Successful posterior lamellar keratoplasty (PLK) was first reported in 1956. Interest in partial-thickness corneal transplantation saw a resurgence after reintroduction of PLK by Melles in 1998. As PLK, commonly referred to as endothelial keratoplasty (EK), has gained popularity for treatment of endothelial diseases of the cornea, there have been numerous reports on variations of this specialized surgery. Most publications and presentations at scientific meetings have discussed the technique known as Descemet’s stripping automated endothelial keratoplasty (DSAEK).

DSAEK has replaced penetrating keratoplasty (PK) in many cornea practices for the treatment of disorders of the corneal endothelium, including Fuchs endothelial dystrophy, pseudophakic and aphantic corneal edema, iridocorneal endothelial syndrome, congenital hereditary endothelial dystrophy, and endothelial failure of previous penetrating grafts. The popularity of DSAEK in comparison with PK and other variations of EK is due to its advantages: easier donor tissue preparation, quicker recovery of patient UCVA and BCVA, astigmatic neutrality, avoidance of an open-sky keratoplasty procedure, and associated decrease in intra- and postoperative surgical complications due to smaller incision size.

The DSAEK procedure calls for automated preparation of donor corneal tissue with use of an artificial anterior chamber. A microkeratome, similar to those used in LASIK, makes a cut at a desired depth in the donor tissue, depending on corneal thickness as measured by ultrasonic pachymetry. Most surgeons desire a posterior donor tissue depth of 100 to 200 µm.

A number of devices can be used for donor tissue preparation, including the Horizon DSAEK system (Refractive Technologies, Cleveland) and the Moria DSAEK-ALTK system (Moria SA, Antony, France). Once the posterior corneal button is trephined to the desired diameter (typically 8.25–9 mm), the diseased host endothelium is removed with a reverse Sinskey hook through an incision similar to a cataract surgery incision. With the diseased tissue removed from the host, the donor tissue can be inserted into the host eye by any one of a number of insertion techniques, using forceps, suture pull-through, or various new insertion devices (Figure 1).

The first ex vivo laboratory studies using vital dye staining to assess endothelial damage in various stages of DSAEK showed that if forceps are used for insertion of donor tissue, compression forceps and wounds smaller than 3.5 mm should be avoided because donor endothelial cell loss was greater in these situations (Figures 2A and B).

After the tissue is unfolded and centered in the anterior chamber, an air bubble is injected to promote donor stromal adherence to the host corneal stroma. With the increase in popularity of DSAEK, surgical procedures for corneal endothelial disease in patients with concomitant cataracts or previous glaucoma surgery have become more frequent. The main concerns with these procedures are whether DSAEK remains safe and effective despite the presence of cataracts or previous glaucoma surgery; and whether the risks of complications such as donor tissue dislocation, pupillary block glaucoma, primary graft failure, and immune endothelial rejection are equivalent to DSAEK in the absence of concomitant eye disease. The question is whether deviation from PK, a proven surgery is justified in these situations. (For a discussion of DSAEK after glaucoma surgery, see the sidebar on page 18.)
COMBINING DSAEK WITH PHACO

Special considerations must be made in combined cases of DSAEK and cataract removal. Whether combined or sequential surgery (cataract then DSAEK vs DSAEK then cataract) should be performed must be the first consideration. Preoperative assessment of visualization through the cornea helps with this decision. If visualization is impossible due to dense bullae, diffuse edema, or dense subepithelial haze, either a traditional triple procedure with PK must be used, or DSAEK followed by cataract surgery 6 to 8 weeks later can be considered.

Capsular staining dyes can improve visualization of the capsulorrhexis and removal of host Descemet’s membrane in some corneas with difficult views, avoiding the need for PK or sequential surgery in certain situations. Even with good visualization, novice surgeons may want to consider sequential surgery initially until greater comfort in DSAEK technique is achieved, as these cases will have increased anterior chamber inflammation, more chamber instability, greater risk of endothelial cell loss, and greater risk of IOL decentration. In these situations, the cataract surgery can be performed first followed by DSAEK 2 to 3 months later.

IOL IMPLANTATION

Lens implantation is another important consideration in combined DSAEK procedures. Both IOL design and IOL power require additional preoperative planning. Donor tissue insertion and air bubble placement can lead to IOL decentration during combined DSAEK/cataract cases. Complicating factors in combined cases may include chamber instability after cataract removal, iris prolapse, IOL instability from a large capsulorrhexis, and pupil dilation with IOL dislocation out of the capsular bag.

