Additional benefits are provided by the use of the femtosecond laser in cataract surgery.

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The main goals of any surgical procedure are to achieve the best anatomic and functional restoration via a painless procedure with minimal tissue invasiveness, fast recovery, and low potential for complications. Microincision cataract surgery (MICS) was a term first coined by our group in 2002 to describe cataract surgery performed through a sub-2-mm incision while aiming to achieve these goals.1,2

Bimanuality is one of the major benefits of MICS. It enables the separation of irrigation from the phaco and aspiration tip, allowing the surgeon to stabilize the anterior chamber; maintain distance between the posterior capsule and the phaco tip; decrease turbulence for less invasive surgery; and work with fluidics like two separate instruments, inducing less trauma to surrounding tissues.1,2

In the past 4 years, several authors have reported on the improvements afforded to cataract surgery with the use of femtosecond lasers for incision creation and other surgical steps. Today, femtosecond lasers can ensure the stability, reproducibility, precision, length, width, and design of corneal incisions, all of which have significantly improved this step of cataract surgery.3 We have shown that corneal incisions created with a femtosecond laser were stable and induced no aberrations, and favorable results were achieved using a triplanar configuration.4

SURGICAL TECHNIQUE

Laser operating room. Our approach to femtosecond laser MICS (femto-MICS) begins in the laser operating room (OR). Topical drops (preservative-free lidocaine 2% and cyclopentolate 1%) are instilled to achieve anesthesia and adequate pupil dilatation of 6 mm or greater. The LenSx Laser System (Alcon) is docked to the patient’s eye, after which the lens capsule and nucleus positions, anterior capsulotomy site, and corneal incision configurations are precisely adjusted under 3-D optical coherence tomography image guidance. Nucleus fragmentation and anterior capsulotomy (5 mm) are followed by the creation of clear corneal incisions. In all cases, we use a hybrid pattern for nucleus fragmentation, as this configuration allows us to achieve better fluid dynamics for the MICS technique.

A triplanar primary corneal incision (2.2 mm; Figures 1 and 2) at the steepest meridian on corneal topography is performed (first and third sidecut angles, 60º to 70º; second sidecut angle, 15º to 25º) for the purpose of IOL implantation. Next, a uniplanar 1-mm secondary corneal incision (sidecut angle, 30º to 45º; Figure 2) is performed 90º away for insertion of manipulating instruments. All of these parameters must be selected by the surgeon in a rational manner according to the corneal characteristics of each patient.

At the time our clinical study was conducted, the LenSx laser allowed the creation of only two incisions, as described above; however, current software enables the creation of three incisions—two for cataract surgery and a third for IOL implantation—to adapt better to the MICS technique. We always place the incision through which the IOL is implanted at the steepest meridian of corneal astigmatism, close to the corneoscleral limbus.

General OR. The patient is then transferred to the general OR and placed under a standard operating microscope. The surgeon manually creates a 1-mm incision that will be used for the introduction of the MICS phaco probe, and the secondary incision previously created with the femtosecond laser is opened with a Sinskey hook. The anterior capsulorhexis is grasped, and phacoemulsification is performed.
through the 1-mm manual incision (Figure 3). The IOL is implanted via the 2.2-mm anterior incision, which was created earlier by the femtosecond laser but is opened only at the time of implantation. The IOL of our choice is one that fits through a 1.8- to 2.2-mm incision, depending on the power and type of the IOL.

After surgery, patients rest for 30 minutes. They are then examined at the slit lamp to confirm the sealing of the corneal incision using a fluorescein Seidel test before discharge.

**PROSPECTIVE STUDY**

We performed a prospective study comparing bimanual femto-MICS with 2.2-mm coaxial phacoemulsification assisted by the LenSx femtosecond laser (ie, femto-coaxial). A total of 94 patients were enrolled in the study, including 25 in the MICS LenSx group, 23 in the microcoaxial 2.2-mm LenSx group, 23 in the standard MICS group, and 23 in the microcoaxial 2.2-mm standard group. The following results were obtained.5

**Surgical efficiency.** Mean ultrasound power was 1.8 ±0.9% for femto-MICS incisions and 14.7 ±4.9% for femto-coaxial incisions (P<.001). Effective phacoemulsification time (EPT) values for femto-MICS and femto-coaxial incisions were 1.5 ±0.9 and 4.5 ±2.9 seconds, respectively (P=.002; Figure 4).

**Visual and refractive results.** At 1 month, the mean postoperative spherical equivalent was -0.26 for femto-MICS and -0.33 for femto-coaxial (P>.05). The visual efficacy index value at 1 month was 160.2% for femto-MICS and 149% for femto-coaxial. The mean total corneal higher-order aberrations (6-mm pupil) both before and after surgery were 0.6 ±0.4 and 0.66 ±0.2 μm, respectively, for femto-MICS and femto-coaxial (P=.10). The mean value for internal coma (4-mm pupil) for both procedures was 0.13 μm.

