Optimizing refractive lens exchange with bimanual microincision phacoemulsification

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Bimanual microincision phacoemulsification entails the removal of the crystalline lens through 2 1.2 mm incisions. Infusion is provided through a separate irrigating handpiece, and phacoemulsification and aspiration are performed through a sleeveless phacoemulsification needle. We describe a technique for refractive lens exchange using bimanual microincision phacoemulsification. Capsulorhexis formation, cortical cleaving hydrodissection, lens extraction in the iris plane, and residual cortex removal are performed through the microincisions. This technique offers improved surgeon control throughout the procedure and added safety by maintaining continuous pressurization of the eye while removing the lens far from the posterior capsule.

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The notion of removing the crystalline lens through 2 microincisions is not new and has been attempted since the 1970s with varied success.[1–5] With the development of new phacoemulsification technology and power modulations,[6] we can emulsify and fragment lens material without generating significant thermal energy. Thus, removal of the cooling irrigation sleeve and separation of infusion and emulsification/aspiration through 2 separate incisions is a viable alternative to traditional coaxial phacoemulsification. Machines such as the AMO WhiteStar, Staar Sonic Wave, Alcon NeoSoniX, Bausch & Lomb Millennium (with burst mode), and ARC Laser's Dodick neodymium:YAG laser photolysis system offer the potential of relatively "cold" lens removal and the capacity for bimanual lens surgery.[7–10]

With advances in multifocal and accommodating intraocular lens (IOL) technology, removal of the crystalline lens as a form of refractive surgery (ie, refractive lens exchange) should become more popular. We think bimanual microincision phacoemulsification has several advantages that will make it a procedure of choice for refractive lens exchange. The following is our technique for refractive lens exchange using bimanual microincision phacoemulsification.

Surgical Technique

The procedure is performed under topical anesthesia after informed consent is obtained, preoperative measurements for an IOL are made, and preoperative dilation and antibiotics are administered. A Paratrap diamond keratome (Mastel Precision Surgical Instruments) is used to create 2 1.2 mm clear corneal incisions 30 to 45 degrees from the temporal limbus and 60 to 90 degrees from each other (Figure 1). After 0.5 cc of nonpreserved lidocaine 1% is instilled into the anterior chamber, complete expansion of the anterior chamber with sodium hyaluronate 3.0%–chondroitin sulfate 4.0% (Viscoat®) is performed. A straight 25-gauge needle is inserted through the right-hand microincision to perforate the central anterior lens capsule while the flap edge is simultaneously lifted to begin a capsulorhexis (Figure 2). Needles routinely bent at the tip for conventional capsulorhexis initiation lacerate the roof of the microincision during withdrawal of the needle. A straight, unaltered, 25-gauge needle is less likely to result in this complication. After the needle is removed, a capsulorhexis forceps (ASICO) designed to fit and function through a 1.0 mm incision is inserted through the

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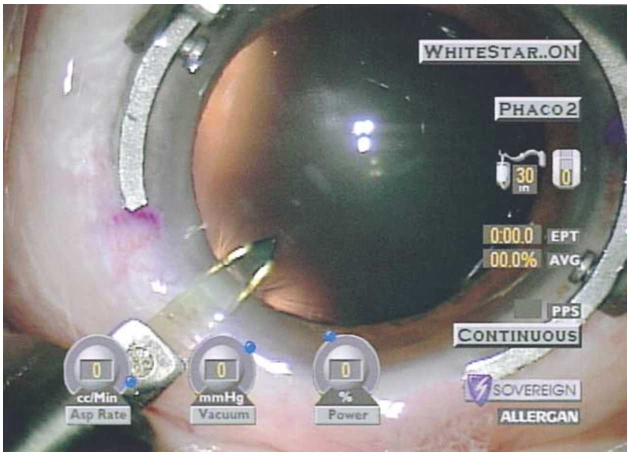

Figure 1. (Fine) A left-handed 1.2 mm clear corneal microincision is placed 45 degrees from the temporal limbus using a diamond knife.