Three-piece IOL designs provide better stability in the capsular bag than one-piece lens designs; however, beginning DSAEK surgeons may want to consider avoiding one-piece designs until comfort with the procedure is achieved, especially in cases of chamber instability and unintentional larger capsulorrhexis size. I avoid use of multifocal or accommodating IOL designs in these cases because of concerns regarding decreased contrast sensitivity from the lens optics or from the graft-host interface in lamellar procedures.

Regardless of the IOL design chosen, a smaller capsulorrhexis (5 mm) and use of intraoperative miotics can improve lens implant stability and decrease risk of IOL decentration during donor tissue insertion and air bubble placement. The determination of lens implant power and the resulting postoperative refractive outcome is another concern with combined DSAEK and cataract removal. For years, this has been an unknown variable with traditional triple procedures with PK; postoperative astigmatism and keratometry values varied from case to case after suture removal. Reports have shown that DSAEK patients develop a hyperopic shift after donor tissue adherence and postoperative healing.
Patients who have previously undergone glaucoma surgery also raise special concerns for DSAEK. Glaucoma patients have risk factors for increased corneal endothelial damage, whether from carbonic anhydrase inhibitor toxicity to the endothelium, IOP-induced endothelial damage, shallow angles with increased risk of peripheral iris-synechiae and resulting iris-cornea touch, or endothelial trauma from trabeculectomy or insertion of a glaucoma drainage device (GDD). GDDs are associated with decreased rates of penetrating graft survival at 1 and 2 years postoperatively, with reports demonstrating low graft survival rates in eyes with GDD at 5 years.1

The main difficulty with DSAEK in patients with previous glaucoma surgery, whether filtering bleb or GDD, is the ability to maintain an air bubble after air insertion, as both types of fistula immediately shunt air from the anterior chamber. This prevents the elevation of intraocular pressure (IOP) that is required to facilitate donor tissue adherence at the end of DSAEK. The shunting phenomenon may lead to an increased risk of tissue dislocation and increased need for secondary procedures if it is not handled appropriately at the time of surgery.

Other concomitant findings that may lead to air bubble instability in eyes with glaucoma include large peripheral iridectomies, aphakia, peripheral anterior synechiae, anterior chamber vitreous, and shallow anterior chambers. The preoperative DSAEK evaluation should identify these risk factors for air bubble maintenance.

A review of DSAEK in 16 patients with previous filtering blebs or GDDs found an increased rate of tissue dislocation compared with 134 consecutive cases of DSAEK without glaucoma (28.6% vs 13.4%) and an increase in reoperation rate (42.9% vs 19.4%). Indications for reoperation included the need to repeat air bubble placement, release of iris adhesions, additional IOP-lowering surgery, or ultimate conversion to penetrating keratoplasty.2

To overcome the problem of air shunting through the GDD or filtering fistula in patients with previous glaucoma surgery, surgical pearls for DSAEK include the following. The tube of the GDD can be obstructed with cohesive ophthalmic viscosurgical device, suture intubation, or a dissolvable collagen plug. Suture placement over all openings including the corneal or corneoscleral wound and each paracentesis site will allow better air stability in the anterior chamber upon air injection. Air can be injected with a 30-gauge needle rather than a cannula to reduce the likelihood of air escape through the injection site. Finally, always check for anterior chamber vitreous, as this can be difficult to see in edematous corneas and is not uncommon in eyes with glaucoma and corneal decompensation. Without adequate anterior vitrectomy, tissue dislocation can occur from vitreous traction on the donor lenticule.

ranging from 1.13 to 1.46 D.\textsuperscript{8,9} Given these reports and my own experience, I suggest that surgeons aim for a target refraction of -1.50 D in all combined cases to achieve close proximity to emmetropia.

Based on previous clinical series, DSAEK does not induce significant astigmatism; however, if this is a concern, the corneal or corneoscleral incision can be made on the steep axis, as with cataract surgery.

In summary, surgical pearls for combined DSAEK and phacoemulsification include a low threshold for use of capsular staining dyes, a smaller capsulorrhexis than usual to improve IOL stability, intraoperative miotics to aid with tissue insertion and IOL stability, use of cohesive rather than dispersive viscoelastic agents as they are easier to remove from the anterior chamber, and targeting a postoperative spherical outcome of -1.50 D with IOL calculations in pursuit of postoperative emmetropia.

**CONCLUSION**

Although DSAEK in combination with cataract surgery requires special considerations, it conveys several advantages: faster visual recovery; ease of donor tissue preparation; avoidance of open-sky keratoplasty; and reduced intraoperative and postoperative complications, including avoidance of suture-related complications and little or no induction of postoperative astigmatism. With appropriate preoperative assessment, patient counseling, and alterations in technique, excellent outcomes can be achieved despite ocular comorbidities with DSAEK surgery.

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