A Simple, Cost-Effective Method for Practicing Phacoemulsification in the Cadaveric Eye

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Abstract. The authors describe an inexpensive, reliable method for practicing intraocular surgery using a rigid contact lens as a temporary keratoprosthesis. This method allows clear visualization of the anterior chamber and lenticular structures for practicing modern cataract surgery, including capsulorhexis, hydrodissection, phacoemulsification, cortical aspiration, and intraocular lens insertion. [Ophthalmic Surg Lasers 1998;29:253–256.]

Practice is an essential tool for acquiring new skills and knowledge. During residency, it is something to which we all must dedicate a considerable amount of time. Mastering the techniques of modern intraocular surgery by practicing on cadaveric eyes can be difficult. Continuous tear circular capsulorhexis, hydrodissection, phacoemulsification, cortical aspiration, and intraocular lens (IOL) insertion all require excellent visualization. Unfortunately, the cadaveric cornea often does not provide such a level of clarity.

To overcome this problem, several different techniques have been used. If epithelial edema is the problem, simply scraping off the epithelium may be all that is required to adequately visualize the anterior chamber. However, stromal edema is a much more common and difficult problem to overcome. The removal of the cornea with surgical practice through an “open sky” approach provides excellent visualization. Unfortunately, it has serious shortcomings as a method of practicing phacoemulsification.

The current machinery available for phacoemulsification relies on a closed or nearly closed system in the anterior chamber to remove the nucleus. Although the techniques can be used through an open-sky approach, the differences in procedure are enough to significantly decrease the teaching potential. For example, the removal of the cornea can create a situation that simulates posterior pressure in which the lens–zonule diaphragm rotates anteriorly. This can greatly change the vector forces created during capsulorhexis. A second problem is anterior prolapse of the nucleus. Generally, a smaller than normal capsulorhexis has to be created to prevent the nucleus from being expressed out of the capsular bag by the fluid forces generated from both the hydrodissection cannula and the phacoemulsification hand piece.

Recently, another group reported a technique for creating a closed anterior chamber system that provides adequate visualization. It involves using a sutured-in operative keratoprosthesis to replace the cornea. The keratoprosthesis works well, and is simple to use. Its major drawbacks are bulk and expense. The prosthesis costs several hundred dollars and is therefore ill-suited for use by large groups of residents performing sequential and simultaneous procedures during wet labs. Consequently, we began looking for a way to achieve a similar result using a less expensive keratoprosthesis.

MATERIALS AND METHODS

Rigid contact lenses are inexpensive and easily available. Our preparation technique uses plano or toric rigid contact lenses of 9 mm in diameter or greater. The power of the lens makes little difference, and the diameter should be selected based on ease of
preparation, as well as the type of surgery being practiced. The materials necessary are listed in the table.

The preparation is begun by mounting the donor eye on the operating stage. The eye can be mounted into a rigid, foam mannequin head, with pins passed through the remaining rectus muscle stumps. This reduces the "posterior pressure" produced by operating stages that use suction to hold the donor eye.

Next, the corneal epithelium is scraped off to the limbus using the edge of a keratome blade. All of the remaining perilimbal conjunctiva and Tenon's capsule should be removed. This helps to ensure good adhesion of the contact lens to the globe. A scleral tunnel wound is then constructed in the usual fashion. A paracentesis should be placed 1 to 2 mm posterior to the limbus (farther posterior than is customary) such that the edge of the contact lens and the glue will not obstruct the opening. The anterior chamber should be filled with viscoelastic or balanced salt solution (BSS) prior to the entering of the eye with the keratome knife.

Next, a trephine is used to remove the cornea from the eye-bank eye (Fig. 1). The use of a relatively small-diameter trephine (6 or 7 mm in diameter) will make it easier to attach the contact lens to the eye. Dilation of the iris should be performed at this point; usually, we simply disinsert the iris at its root, thereby providing an unimpeded view of the lens (Fig. 2). The external surface of the globe must be dried meticulously; this can be performed with a cotton swab.