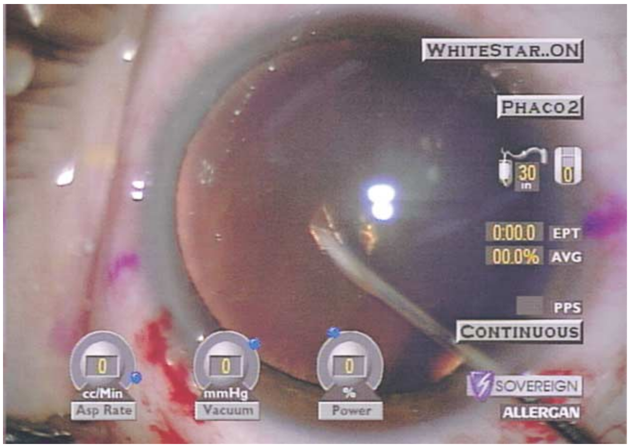

Figure 2. (Fine) A straight 25-gauge needle begins the capsulorhexis by perforating the central anterior lens capsule while the flap edge is simultaneously lifted.

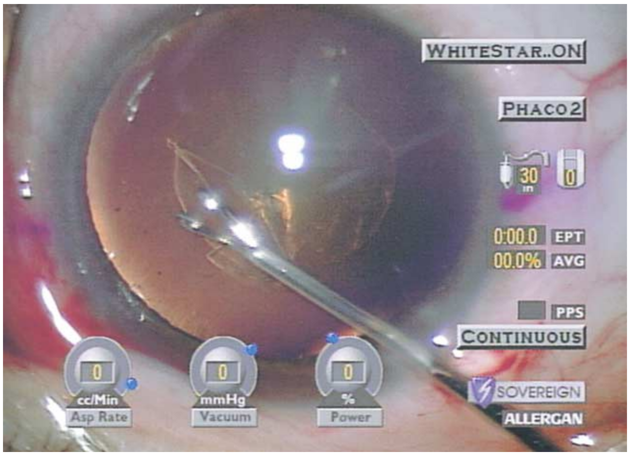

Figure 3. (Fine) A capsulorhexis is formed with a microincision capsulorhexis forceps.

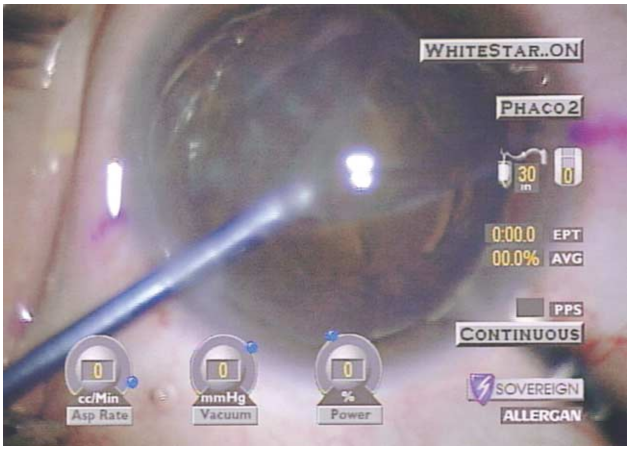

Figure 4. (Fine) The beveled irrigating handpiece within the left-handed microincision.

same incision and used to complete a 5.0 to 6.0 mm capsulorhexis (Figure 3).

Cortical cleaving hydrodissection[11] with decompression is performed in 2 separate distal quadrants followed by a third round of hydrodissection to prolapse the entire lens or at least one half of the lens out of the capsular bag. The Duet System microincision irrigating handpiece (MST Microsurgical Technology) (Figure 4) is placed in the left-hand incision, and the sleeveless phaco needle is inserted through the right-hand incision. Lens extraction is then performed, without phaco power in most cases, using high levels of vacuum while carouselling the relatively soft lens in the plane of the iris until it is consumed (Figure 5). Small amounts of ultrasound energy can be used when needed. Care should be taken to avoid directing the infusion flow toward the phaco needle tip to prevent dislodging nuclear material from the tip. While infusion is maintained with the irrigating handpiece, the phaco needle is removed and the aspiration hand-

