

Point/Counterpoint: Is the Architecture of Laser Clear Corneal Cataract Incisions Satisfactory?

Yes, and it is getting better with experience and technological advances.

BY KERRY D. SOLOMON, MD



I love the flexibility the femtosecond laser gives me, and incisions created with this technology will only get better in time.

FLEXIBILITY

What I enjoy about laser cataract surgery is that I have the flexibility to construct different sizes and shapes of incision. For example, I use a three-plane primary cataract incision. I make a vertical cut-down that is about 60% depth of the total corneal thickness, followed by a horizontal cut that travels just short of the anterior chamber, and then another vertical cut-down. The advantage of that geometry is that the incision self-seals regularly, consistently, and reproducibly. It also allows me to shorten the length of the tunnel. In other words, instead of a square incision, I create a reverse trapezoid: the external portion is 2.3 mm, and the internal portion is 2.5 mm. I find that this geometry reduces “oar locking” and improves visibility compared with a manually created incision. The length of the tunnel, however, is only 1.5 mm, so visibility is excellent.

I think clear corneal incisions created with a laser are more prone to edema than those made with a blade, although I do not know the reason for this difference. I have found, however, that using a reverse trapezoid configuration, moving the incision farther up to the

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These incisions are currently falling short in terms of refractive benefits.

BY WILLIAM F. WILEY, MD



The demand on corneal incisions to improve the refractive result of cataract surgery has never been greater, owing to the emergence of true refractive cataract surgery and patients' expectations of a reduced or eliminated need for spectacles postoperatively. Ophthalmologists' original goal was a safe, minimally invasive, quick-healing, cosmetically appealing, “predictable” incision. To this last point, surgeons traditionally attempt to predict the incision's astigmatic effect on the eye and incorporate that information into the surgical plan to allow for the accurate axial placement of and power adjustments to toric IOLs and limbal relaxing incisions. Unfortunately, posterior corneal astigmatism, variable tissue response, and marginal preoperative biometric diagnostics make it quite challenging for ophthalmologists to reliably predict their surgically induced astigmatism.

In theory, creating the clear corneal cataract incision with a femtosecond laser should improve refractive predictability, but I do not believe this goal has been achieved in practice. Furthermore, I would argue that it is better to measure the refractive effect of the incision directly than to make educated guesses about astigmatism.

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periphery, and shortening the tunnel have reduced the amount of edema I see.

The wound architecture I am using with the laser allows me to hydrate the roof of the incision readily. I find that my laser incisions self-seal better than those I create manually, but it is because the wound architecture is different. When I create incisions with a blade, I go straight in, and the incisions seal very well. Someone could argue that my manual incisions would seal just as well as my laser incisions if I used a reverse trapezoid configuration for both, but achieving that architecture with a blade would be more challenging.

I should note that I do not use the laser to create cataract incisions in eyes with a history of radial keratotomy. I also tend to use a blade when dense scarring is present in the arcus senilis or at the corneal periphery.

EVOLUTION

The location of the cataract incision under the operating microscope may not be where it appeared it would be on the laser system. I have found that this problem occurs less as a surgeon gains experience with the laser cataract procedure. That said, I had an incision not be where I intended just a week before the writing of this article. I simply ignored it, never broke the seal. Instead, I created an incision at the desired location with a diamond blade. I expect that future iterations of laser technology will address this problem through better registration. Along those lines, enhanced registration should also help ophthalmologists to improve the consistency of incisional alignment, which will reduce surgically induced astigmatism.

I would expect surgeons to discover more novel ways to create cataract incisions. For example, for LASIK procedures, surgeons now use something called an *inverted sidecut*, which has advantages in terms of epithelial ingrowth. In time, I anticipate that ophthalmologists will be able to create inverted sidecuts for the clear corneal cataract incision as well.

Already, manufacturers are modifying the amount of energy that laser systems use as well as the spot size separation. The technology and the incisions it allows surgeons to create will only get better. The point is for industry to continue to improve the refractive outcomes that surgeons can achieve for their patients. ■

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INTRAOPERATIVE ABERROMETRY

Intraoperative aberrometry (IA) has decreased the need for a predictable cataract incision. The technology allows surgeons to measure the direct effect of the incision on the axis and power of astigmatism. In addition, they can measure the incision's effect on posterior corneal astigmatism, which is very difficult to predict with current preoperative diagnostics. The challenge of IA is that it requires careful management of intraoperative surgical variables to obtain accurate and reliable readings. One of the most important variables is IOP. When the pressure is too low, the eye becomes soft and prone to distortion. An improperly made cataract incision can compromise IOP, resulting in poor IA readings, or it can leak, requiring additional stromal hydration that may alter IA readings through an induction of astigmatism or a change in its axis. Moreover, an incision created too centrally may interfere with and alter the IA readings. Ideally, the cataract incision should be made as peripherally as possible to avoid interfering with IA readings (Figure 1).

