Air-assisted Descemet-stripping automated endothelial keratoplasty with posterior chamber iris-fixation of aphakic iris-claw intraocular lens

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We report a combination of surgical techniques during Descemet-stripping automated endoithelial keratoplasty and intraocular lens (IOL) exchange in patients with pseudophakic bullous keratopathy and angle-supported anterior chamber IOLs. During this procedure, the anterior chamber IOL is exchanged for a posterior chamber iris-claw IOL enclavated to the posterior iris; the anterior chamber is kept filled with air using an air–fluid exchange machine during descemetorhexis and insertion of the donor endothelial disk.

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Online Video

Descemet-stripping automated endothelial keratoplasty (DSAEK), which replaces only the diseased layers of the donor, has become a popular alternative to penetrating keratoplasty in patients with corneal endothelial cell dysfunction. The advantages of DSAEK include faster visual recovery, minimal change in astigmatism, lower risk for wound dehiscence, and a tectonically stable globe. In addition, the risk for intraoperative expulsive suprachoroidal hemorrhage is reduced. The main disadvantages are a higher rate of graft dislocation and an increased rate of endothelial cell loss.

In 1998, Melles et al.[1] presented a surgical technique in which partial corneal transplantation was performed for replacement of diseased endothelium. In 2000, Terry and Ousley[2] performed the first endothelial keratoplasty in the United States and called it deep lamellar endothelial keratoplasty. In 2006, Gorovoy[3] reported the use of a microkeratome instead of hand dissection to prepare the donor graft and called it Descemet-stripping automated endothelial keratoplasty (DSAEK).[4–7]

Graft detachment is the most frequent early postoperative complication after DSEK (10% to 35% of cases), particularly for surgeons who are new to the procedure. Various techniques to enhance graft attachment have been proposed. Meisler et al.[8] used an air–fluid exchange system to promote graft adhesion during DSAEK. They used a 30-gauge needle fixed to the recipient limbus to introduce air into the anterior chamber during the procedure. Mehta et al.[9] used an anterior chamber maintainer at the recipient limbus attached to a 3-way tap connected to the air syringe to keep the anterior chamber air filled during descemetorhexis.

The surgical correction of aphakic eyes with corneal edema without adequate capsule support is controversial. Debate persists between selection of an angle-supported anterior chamber IOL, a sutured posterior chamber IOL, or, recently, an iris-claw IOL.[10] Angle-supported anterior chamber IOLs are associated with complications, such as bullous keratopathy, because of the presence of haptics in the iridocorneal angle and continuing endothelial cell loss.[11]

The Artisan aphakia IOL (Ophtec BV), one of the latest versions of this type of iris-fixated IOL, is a single-piece poly(methyl methacrylate) (PMMA) IOL with haptics that are attached to the iris with clips on both

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sides of the optic. The haptics are enclavated to the midperiphery of the iris.[12–15] Implantation of the iris-claw IOL behind the iris seems to preserve the anatomy of the anterior segment with respect to the free iridocorneal angle; there is also less progressive endothelial cell loss, hence better preserving endothelial cells. Some surgeons use iris-sutured IOLs during keratoplasty in cases in which access and visualization are good; however, it is significantly more difficult when the view is poor and access restricted, as in cases of DSAEK.[16]

Lake and Rostron[17] attempted to overcome these technical problems in cases of Artisan anterior chamber iris-claw IOL insertion during DSAEK with a modified technique. The disadvantage of PMMA IOLs in the anterior chamber, other than the increased risk for graft rejection, is decreased anterior chamber volume and depth, which makes graft unfolding more difficult,[16,17] specifically because the graft endothelium will touch the IOL optic.

We report a combination of surgical techniques during DSAEK and IOL exchange in patients with pseudophakic bullous keratopathy and angle-supported anterior chamber IOLs. To our knowledge, there is no similar report combining these 2 procedures during which anterior chamber IOLs are exchanged with posterior chamber iris-claw IOLs enclavated to the posterior iris and the anterior chamber is filled with air with a gas–fluid exchange machine during descemetorhexis and insertion of the donor disk.

