

REFRACTIVE DECISIONS

Advancing Femtosecond Applications

Jay Pepose, MD, PhD

Femtosecond lasers gave new life to LASIK and now stand poised to revolutionize other ophthalmic surgeries. Even within LASIK, the femtosecond laser's role has grown. In addition to the safety and predictability that it brought to flap-making, it also enabled flap customization: We can now select the shape, thickness, hinge size and position, and side-cut architecture for each. The ability to make inverted side cuts may lead to less biomechanical weakening of the cornea, as well as to more rapid corneal reinnervation.

Femtosecond lasers have also become faster, allowing them to deliver more pulses per second. This, in turn, enables smaller spots with tighter spacing between spots. The results are smoother beds, significantly less inflammation, and the near-eradication of the opaque bubble layer. All in all, femtosecond lasers have changed the LASIK process dramatically, reducing complications and improving outcomes. But LASIK is just the beginning of femtosecond lasers in eyecare. Thanks to its precision and reproducibility, the femtosecond laser is now being used for both refractive and therapeutic purposes in virtually all aspects of anterior segment surgery.

Refractive Applications

In some applications, the femtosecond laser can correct refractive error and presbyopia without assistance from an excimer laser. In the INTRACOR

procedure, corneal biomechanical forces are redistributed by concentric cylindrical cuts entirely within the corneal stroma. This creates a kind of "controlled ectasia" in which the cornea bulges centrally, creating a small refractive change that can improve near vision by up to six lines. More studies are needed to help answer important questions about reproducibility, predictability, stability, and reversibility—as well as the nature of enhancement procedures.

With regard to all-femtosecond LASIK, one such procedure, given the acronym FLEX (femtosecond lenticule extraction), uses the femtosecond laser to create a tissue lenticule within the corneal stroma. Removal of the lenticule via a flap or a laser incision provides the refractive correction. Studies on both of these procedures are ongoing, and questions remain (regarding the limitations of each procedure and the stability of the results), but initial results have proven principle.

We already use the femtosecond laser to make a pocket or flap for intracorneal inlays to correct presbyopia, but some are looking to use the femtosecond laser for procedures that directly reverse presbyopia. In theory, older crystalline lenses could be "softened," allowing them once again to accommodate. This may work by creating micro-incisions in the mid-peripheral lens that act as gliding planes. Other studies look at using femtosecond lasers to change the anterior lens curvature.

Therapeutic Applications

Therapeutic applications include corneal wedge resections, arcuate keratotomies, and limbal relaxing incisions. These femtosecond-driven procedures can be used along with full or partial thickness corneal transplants,

corneal biopsies, corneal tattooing, and limbal stem cell transplantation.

There is currently an explosion of interest in using femtosecond lasers in cataract surgery because of their precise cutting ability. Available femtosecond laser devices can soften and divide the nucleus, perform the capsulorhexis, and make the initial corneal incision and paracentesis, along with limbal relaxing incisions. Even though there are just a handful of units in clinical use at this time, femtosecond lasers are clearly the "next big thing" in cataract surgery.

Looking Ahead

The future of femtosecond laser procedures is bright. However, amidst the excitement about widespread application in cataract and anterior segment surgery, we must determine whether these procedures translate into better outcomes and, if they do, at what cost. How will we need to alter patient flow and the location of the laser to be most efficient? What business model will evolve that makes sense for the patient, the surgeon, and the manufacturer? Only when these questions are answered can we determine whether femtosecond-driven procedures are better than current alternatives.

Up until recently, most femtosecond lasers were designed for either corneal or cataract applications. Having a laser platform that could perform in both areas would greatly increase the instrument's utility and cost effectiveness.

The femtosecond laser is an enormously versatile device and will be with us for years to come. As our understanding of the technology becomes more sophisticated, I believe the number of ways in which we use this technology will grow exponentially. ●



Jay Pepose, MD, PhD, is the founder and medical director of the Pepose Vision Institute, as well as professor of clinical ophthalmology at Washington University School of Medicine and the Barnes-Jewish Hospital, all located in St. Louis. He serves as a consultant for Abbott Medical Optics Inc and for Bausch + Lomb. Support for this column is provided by an educational grant from Abbott Medical Optics Inc.