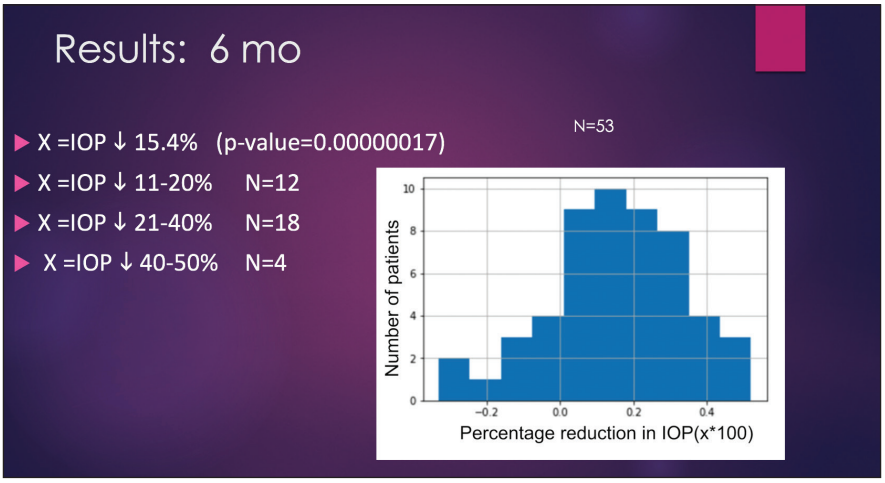

Figure 8. Average reduction in IOP at 6 months. N = 53. A clinically significant number of eyes saw a decrease in IOP of 15% [*p*= 0.00000017]; 12 eyes had a decrease in IOP of 11% to 20%; 18 eyes experienced lowered IOP of 21% to 40%; and 4 eyes enjoyed lowered IOP by 40% to 50%.

my team and I delivered 95 to 100 treatment spots each to 53 eyes of 53 patients. We took all comers, as long as they had open-angle glaucoma. Some patients were on medications, while some were naive to treatment. We used a consistent protocol: at the beginning of the trial I only placed 80 applications, but toward the end, I consistently treated with 100 applications, 360º as a single setting. We used a program that NIDEK has incorporated into the YC-200 S plus laser called SLT-NAVI, which helps the surgeon evenly distribute the laser applications throughout the 360º circumference.

I'd like to share the 3-month and 6-month data on this SLT treatment group. During this time, my team and I did not change any patient's medications; whatever they were using preoperatively is what we maintained. Figure 6 shows a scatter plot of the change in IOP from baseline (pre-laser) to 6 months postoperatively, where IOP is presented in mm Hg. The majority of the patients whom we treated were below the red regression line, indicating that their IOPs were much better 6 months after the treatment compared to before. That's what we would expect with any SLT laser treatment.

We also compared the percentage of IOP reduction from 3 months to 6 months in this cohort. As the histogram in Figure 7 shows, most patients had excellent results. By 6 months, most patients showed a decrease in IOP of about 17%. Some individuals had a fantastic 40% reduction in IOP by 6 months. Overall, the clinical experience was quite good.

My staff and I broke down the information a little bit differently and looked at the average percentage of IOP reduction at 6 months (Figure 8). Averaging the outcomes together, we achieved slightly greater than a 15% reduction in IOP.

To summarize, this was the first clinical study with the YC-200 S plus laser. Its efficacy is comparable to other published studies.[20] My experience is that the NIDEK YC-200 S plus laser is a very intuitive, well thought-out, ergonomically comfortable laser to work with, and it has superb safety controls.

CONCLUSION

Dr. Barnebey: We hope we have provided a robust discussion and a deeper understanding of clinical approaches to the diagnoses and management of glaucoma. Also, we hope this talk has provided a good introduction to the capabilities of the YC-200 S plus laser. ■

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