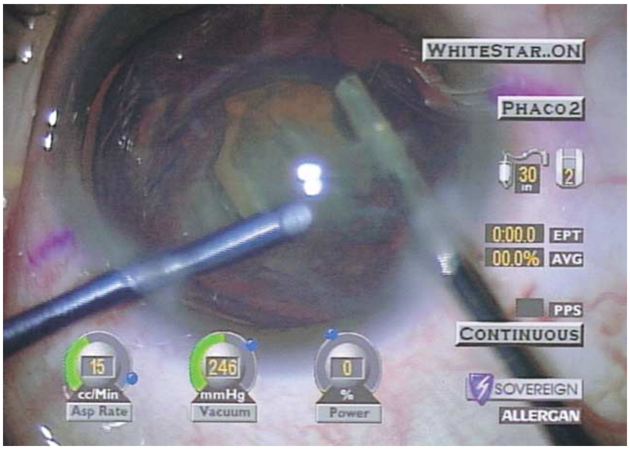

Figure 5. (Fine) The soft lens is carouselled in the iris plane and consumed using high vacuum levels. Forward movement of the lens is prevented with the irrigating handpiece.

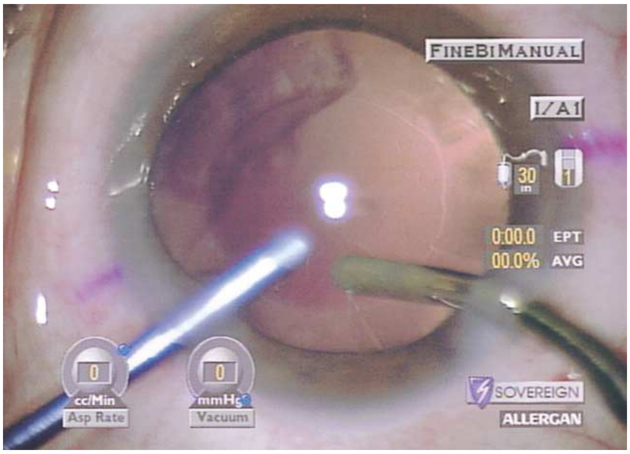

Figure 6. (Fine) Subincisional cortex is easily removed using bimanual I/A handpieces. (The effective phaco time = 0 and average percent phaco power = 0 after lens removal).

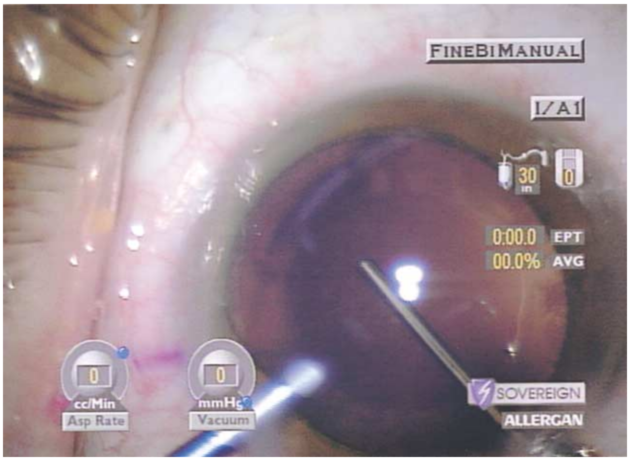

Figure 7. (Fine) Viscoelastic material is injected into the capsular bag while infusion is maintained with the irrigating handpiece.

piece is inserted to remove residual cortex and polish the posterior capsule. If subincisional cortex is difficult to extract, the irrigation/aspiration (I/A) handpieces can be alternated between the 2 incisions to gain easier access to the subincisional capsule fornix (Figure 6).

Once all cortex has been removed, the aspiration handpiece is removed and viscoelastic material is injected into the capsular bag and anterior chamber while the irrigating handpiece is withdrawn (Figure 7). The viscoelastic cannula is removed from the eye, and a new 2.5 mm clear corneal incision is placed between the 2 microincisions for IOL insertion. After IOL insertion, stromal hydration of the 2.5 mm incision is performed to assist in its self-sealing. Bimanual I/A is performed to remove all viscoelastic material. The aspiration handpiece is then removed and irrigation of the anterior chamber maintained. Stromal hydration of the empty incision is performed to assist in closure of the microincision. The irrigation handpiece is removed followed by stromal hydration of that incision. In this manner, the eye is fully formed and pressurized throughout the procedure, avoiding hypotony and shallowing of the anterior chamber.

Discussion

Bimanual microincision phacoemulsification offers advantages over traditional phacoemulsification techniques for routine cataract extraction and refractive lens exchange. Although coaxial phacoemulsification is an excellent procedure with low amounts of induced astigmatism,[12] bimanual phacoemulsification offers the potential for truly astigmatic neutral incisions. In addition, these microincisions should behave similar to a paracentesis incision with less likelihood for leakage and, theoretically, a lower incidence of endophthalmitis.