SURGICAL TECHNIQUE

The operative eye is prepared properly and draped in the sterile manner. A 1.0 mm tangential inferior paracentesis is made at 6 o'clock, entering the anterior chamber in the posterior limbal area directly parallel to the iris. A 5.5 mm mid-limbal incision is created at 12 o'clock, and 2 vertical paracenteses (at 10 o'clock and 2 o'clock positions) are performed for entrance of the enclavation needle. If there is an angle-supported IOL, it is removed through the main incision. Meanwhile, the recipient epithelium can be removed to improve visualization. Bimanual anterior vitrectomy is performed with a vitrectomy system to clear vitreous from the anterior chamber and retropupillary area before iris-claw IOL insertion. Then, a small amount of ophthalmic viscosurgical device (OVD) (sodium hyaluronate 1%) is injected behind the pupillary plane to tamponade the existing vitreous; the anterior chamber is filled and formed with inflowing air.

The iris-claw IOL is inserted through the incision upside down in a reverse position. A lens-holding forceps is introduced through the incision, and the IOL is firmly held. One half of the IOL is slipped through the pupil posteriorly and maintained horizontally with the forceps, with the haptics positioned at 3 o'clock and 9 o'clock. By gentle forward elevation of the haptic, the pattern and site of enclavation will be visible through the iris tissue. At the same time, through the paracentesis, the iris is enclavated into the IOL haptic using an enclavation needle (Figure 1). While the IOL is firmly grasped with the forceps, the other half of the IOL is slipped under the iris and again elevated to show the enclavation site. The maneuver is repeated on the other side, achieving perfect iris-claw IOL centration under the pupil.

The anterior chamber and globe remain filled with air despite the large incision. The volume of air inflow by the air–fluid exchange machine (Accurus, Alcon Laboratories, Inc.) can be titrated to keep the anterior chamber formed and air filled. A peripheral iridectomy is performed. Because the air is infused into the anterior chamber with controlled pressure, it will remain there; however, the air sometimes escapes into the posterior chamber. This air bubble can be removed from the anterior vitreous by aspiration with a blunt needle through the iridectomy. During this stage, the anterior chamber can be filled with a balanced salt solution through the inflow.

After the IOL exchange, DSAEK is performed. The donor cornea is prepared first, followed by surgery in the recipient. The dissection of the donor lamellar disk with the cornea mounted on an artificial anterior chamber is usually done by the eye bank (precut tissue) or by the physician (surgeon cut) using a microkeratome (ALTK, Moria). Complete flap resection is performed to leave an 8.5 to 9.0 mm stromal bed. Donor tissue is then transferred to a Barron punching system (Katena Products, Inc.) and cut with an 8.0 to 9.0 mm diameter punch according to the recipient

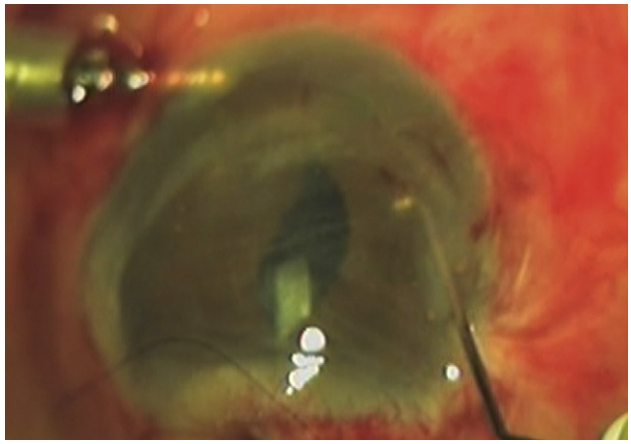

Figure 1. Fixation of Artisan aphakia IOL with forceps and enclavation while the IOL haptic is indented from the posterior of the iris to show the enclavation site.

corneal size, and the area of Descemet membrane and endothelial cells are stripped.

