One-Year Results and Anterior Segment Optical Coherence Tomography Findings of Descemet Stripping Automated Endothelial Keratoplasty Combined With Phacoemulsification

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Objective: To report 1-year results and anterior segment optical coherence tomography findings of Descemet stripping automated endothelial keratoplasty combined with phacoemulsification in patients with cataract and Fuchs endothelial dystrophy.

Methods: Twelve eyes of 11 patients with at least 1-year follow-up were retrospectively reviewed. Measured variables included best spectacle-corrected visual acuity, refractive spherical equivalent and predictability, anterior corneal keratometric values, complications, and anterior segment optical coherence tomography findings.

Results: The mean follow-up was 14.33 months (range, 12-18 months). The best spectacle-corrected visual acuity was unchanged (8%) or improved (92%) in all eyes compared with the preoperative levels. A mean (SD) discrepancy between the targeted postoperative refraction and the actual postoperative spherical equivalent refraction (hyperopic shift) of 1.46 (0.76) diopters (D) (range, −0.05 to 3.14 D) was observed. A significant correlation existed between the ratio of central graft thickness to mean peripheral donor corneal lenticule thickness at 3 mm and induced hyperopic shift ($R^2=0.65$, $P<.001$).

Conclusions: Descemet stripping automated endothelial keratoplasty combined with phacoemulsification and intraocular lens implantation in patients with coexisting Fuchs endothelial dystrophy and cataract improved best spectacle-corrected visual acuity without progressive time-dependent complications. A correlation exists between donor corneal lenticule shape and induced hyperopic shift.

Descemet stripping automated endothelial keratoplasty (DSAEK) is a lamellar corneal surgical technique for the selective replacement of abnormal corneal endothelium. The main indication for DSAEK is diseased corneal endothelium, as found in Fuchs endothelial dystrophy and pseudophakic bullous keratopathy. Quick visual rehabilitation, fewer induced refractive errors, minimal postoperative discomfort, and corneal integrity and biomechanical tensile strength are among the reasons for DSAEK gaining popularity.

In patients with coexisting corneal endothelial disease and cataract, the combination of penetrating keratoplasty (PK) and cataract extraction is an effective treatment with acceptable results. One limitation of this surgery, however, is the difficulty in performing accurate intraocular lens (IOL) calculations because of the unpredictable final post-PK corneal curvature values. A 2-staged procedure (PK consecutively followed by cataract extraction) allows for more accurate IOL calculation but has the disadvantage of being less cost-effective, with a longer recovery period. The combination of DSAEK with simultaneous cataract extraction is an alternative technique in patients with coexisting cataract and endothelial disease that could allow them to overcome these potential limitations. In a recently published study, Covert and Koenig reported their early visual outcomes in patients undergoing DSAEK combined with phacoemulsification and IOL implantation in a case series of 21 patients with 6-month follow-up.

The purpose of this study was to report 1-year refractive and visual outcomes of DSAEK combined with phacoemulsification and IOL implantation in patients with cataract and Fuchs endothelial dystrophy. In addition, in all post-DSAEK corneas in this series, we evaluate and describe the findings from anterior segment optical coherence tomography (AS OCT).
METHODS

PATIENTS

This study included 12 (of 18) patients (September 3, 2005, to August 30, 2006) with cataract and corneal edema from Fuchs endothelial dystrophy who underwent DSAEK along with phacoemulsification and IOL implantation with at least 12 months of postoperative follow-up and AS OCT (Visante; Carl Zeiss Meditec, Dublin, California) at the last follow-up examination. Patients were asked to sign an informed consent form before treatment. University of Miami Miller School of Medicine institutional review board approval was obtained before medical record review.

PREOPERATIVE ASSESSMENT

A complete ophthalmologic examination was performed before surgery to exclude other ocular diseases. Preoperative evaluation included manifest refraction, best spectacle-corrected visual acuity (BSCVA), corneal topography (TMS-1; Tomey, Nagoya, Japan) (in 9 of 12 patients, precise anterior corneal topography was performed preoperatively), biomicroscopy, and a fundus examination. The BSCVA was measured using Snellen acuity charts.

TISSUE PREPARATION

Before surgery, the donor tissue was prepared using a mechanical microkeratome (LASKone; Moria, Antony, France). Corneascleral donor tissue was mounted on a Moria artificial anterior chamber, the corneal epithelium was removed, and a microkeratome with a 390-mm head was used to cut the anterior lamellar corneal lenticule. After flap creation, the anterior corneal lenticule was replaced over the posterior lamellar corneal graft and then was placed in a corneal storage medium (Optisol; Chiron Ophthalmics, Irvine, California). Immediately before surgery, the anterior flap was removed, and the posterior lamellar graft was trephinated from the endothelial side using an 8.00- to 8.50-mm Barron-Hessburg trephine (Katena Products Inc, Denville, New Jersey) under the surgical microscope. The donor corneal lenticule remained on the donor punching block among the endothelium covered with a small amount of viscoelastic material (Healon; Advanced Medical Optics, Santa Ana, California).