The major advantage of bimanual microincisions that we see is an improvement in control of most endocapsular surgery steps. Because viscoelastic material does not leave the eye easily through these small incisions, the anterior chamber is more stable during capsulorhexis construction and there is less likelihood for an errant capsulorhexis to develop. Hydrodelineation and hydrodissection can be performed more efficiently because of a higher level of pressure building in the anterior chamber before eventual prolapse of viscoelastic material through the microincisions.

In addition, separating the irrigation from the aspirating phaco needle allows improved followability by avoiding competing currents at the needle tip. In some instances, the irrigation flow from the second handpiece can be used as an adjunctive surgical device, flushing nuclear pieces from the angle or loosening epinuclear or cortical material from the capsular bag.

Perhaps the greatest advantage of the bimanual technique is its ability to easily remove subincisional cortex. As originally described by Brauweiler,[13] by switching infusion and aspiration handpieces between 2 microincisions, 360 degrees of the capsular fornices are easily reached and cortical cleanup can be performed quickly and safely.

The disadvantages of bimanual phacoemulsification are easy to overcome. Maneuvering through 1.2 mm incisions can be awkward when first using the technique, and additional equipment is necessary (eg, small-incision keratomes, a capsulorhexis forceps, irrigating choppers [for dense nuclei], and bimanual I/A handpieces).

All major instrument companies are working on irrigating choppers and other microincision adjunctive devices for microincision surgery. For refractive lens exchanges, irrigation can be accomplished with the bimanual irrigation handpiece that can also function as the second side-port instrument, negating the need for an irrigating chopper.

The greatest criticism of bimanual phacoemulsification lies in the fluidics and limitations in IOL technology that can be used through these microincisions. By nature of the incision sizes, less fluid flows into the eye than with coaxial techniques. Most irrigating choppers integrate a 20-gauge lumen that limits fluid inflow. This can result in significant chamber instability when high vacuum levels are used and occlusion from nuclear material at the phaco tip is cleared. Thus, infusion must be maximized by placing the infusion bottle on a separate intravenous pole that is set as high as possible. Also, vacuum levels usually need to be lowered to below 350 mm Hg to avoid significant surge flow.

The need to place a relatively large 2.5 mm incision between the 2 microincisions to implant a foldable IOL at the conclusion of bimanual phacoemulsification is perhaps the technique's greatest drawback. An analogy can be made to the days when phacoemulsification was performed through 3.0 mm incisions that required widening for implantation of a 6.0 mm poly(methyl methacrylate) IOL. It was not until foldable IOLs were developed that we could take full advantage of small-incision phacoemulsification. We think the benefits of bimanual phacoemulsification will prompt many surgeons to try it, with the realization that microincision lenses will catch up with the technique. Although these lenses are not available in the United States, many companies are developing lens technologies that will be able to use these tiny incisions.

Medennium is developing SmartLens,® a thermodynamic accommodating IOL. It is a hydrophobic acrylic rod that can be inserted through a 2.0 mm incision and expand to the dimensions of the natural crystalline lens (9.5 mm × 3.5 mm). A 1.0 mm version of this lens is also being developed. ThinOptiX Fresnel lenses will soon be under investigation in the U.S. and will be implantable through 1.5 mm incisions. Finally, injectable polymer lenses are being researched by Pharmacia and Calhoun Vision.[14,15] If viable, the Calhoun Vision injectable polymer would permit a light-adjustable IOL to be injected through a 1.0 mm incision that can be refined postoperatively to eliminate lower-order and higher-order optical aberrations.

The use of bimanual microincision phacoemulsification for refractive lens exchange and routine cataract surgery maintains a more stable intraocular environment during lens removal. This is especially important in patients with high myopia, who are at greater risk for retinal detachment after lens extraction.[16–18] Maintaining a formed and pressurized anterior chamber throughout the procedure should decrease the tendency for anterior movement of the vitreous body with a theoretical lower incidence of posterior vitreous detachment occurring from intraoperative manipulations. Future studies are necessary to document a significant reduction in posterior segment morbidity with this method of lens removal.

We have found this technique to be simple, efficacious, and safe since most of the lens extraction occurs in the plane of the iris and away from the posterior capsule and corneal endothelium.

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