The corneal surface can be marked gently with a 9.0 mm marker to outline where to strip the recipient Descemet membrane and the fixation area of the donor tissue. The air inflow is attached to the air–fluid exchange machine set at 40 mm Hg by monitoring the intraocular pressure and anterior chamber depth. Descemet membrane is stripped while the anterior chamber is formed with air in a circular pattern (descemetorhexis) under the area of the epithelial reference mark with an anteriorly bent blunt needle or custom instrument (modified Price-Sinskey hook). Descemet membrane and endothelium are stripped completely from within the scored area and removed from the anterior chamber using a 45-degree or 90-degree Descemet stripping instrument. Providing contrast, air also aids in good visualization of Descemet membrane during the stripping procedure. There is no need for trypan blue staining of Descemet membrane (Figure 2).[A]

The trephined donor corneal lenticules (containing posterior stroma, Descemet membrane, and endothelium) are brought into the operative field; a small amount of OVD is placed on the endothelial surface and the disk is folded over itself into an asymmetric 60:40 "taco" shape, with the endothelial side inward. Using a long DSAEK forceps, the donor disk is gently grasped and inserted into the eye. During insertion, air inflow pressure is reduced to keep the anterior chamber formed and allow disk maintenance in the anterior chamber. The disk will adhere to the posterior stroma on entrance in the folded fashion, and air flow from beneath enhances the adhesion (Video, available at http://jcrsjournal.org). The incision is closed with 10-0 nylon sutures, and the anterior chamber depth is maintained by continuous inflow of air.

A modified Pierce-Sinskey hook is used to complete unfolding, centration, and stretching of the donor disk at the edges to eliminate tissue wrinkles (Figure 3). While the anterior chamber is still pressurized with air, the corneal surface is massaged to remove fluid from the donor–recipient interface. The air is left in place for 10 minutes. To prevent air–pupillary block, 20% to 30% of anterior chamber volume is replaced by a balanced salt solution. The air inflow is removed and the related paracentesis closed with a single 10-0 nylon suture. The patient remains supine for 30 to 60 minutes in the recovery room to allow the retained air bubble to push the donor tissue up against the recipient cornea. A paracentesis release can be applied to prevent pupillary block by ensuring that the remaining air bubble is above the pupillary border when the patient is in the sitting position.

DISCUSSION

For decades, anterior chamber angle-supported[18] and sclera- or iris-fixated posterior chamber IOLs[19,20] have been the most popular types for secondary IOL implantation in the absence of capsule support. Transscleral or iris-fixation IOLs used previously for exchange of angle-supported anterior chamber IOLs are more time consuming and have steeper learning curves than iris fixation of Artisan aphakia IOLs.

Rijneveld et al.[21] were the first to report retropupillary fixation of an iris-claw IOL in aphakia. Later, Mohr et al.[22] reported retropupillary iris-claw IOL fixation in 48 aphakic patients. No major complication

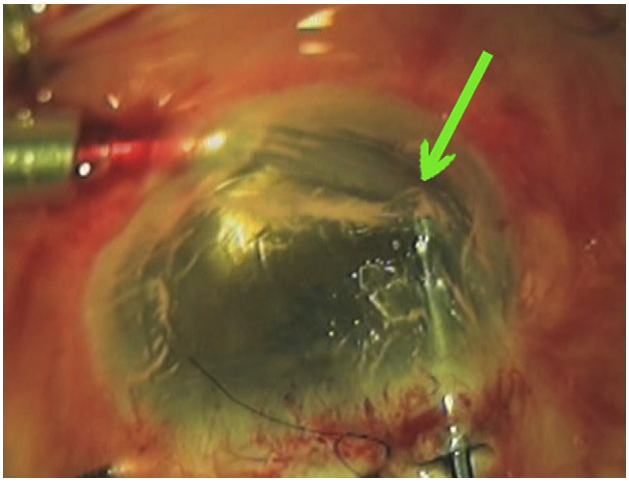

Figure 2. Good visualization of Descemet membrane (*arrow*) during stripping while the anterior chamber is formed with air.