**Pachymetry, endothelial cells, and macular thickness.** Relative to preoperative values, there were no significant changes in postoperative pachymetry, endothelial cells, or macular thickness values in either group (P>.05).

**Complications.** In the femto-MICS group, posterior capsular rupture and anterior capsular rupture with no tear to the posterior capsule both occurred in 4% of cases. In the femto-coaxial group, 4% of cases had bridges due to an incomplete capsulorrhexis. These bridges were removed without complication using Utrata forceps.

**DISCUSSION**

The capsulorrhexis is a crucial and essential part of cataract surgery. Especially in premium lens patients, this surgical step requires an exact diameter and perfect centration to achieve the optimum positive effect on lens stability, and it contributes to the success and performance of lenses with accommodating, multifocal, and toric characteristics. Femtosecond laser technology can achieve accurate and predictable size, shape, and centration of the capsulorrhexis. The laser also creates a more resistant capsulorrhexis to provide stronger support during lens removal and IOL implantation. Reduced phaco time and energy during phacoemulsification is an added value of laser-assisted cataract surgery.2,6-8

The reduction of EPT and ultrasound power settings

**TAKE-HOME MESSAGE**

- Bimanuality is one of the major benefits of MICS because it enables the separation of irrigation from the phaco and aspiration tip.
- Femtosecond lasers can ensure the stability, reproducibility, precision, length, width, and design of corneal incisions.
- The femto-MICS technique adds value to the safety and effectiveness of cataract surgery, but larger studies with longer follow-up will be needed to justify the cost-benefit associated with use of the femtosecond laser.
is an advantage of the MICS technique. In a literature review comparing MICS and coaxial phacoemulsification, a greater number of studies showed better outcomes in EPT values with MICS.9-16 Additionally, lower induction of corneal aberrations has been reported following MICS in comparison with coaxial techniques, demonstrating the importance of the microincision.9,17-24

In our analysis of surgical efficacy, we referenced one of our own publications16 to compare the values of EPT and ultrasound power for different techniques, including femto-MICS (1.0-mm incision), MICS (1.8-mm incision), femto-coaxial (2.2-mm incision), and coaxial (2.8-mm incision). The median EPT value was lower with femto-MICS compared with MICS (1.5 ±0.9 vs 2.19 ±2.77 seconds) and lower with femto-coaxial than coaxial (4.5 ±2.9 vs 9.2 ±12.38 seconds). Mean ultrasound power was lower with femto-MICS than with MICS (1.8 ±0.9% vs 5.28 ±3.91), and lower with femto-coaxial than coaxial (14.7 ±6.9 vs 19.2 ±10.98).

The significant reductions seen in EPT and ultrasound power between femto-MICS and femto-coaxial are comparable with the reductions between MICS and coaxial phacoemulsification, thus demonstrating the tissue-protection benefits of microincisions in cataract surgery. In regard to safety, phacoemulsification time and ultrasound use were reduced, consistent with previously published studies.25-28 This reduction correlates not only with efficiency but also with endothelial and macular protection, as shown by our results.

The mean postoperative spherical equivalent was -0.26 for femto-MICS and -0.33 for femto-coaxial. These values are comparable with a previous report of a mean postoperative spherical equivalent of -0.30.25 With respect to higher-order aberrations (corneal and internal), which our study was the first to assess, no significant change was seen from pre- to postoperative values.

We believe that our complication rate was lower in the non-MICS group due to the high level of surgeon experience in the use of femtosecond laser technology for corneal procedures; therefore, the coupling of the system was accurate, achieving a perpendicular surface for the laser pulses and creating a good capsulorrhexis, a key stage in cataract surgery.

The surgeon’s identification during the procedure of any functions the femtosecond laser was unable to complete is crucial to reduce complications, and checking for the existence of adhesions or bridges of the capsulorrhexis is vital. Failure to recognize an incomplete capsulorrhexis, and as a result making an aggressive approach in terms of rapid decompression of the anterior chamber, could result in a serious complication.

**CONCLUSION**

Our study5 suggests that the use of the femtosecond laser promotes a safe procedure with good visual outcomes and results in efficient nuclear fragmentation. The femto-MICS technique adds to the safety and effectiveness of cataract surgery. In the near future, femtosecond laser technology will likely achieve high acceptance among cataract surgeons because, despite its cost, it is, from the surgical standpoint, an intuitive technology that is easy to learn and incorporate into a surgical routine. However, this technology will not eliminate the need for surgical skills and proper training. We believe that this is a technology for which manual skill remains the most important element. A surgeon with prior experience in handling the femtosecond laser for LASIK will find it easier to use the suction cone; therefore, the transition will be easy.

To the best of our knowledge, this is the first study evaluating the femto-MICS technique, and more research with a larger number of patients and longer follow-up is necessary to justify the cost-benefit associated with use of the femtosecond laser for cataract surgery. Most likely, the development of specific and new financial management models will bring practical value to the incorporation of laser cataract surgery in the near future. ■
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