A Contact Lens as an Artificial Cornea for Improved Visualization During Practice Surgery on Cadaver Eyes

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Objective: To describe the use of a polymethylmethacrylate contact lens as an artificial cornea to enhance visualization for practice surgery using cadaver eyes.

Design: The opaque cornea of a cadaver eye is removed by trephination. Cyanoacrylate glue is used to secure a large-diameter polymethylmethacrylate contact lens to the corneal rim.

Results: Excellent visualization for practice surgery is achieved with this technique. The adhesion of the contact lens to the cadaver eye maintains the anterior chamber sufficiently to perform phacoemulsification cataract extraction or pars plana vitrectomy.

Conclusions: This technique improves visualization of the intraocular structures during practice surgery, thereby enhancing the ability of the learning surgeon to perform and practice delicate surgical maneuvers. The procedure is simple, effective, and inexpensive.

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Practice surgery using human cadaver eyes can be of benefit to the learning surgeon. However, corneal edema, which is often present in cadaver eyes, impairs visualization of the intraocular structures. Although the corneal epithelium can be removed to improve visualization, clarity usually remains compromised owing to stromal edema (Figure 1). For practicing delicate microsurgical intraocular techniques, such as continuous curvilinear capsulorrhexis,1 phacoemulsification, and pars plana vitrectomy, a clear intraocular view is essential.

Corneal edema may be partially overcome by the application of topical glycerin or by using the cadaver eyes as soon as possible after death and enucleation. Other techniques that have been reported to enhance visualization include the use of (1) sutured temporary keratoprostheses,2-4 (2) intraocular high-molecular-weight osmotic solutions5 combined with tissue fixatives,6 and (3) contact lenses as artificial corneas.7,8 Strategies to avoid the problems associated with cadaver eyes include the use of live rabbits,9 synthetic model eyes,10,11 and computer-simulated eye surgery.12

We describe a simple, time-efficient technique using a polymethylmethacrylate (PMMA) contact lens as an artificial cornea in cadaver eyes to provide good visualization of intraocular structures during practice surgery.

Methods

Autopsied eyes that are not suitable for organ donation are available for practice surgery and research purposes and can be obtained through eye banks. Human tissue is used for this model, thus, universal fluid precautions to prevent the possible transmission of disease were used for all described techniques. The eye is prepared by wrapping it in 5 1/2x5-cm gauze pads and placing it in the mounting well of a 2-piece synthetic head8 designed for practice eye surgery. Conjunctival tissue and the Tenon capsule are removed from the part of the eye that remains exposed. The epithelium is then scraped from the cornea and limbus. For cataract surgery, a scleral tunnel and a paracentesis port are created. A 7.5-mm central corneal button is then excised using a trephine. The iris is removed in total through the corneal opening created by the trephine. A large-diameter (9.0- to 9.5-mm), rigid PMMA contact lens is centered over the circular wound. A glue applicator rod, fashioned from 16-gauge wire bent at a 270° to 360° angle 3 mm from the tip (Figure 2), is used to place a small spot of cyanoacrylate glue at 4 points to stabilize the PMMA lens (Figure 3). Next, a continuous, watertight seal is achieved by applying additional glue along the perimeter of the contact lens at the contact lens–ocular interface (Figure 4). Polymerization of the glue is facilitated by applying a brisk stream of balanced salt solution or isotonic sodium chloride solution forcefully onto the cen-
ter of the lens and allowing it to flow peripherally over the glue. The outwardly directed flow prevents the glue from spreading onto the central portion of the contact lens, which can cause problems with visualization. A conditioning solution for rigid contact lenses serves as a wetting agent that can be used throughout the surgical procedure to provide a smooth optical surface, thereby achieving excellent visualization of intraocular structures.

In addition to cataract surgery, 3-port pars plana vitrectomy can be accomplished using this model. After exposing the sclera and removing the corneal and limbal epithelium, 3 sclerotomies are made 3.5-mm posterior to the limbus, and an infusion cannula is secured in one of the ports. The ports are temporarily closed with scleral plugs. The infusion tubing is clamped, and a central corneal button is removed by trephination. After securing the PMMA lens, as described previously, vitrectomy techniques, including endolaser photocoagulation, can be performed either with the crystalline lens in situ or subsequent to removing it by phacoemulsification or pars plana lensectomy (Figure 5). Alternatively, the lens and iris may first be removed through the corneal opening created by the trephine to provide wide-angle viewing of the posterior segment. Viscoelastic solution or methylcellulose solution can be used to optically couple a fundus lens to the surface of the PMMA artificial cornea for optimal viewing of the posterior pole.

Once all of the practice procedures are completed, the PMMA contact lens can be removed, cleaned by scraping with a sharp blade, and reused on additional eyes.