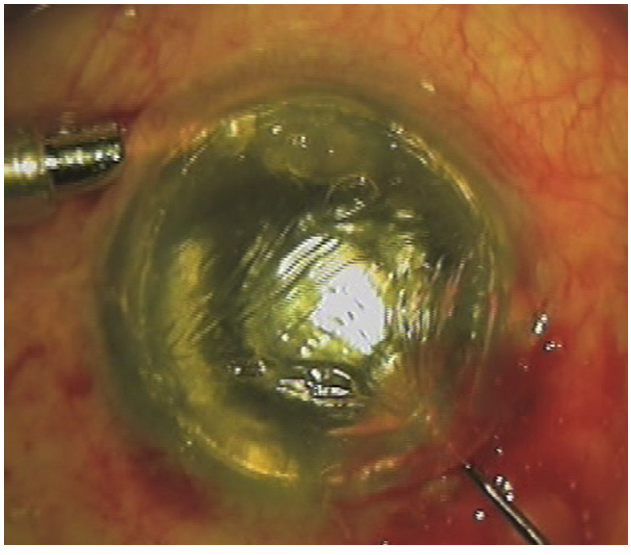

Figure 3. The donor disk is attached, and the edges are stretched to eliminate tissue wrinkling.

was observed, and the new technique was shown to be superior (in simplicity, reliability, and best anatomical results) to other techniques. Another study showed the relative safety of posterior iris fixation of the iris-claw IOL through a scleral tunnel incision in patients without adequate capsule support.[23]

We report DSAEK combined with posterior chamber iris fixation of the Artisan aphakia IOL performed as a secondary IOL implantation in aphakia or exchange of anterior chamber angle-supported IOLs in cases of aphakic or pseudophakic bullous keratopathy. This surgical technique was designed to respect anterior segment anatomic features as much as possible and to implant the IOL in the ideal location—behind the iris plane away from the donor corneal endothelium and avoiding the angle. Some authors have expressed concern about the potential of the iris-claw lens to damage the iris or the corneal endothelium.[24,25] If enclavation fails, dislocation of the iris-claw IOL into the vitreous cavity results. Such a complication may result from weak or inadequate holding of the IOL with forceps. To place half the IOL behind the iris at each time secures proper positioning of the IOL during enclavation and prevents this complication. In addition, inadequate iris tissue enclavation may cause slippage of the iris-claw haptics, especially in the long term.

Use of air during DSAEK has been reported. Mehta et al.[9] used air only in the anterior chamber maintained by a syringe during descemetorhexis. Meisler et al.[8] used air inflow through a 30-gauge needle. Our technique uses continuous air inflow supplied by an air–fluid exchange system during all steps of DSAEK, including descemetorhexis, donor disk insertion, unfolding, and enhancement of adhesion.

Insertion of the donor disk by forceps still has its place, and in our hands donors retain high endothelial cell counts (ECC) and corneal clarity. Even some pioneers have shown higher ECC with forceps insertion.[B] Inserters were recently introduced, and we will consider their application in the near future.

We have performed 10 combined procedures with about 6 months of follow-up. The posterior chamber–fixated iris-claw Artisan IOLs have remained attached and there has been no case of IOL dislocation. Cases of air-assisted DSAEK have clear corneas with successfully attached donor lenticules; there has been no case of donor disk dislocation and few rebubbling procedures were required. The rate of donor dislocation remains to be studied after an adequate number of cases have been performed. Maintenance of air in the anterior chamber during the procedure seems to dry the donor–recipient interface, enhancing the adhesiveness of both surfaces. Intraoperative delay in proper repositioning of the donor lenticule usually leads to difficult manipulation due to an immediate strong adhesion. In these cases, calculation of the IOL power is difficult. An approximate A-constant is suggested for the Artisan aphakia IOL. The effect of posterior chamber retropupillary placement and reversing this IOL, as well as the hyperopic shift induced by DSAEK on IOL power calculation, requires further evaluation.

In summary, DSAEK combined with posterior chamber iris fixation of the Artisan aphakia IOL appears to be a safe method for the management of pseudophakic corneal edema. Long-term results of vision and the possible complications require properly designed studies.

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