Redefining Precision Capsulotomies Post Premium Cataract Surgery

Recent advances in YAG laser technology may reduce IOL pitting and bring a measure of precision and standardization to this routine procedure.

BY INDER PAUL SINGH, MD

Cataract surgery is experiencing a paradigm shift: due to the advent of premium IOLs, advanced laser technologies, precise diagnostics, and evolving techniques, cataract surgery is becoming more like elective refractive surgery, with higher expectations from both surgeons and patients for high-quality outcomes. When these patients develop posterior capsule opacification (PCO) and require a capsulotomy, I believe we have an opportunity to advance the standard of care by offering premium refractive outcomes in routine capsulotomies.

Before premium IOLs, we used to delay YAG capsulotomies until the capsule had significant opacification or the patient voiced strong complaints. Due to patients' heightened awareness of their quality of vision, and the impact of even mild PCO on the quality of vision in eyes implanted with a multifocal or EDOF lens,[1,2] we are appreciating the need to sometimes perform YAG capsulotomies earlier for patients with higher post-procedure expectations.

THE CASE FOR PRECISE CAPSULOTOMIES

Nd:YAG capsulotomies should be performed with the same level of precision and predictability as cataract surgery. We must ensure that we do not pit or shift the IOL, the capsule's edges are perfectly positioned, and that we have a symmetric capsulotomy leaving an overlapping edge around the optic. Capsulotomies must also be perfectly sized: too small of a capsulotomy may induce glare, halos, and other dysphotopsia; one made too large may allow vitreous to escape or the lens to move, inducing refractive error such as hyperopia. Premium IOLs may be impacted even more by the variability in technique of the procedure.

Despite the change in paradigm, we still have not seen standardized techniques for precise Nd:YAG laser capsulotomies. YAG lasers of the past had less predictable energy delivery, and we surgeons have needed better techniques to avoid pitting the IOL—one of the most common adverse events of an Nd:YAG capsulotomy.

POSITIONING THE BEAM FOR SAFE, REPRODUCIBLE CAPSULOTOMIES

When an Nd:YAG laser fires, it creates plasma, which results in a cavitation bubble, producing a shock wave of acoustic energy. Much of this acoustic wave reverberates anteriorly back toward the laser source and is the mechanism for capsule rupture. We aim the laser at least 100 µm behind the IOL to prevent pitting the optic with laser induced plasma and/or the acoustic wave propagating back toward the posterior capsule.

I have been collaborating with Karl Brasse, MD, MRCOphth, (Germany) on perfecting the capsulotomy technique with the

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Reflex™ NEO line of YAG lasers from Lumibird Medical (formerly Ellex). We realized if we aim the Nd:YAG laser beam farther back in the eye, up to 2,000 µm behind the posterior capsule, we can take advantage of the properties of the cavitation bubble created by the plasma. Then we can cleanly dissect tissue centrally, allowing careful construction of the capsule opening symmetrically outwards, from the center, adequately exposing the properties of premium IOL optical zones. This technique can produce a clean break of the capsule with extremely low risk of hitting the IOL. The NEO YAG lasers are built with a 2,000-µm (2-mm) posterior offset—the largest of any YAG laser clinically available. In my hands, I can create a very controlled, precise capsulotomy using an efficient number of shots (15 to 30) and approximately 2.0 to 2.50 mJ of energy per shot.

Furthermore, applying the Nd:YAG laser farther back behind the lens takes advantage of its collapsing cavitation bubble formed due to plasma, to break up a larger area of the capsule per shot, resulting in fewer free-floating fragments and less potential of inducing floaters post procedure. This technique also creates a beautiful, circular capsulotomy while reducing the risk of changing the lens' positioning, moving the haptics, or causing significant disruptions to the vitreous interface.

Energy delivery with the Reflex™ NEO YAG lasers is delivered with a sharper rise and fall relative to other lasers—an optical principle called a truncated Gaussian Curve—which reduces the size of the plasma convergence zone and creates more efficient energy delivery. A principle that is important to appreciate with an Nd:YAG laser is the nonlinear relationship between increasing the energy on the laser and the increase in convergence zone. For example, in a liquid medium, 1 mJ of laser energy produces approximately 110 µm size of dispersion of fluid. If we increase the laser's energy delivery to 10 mJ—a 10-fold increase—the size of the dispersion only increases by a factor of 2 to 220 µm. Applying the plasma formation 2,000 µm behind the lens results in the cavitation bubble it creates completing its natural life cycle and fully collapsing to release an anterior hydraulic jet effect as the mechanism for capsule destruction instead of the propagating acoustic energy wave. The anterior vitreous space is hardly affected at all. From a safety perspective, the Reflex™ NEO

lasers do not cause a significant disruption to the vitreous or the surrounding tissues.