RESULTS

Replacing the opacified, edematous corneas of cadaver eyes with PMMA contact lenses consistently resulted in excellent visualization of intraocular structures during practice surgery. The optical clarity achieved with this technique facilitates visualization of intraocular structures. As a result, the performance of delicate and difficult microsurgical maneuvers, such as capsulorrhexis (Figure 4), phacoemulsification, and intraocular lens implantation, can be practiced more effectively. The adhesion of the contact lens is sufficient to provide a watertight seal at the intraocular pressures encountered during phacoemulsification or pars plana vitrectomy. If excessive forces are applied or if the eye is substantially distorted during the procedure, the glue seal can be disrupted and leaks will occur along the perimeter of the contact lens–limbal interface. This can be remedied by applying additional glue to the leakage site(s) to reestablish a watertight seal. Once mastered, preparing the eye and gluing the contact lens in place adds only 5 to 7 minutes to the procedure time. Pars plana vitrectomy and endolaser photocoagulation (Figure 5) can be practiced on the same eye after phacoemulsification has been performed. One PMMA lens can be used on multiple eyes without difficulty after the glue is scraped off or removed with nail polish remover.
COMMENT

Using a PMMA contact lens as an artificial cornea on cadaver eyes improves visualization of intraocular structures during practice surgery and closely simulates intraocular surgery in patients. This method may be used for performing and practicing delicate and difficult microsurgical maneuvers such as capsulorrhexis, phacoemulsification, and posterior segment surgery. Anterior and posterior procedures may be completed on the same postmortem eye. Furthermore, each training session can be concluded by reattaching the corneal button to the cadaver eye to practice keratoplasty suturing techniques.

Other practice surgery teaching systems for anterior or posterior segment surgery reported in the literature include temporary keratoprostheses,\textsuperscript{2,4} the intraocular injection of high-molecular-weight osmotic material\textsuperscript{5} and tissue fixatives,\textsuperscript{6} live animals,\textsuperscript{7} model eyes,\textsuperscript{10,11} and computer-simulated eye surgery.\textsuperscript{12} A temporary intraoperative keratoprosthesis, such as the design described by Eckardt and Eckardt,\textsuperscript{2} although effective in providing clear visualization of intraocular microanatomy, is expensive (up to $250 per keratoprosthesis). Also, each keratoprosthesis is likely to have a limited useful lifetime in a microsurgical laboratory. The use of intraocular high-molecular-weight osmotic material\textsuperscript{5} with tissue preservatives,\textsuperscript{2} despite an initially clear cornea, has the disadvantage of rehydrating with time so that visualization becomes increasingly compromised as the case progresses.\textsuperscript{2} Furthermore, anterior segment tissues exposed to the fixatives may have an altered consistency that modifies the tissue response during surgical manipulation.

Our technique may be accomplished with minimal expense. Polymethylmethacrylate contact lenses not suitable for sale to the public may be used, and they can be obtained at no cost from contact lens distributors. Once the artificial cornea is in place, excellent visualization is maintained throughout the practice session by using a standard contact lens wetting agent. Because the intraocular tissues are not exposed to fixatives, they optimally mimic the feel of a living human eye. The glue seal will break if excessive pressure or torque is applied to the globe, and once the learning surgeon is more experienced and skilled, the entire procedure can often be performed without reapplying glue. However, the torque-sensitive seal requires the learning surgeon to handle the eye gently during practice surgery.

Since presentation of this technique at the 1997 American Academy of Ophthalmology annual meeting, articles have been published by Rootman and Marcovich\textsuperscript{7} and Castellano and colleagues\textsuperscript{8} discussing similar techniques. These researchers also found that using an artificial cornea with cadaver eyes was useful in teaching beginning eye surgeons delicate and difficult intraocular surgical maneuvers. However, our observations and conclusions, which were arrived at independently, have expanded on the techniques described in their articles to include (1) use of contact lens conditioning solution on the PMMA artificial cornea throughout the procedure to maintain superior visualization of intraocular structures compared with a dry contact lens, (2) use of centrifugally applied balanced salt solution to quickly polymerize (‘‘dry’’) the glue without waiting time, and (3) use of the teaching model for practice of pars plana vitrectomy and endolaser photocoagulation.

During the past 4 years, the described technique has been successfully used in the ophthalmic surgery practice laboratory at Mayo Clinic.

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Figure 5. A, Pars plana vitrectomy setup as viewed through a contact lens floating on the artificial cornea. The infusion cannula is secured (bottom right). Light from the light pipe (bottom left) and the suction cutter (top right) is easily seen through the lens system. B, View of the endolaser photocoagulation probe and photocoagulation marks on the retina as viewed through the vitrectomy contact lens and artificial cornea. The photographs were reproduced from video images.
REFERENCES


Ophthalmologic Numismatics

Jules Gonin, 1870-1935, of Lausanne, Switzerland, is known as the father of retinal detachment surgery because he revolutionized the procedure by developing the practice of looking for the retinal break and closing it. After Gonin’s death, the Gonin Medal was established in his memory by the International Council of Ophthalmology and the University of Lausanne as the supreme prize in international ophthalmology. It is awarded every 4 years to the person, who in the opinion of the International Council of Ophthalmology, has done the most for the specialty of ophthalmology.

The medal is 39 mm in diameter and struck in gold. The obverse, Figure 1, depicts the bust of Jules Gonin facing right. The reverse, Figure 2, depicts 2 hands over an eye surrounded by the Latin inscription, Deo juvante miseris reddidit lucem. This translates to, “With the help of God, he restores light to the afflicted.”

Courtesy of: Jay M. Galst, MD, 30 E 60th St, New York, NY 10022.

Figure 1.  
Figure 2.