Next, a thin bead of cyanoacrylate glue ("superglue") is spread around the external edge of the hole in the cornea with a cotton swab, taking care not to get the glue in the anterior chamber (Fig. 3). This is facil-
itated by using a small trephine and a relatively large-diameter contact lens (such as 9 or 10 mm), which allows one to put the glue farther from the edge of the hole. The glue must be spread in an unbroken bead to ensure watertightness.

Cyanoacrylate glue can be found in both liquid and gel forms. Both forms of glue are compatible with this technique. The liquid form is easily spread around the hole in the cornea and dries faster than the gel. The gel is less likely to run into the eye than the liquid glue, but it does take longer to dry (5–10 minutes). We prefer the liquid glue for its speed of application and its ability to seal easily any leaks at the edge of the contact after its initial application. As long as care is taken with the application of the glue, spillover into the anterior chamber is rare.

At this point, the anterior chamber should be approximately half full with viscoelastic or BSS. Overfilling can cause fluid to be forced out under the contact lens during placement, reducing the effectiveness of the seal of the contact lens against the globe. If any glue has run down on top of the viscoelastic, it should be removed at this time with a cellulose sponge.

Next, a small amount of viscoelastic or BSS is placed in the concavity of the contact lens (Fig. 3). This prevents glue fumes from condensing on the lens. Grasped with forceps, the contact lens is carefully lowered over the corneal hole and firmly pressed against the glue on the cornea. The glue is allowed to dry for a few minutes. If too much glue is used, the excess will be forced into the anterior chamber where it can ruin the preparation.
When the glue has set fully, preparation for phacoemulsification may begin. At this point, the anterior chamber is half filled with air. This air can be forced out through the tunnel incision or paracentesis with viscoelastic or BSS. There may be an extremely thin layer of glue that forms a sort of diaphanous membrane on top of the viscoelastic. This can be cleared from the visual axis by inserting the viscoelastic cannula into the air bubble in the anterior chamber and injecting viscoelastic or BSS. This will blow any glue residue out of the visual axis, allowing a clear view of the lenticular structures. If leakage is noted at any point around the perimeter of the contact lens during phacoemulsification, a small amount of glue may be placed as a sort of caulk to seal the leak. One may then proceed with the normal steps of modern extracapsular cataract extraction: capsulorhexis (Figs. 4 and 5), hydrodissection (Fig. 6), phacoemulsification (Fig. 7), cortical aspiration, and IOL insertion.

DISCUSSION

This preparation is relatively easy to learn, and the only expensive piece of equipment necessary is a corneal trephine. We simply sterilize one that would have otherwise been thrown away after a corneal transplant procedure, and reuse it multiple times. The contact lenses were obtained at no cost because they were lenses that would otherwise have been discarded by the supplier. Lens distributors often have outdated lenses that cannot be used as trial lenses, so they are often provided for research purposes or, in our case, for practice surgery. Theoretically, the lenses may be reused. The glue can be dissolved away with nail polish remover, or it can be broken off the lens with warm water. Reuse of the lenses was not done routinely because of the ease of obtaining discarded lenses in adequate numbers. The procedure is most realistic if viscoelastic is used, but if this is not available due to expense, BSS also works well. Several practice attempts may be necessary before this technique is mastered. If several lenses are available, multiple eyes can be prepared in advance, to be used during a wet lab.

We feel that this surgical practice preparation is a valuable addition to the current techniques. The rigid contact lens eliminates the problem of corneal distortion that may limit visualization during phacoemulsification. This allows the novice to concentrate on other aspects of the procedure. Capsulorhexis, hydrodissection, phacoemulsification, cortical aspiration, and IOL insertion are practiced easily with excellent visualization in human eye-bank eyes. The visualization is of such high quality that observer microscopes and videos can actually provide sufficient information for teachers to instruct surgery pupils. (The photography for this article was obtained from the video-captured images from an operating microscope.) If at any time during the operation a fluid leak is observed under the lens, it can be sealed easily with glue. Our technique provides a realistic environment in which to practice classic phacoemulsification as well as newer techniques such as the “phaco chop.” This technique could also enable the practice of retinal and vitreous surgical techniques. We hope that it will help to train a skillful next generation of ophthalmic surgeons.

REFERENCE