A hope was that femtosecond lasers would increase the reproducibility of the cataract incision and thereby increase the utility of IA. Instead, I have seen laser incisions interfere with IA. Because the currently available lasers have difficulty cutting through arcus senilis, cataract incisions must be placed more centrally, which can compromise IA measurements. I also find

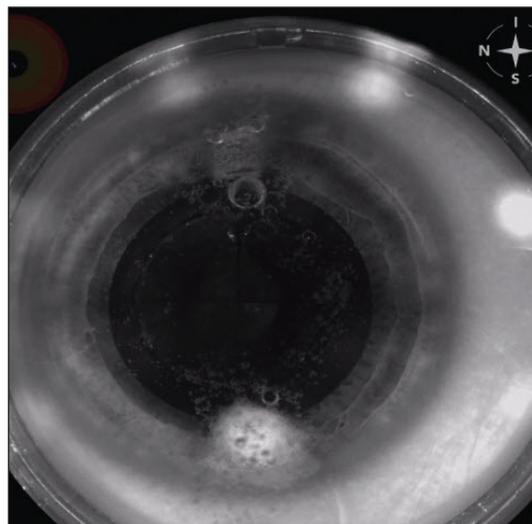


Figure 1. The location of the corneal incision and edema interfere with aberrometry readings.

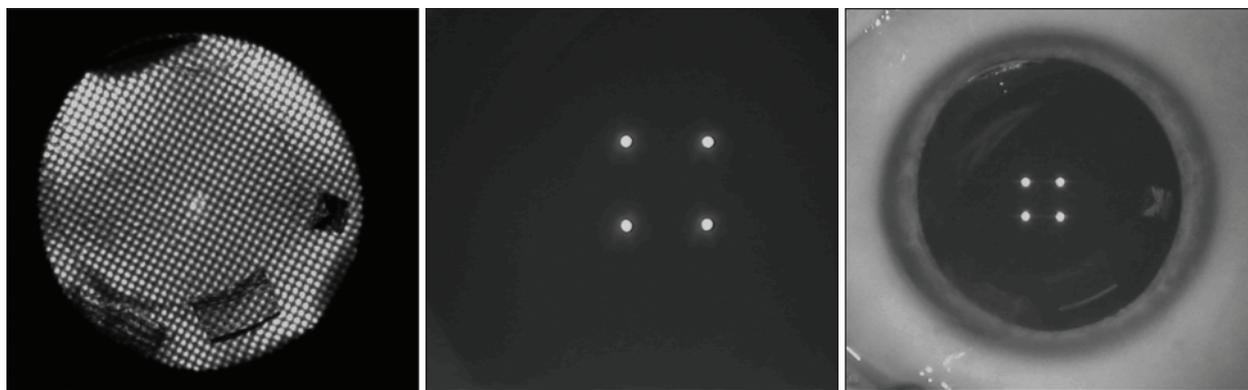


Figure 2. Variable tissue response in the same eye with the same energy levels but two differently placed incisions. The superior incision has a more opaque bubble layer than the inferior incision.

that cataract incisions created with lens-based femtosecond lasers can require greater stromal hydration, which can stretch or traumatize tissue, preventing it from immediately self-sealing.

ENERGY LEVELS

My first experience with a femtosecond laser for cataract surgery involved the use of the iFS Laser (Abbott Medical Optics) in 2010. Because this system was designed to cut corneal tissue, I was not surprised to achieve high-quality, self-sealing, well-created clear corneal cataract incisions. The problem with using the iFS Laser for cataract incisions lay in the system's usable diameter of 9.5 mm: for the incision to be placed at the limbus required offset docking of the patient interface. Although I found this maneuver relatively straightforward, I noticed that offset docking occasionally disrupted the central corneal epithelium, which could interfere with IA readings. Another problem, of course, was that the iFS Laser cannot be used on lens structures, thus limiting the device's usefulness in cataract surgery.

Since then, I have used the Catalys Precision Laser System (Abbott Medical Optics), the LenSx Laser System (Alcon), and the Lensar Laser System (Lensar). All three are superb at cutting lens structures but, in my opinion, have fallen short in terms of corneal incisions. A laser needs a lower numerical aperture angle to focus and deliver energy relatively deep into the eye to reach lens structures. A cornea-cutting laser uses a larger numerical aperture to deliver energy to superficial tissues, allowing for a precise cut with relatively minimal energy. If the laser system has a small numerical aperture, it becomes difficult to optimize energy levels for cutting corneal tissue. If the laser settings generate too much energy, gas bubbles are created that block subsequent laser shots, thus decreasing their efficacy and making it impossible to open or pass through the

incision. Energy levels that are too low do not allow the proper cutting of tissue.

Further complicating matters, corneal density often varies inferiorly to superiorly and anteriorly to posteriorly. This variability seems to affect laser systems with a low numerical aperture, which interferes with the creation of a cataract incision (Figure 2).

Stated another way, at least with current technology, a laser system that is good at softening the nucleus will not also be efficient at cutting corneal tissue.

CONCLUSION

The goal of refractive cataract surgery is to remove the cataract safely and to provide a refractive result that is stable over time. The current femtosecond lasers soften the cataract, allowing for its safe removal, and they allow surgeons to create a stable, predictable capsulorhexis, which promotes the IOL's stability and fixation over time. As far as the cataract incision, however, today's laser technology does not help surgeons to achieve refractive outcomes, and the devices may actually threaten the usefulness of IA, one of the most powerful refractive tools available.

I expect that technological advances will one day allow femtosecond lasers to address both lens structures and the cornea. The ability to use a laser to safely create reproducible, reliable, watertight incisions will be a significant clinical improvement. It will also improve the accuracy of complementary technologies. ■

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