EXCEPTIONAL OPTICS

The Reflex™ NEO laser optics are phenomenal, in my opinion. The laser incorporates a Reflex™ flipping mirror system, bringing the true-coaxial slit lamp illumination, laser aiming beam, and the oculars into alignment at one optical plane. Most Nd:YAG lasers are designed with an oblique illumination tower, which does not allow the user to visualize structures anywhere a few millimeters behind the IOL, therefore making it hard to see any free floating capsular remnants during the treatment. The full red Reflex™ created by the coaxial tower highlights any capsular remnants and allows better visualization of them so we can target them with the laser and decrease the potential for floaters or disturbances that patients often describe postoperatively. When my colleagues and I compared a non-coaxial laser and Lumibird's Ultra Q Reflex™ laser tower, which also provides coaxial illumination,[3] we found that those who were treated with coaxial illumination reported significantly fewer floaters postoperatively compared with those we had treated with the standard Nd:YAG laser.

THE IMPORTANCE OF PRECISE CAPSULOTOMIES

The Reflex™ NEO laser's combination of its second-generation true-coaxial illumination tower, efficient energy profile, and its degree of posterior offset (2 mm) allows us to standardize the disruption of the posterior capsule and create a more precise, predictable, perfectly round, 4.0- to 5.0-mm capsulotomy. Dr. Brasse and I use a cruciate type of pattern, and the efficiency of the laser allows us to use a very small number of shots with little risk of hitting the IOL (my personal rate of lens pitting has decreased significantly since using this Nd:YAG laser [unpublished data]).

NEW TANGO REFLEX™ NEO YAG/SLT LASER

Lumibird Medical is launching its newest YAG laser, the Tango Reflex™ Neo with PROcap™ (Premium Refractive Outcome Capsulotomy). It has several advantageous features. First, it has a discrete heads-up display (Imprint™) within the oculars providing real-time feedback of current energy settings, coupled with a switch mechanism on the joystick for increasing and decreasing laser energy, allowing the surgeon complete focus without having to look away to view settings on the 10.1" touch screen interface. The Tango Reflex™ Neo laser also has an internal fan-cooled laser cavity ensuring a consistent and stable delivery of energy. YAG lasers are inherently inefficient, losing a huge amount of energy to heat, which can cause overheating and shut down with sustained use or deliver varying amounts of energy per shot if energy is poorly managed. Our group presented a paper where we compared an Nd:YAG laser with a passive cooling system to an Nd:YAG laser (Ellex) with the same active cooling cavity as is in the Tango Reflex™ Neo laser.[4] We found less variability in the delivery of energy in the laser with the active cooling cavity. When we use Nd:YAG lasers clinically, it is important to be assured that the energy delivery will not change from case to case, no matter how many capsulotomy procedures a practice might do consecutively.

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MY TECHNIQUE

I found transitioning to the Tango Reflex™ Neo with PROcap™ technique easy; the technique is the same as with other Nd:YAG lasers, but with the tools for a higher level of precision. I like to use a contact lens in these cases. The lens gives me control over patient eye movement while improving efficiency of the laser delivery. My technique is to use a coupling agent (e.g., Systane Gel [Alcon], Genteal gel [Alcon], or a viscoelastic), place the lens on the eye, and apply the laser 2,000 µm behind the lens at a power setting between 2.0 and 2.5 mJ. The Reflex™ NEO laser is the only Nd:YAG laser that allows you to focus at 2,000 µm behind the lens. I typically deliver between 15 and 30 shots. I do not prescribe any NSAIDs or steroids afterward.

CONCLUSION

Even though Nd:YAG capsulotomy is a common procedure, every part of cataract surgery is undergoing constant evolution. Everything we practitioners do can be incrementally improved, and the accumulation of those improvements is how we achieve pristine outcomes. Nd:YAG laser capsulotomies can have a significant impact on our patients' quality of life. Whether they are paying more for a premium IOL or not, patients are expecting better and better outcomes, and I think we owe it to ourselves and our patients to create the most precise capsulotomies possible. ■

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2. Miller VJ, Patnaik JL, Lynch AM, et al. Risk factors predisposing to early Nd:YAG capsulotomy in a Colorado cohort. ARVO Annual Meeting Abstract. *Invest Ophthalmol Vis Sci*. 2018;59:4797.
3. Ultra Q Reflex Product Brochure – Technical specifications. Document number 8448321EN.
4. Tango Reflex Neo Product Brochure – Technical Specifications. Document number 8448330EN.

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