SURGICAL TECHNIQUE

Surgery was performed on the recipient using monitored peri-bulbar anesthesia. A superior conjunctival peritomy was made, followed by thermal cautery. Next, a 3.0-mm superior sclerocorneal tunnel groove was created. A side port incision was made at the limbus, and the anterior chamber was filled with viscoelastic material. The anterior chamber was entered through a corneoscleral wound using a 2.75-mm keratome. The anterior lamellar corneal incisions for drainage of additional fluid from the interface. Viscoelastic material was replaced with balanced salt solution (Alcon Laboratories Inc) using an automated irrigation–aspiration unit. The wound was extended to 5.0 mm. The donor cornea was brought into the operative field, a small amount of viscoelastic material was placed on the endothelial surface, and the posterior portion was folded over itself, with the endothelial side inward. The folded donor tissue was grasped gently using angled nonappositional forceps (Moria) and was inserted into the eye. A single 10-0 nylon suture was placed to secure the corneoscleral wound. A 5-mL syringe of balanced salt solution with a 30-gauge cannula was used to fill the anterior chamber and to unfold the donor corneal lenticule. With the graft centered in the anterior chamber, filtered air was injected into the anterior chamber to secure the DSAEK donor lenticule in place. After 10 minutes, 40% of the air bubble was removed and replaced with balanced salt solution. The patient was instructed to lay face up for 30 to 60 minutes in the recovery room to allow the remaining small air bubble to push the donor tissue up against the recipient cornea. One drop (20 μL) of cyclopentolate, 1%, was instilled into the eye, followed by antibiotic drops, a patch, and a shield.

POSTOPERATIVE EVALUATION

After surgery, all the eyes received antibiotic and corticosteroid combination eye drops 4 times daily for 1 week. Thereafter, topical corticosteroid therapy was gradually tapered during the following year. At each follow-up visit, manifest refraction, BSCVA, corneal topography, AS OCT (Visante), and slitlamp examinations were performed. Measurements at the last available postoperative follow-up visit were included in the statistical analysis.

To evaluate the possible correlation of DSAEK donor corneal lenticule shape with induced hyperopia, a new index, the C:P ratio, was estimated for each patient. This index represents the ratio of the central graft thickness (C) to the mean peripheral graft thickness at 3 mm (P) (C:P ratio). P indicates peripheral graft thickness of an edge at the 3-mm optical zone; P2, peripheral graft thickness of the opposite edge at the 3-mm optical zone.

A modified reverse Sinskey hook (Price Sinskey Hook; ASICO LLC, Westmont, Illinois) was used to score the Descemet membrane in a circular pattern under an epithelial reference mark.

| 3-mm optical zone (P1 + P2)/2 = mean P |
| Native cornea | Corneal graft |

The relationship between the C:P ratio and the induced hyperopic effect was also examined by means of regression analysis. P < .05 was
RESULTS

The mean (SD) follow-up was 14.33 (2.15) months (range, 12-18 months). There were 7 women and 4 men (mean age, 72.0 years; range, 60-86 years). One bilateral and 10 unilateral procedures were performed.

REFRACTION

The mean (SD) spherical equivalent manifest refraction at the last postoperative follow-up examination was 1.11 (1.17) diopters (D) (range, −1.11 to 3.14 D), and the targeted postoperative refraction was −0.36 (0.60) D (range, −1.21 to 0.75 D) (P < .01, paired t test). The mean topographic cylinder value changed from 1.19 D preoperatively to 1.30 D postoperatively (P = .48). The mean (SD) difference between the targeted postoperative refraction and the actual postoperative spherical equivalent refraction was 1.46 (0.76) D (range, −0.05 to 3.14 D), suggesting an induced hyperopic effect by the procedure.

BSCVA MEASUREMENTS

The BSCVA was unchanged or improved in all eyes compared with preoperative levels. Specifically, 1 eye (8%) maintained the preoperative BSCVA, whereas the remaining 11 eyes (92%) experienced a gain of 1 to 8 lines at the last follow-up examination (Figure 2). The mean difference between preoperative and postoperative BSCVA was a gain of 3.3 lines (range, unchanged BSCVA to a gain of 8 lines).

TOPOGRAPHIC FINDINGS (KERATOMETRIC VALUES)

The mean (SD) keratometric values changed from 43.57 (1.53) D (range, 40.16-45.37 D) preoperatively to 43.39 (1.48) D (range, 40.11-44.99 D) at the last follow-up (P = .31).

AS OCT FINDINGS

The mean (SD) total central corneal thickness (with the attached DSAEK button) was 697 (115) µm, whereas the mean (SD) central corneal donor graft thickness was 158 (52) µm. The mean (SD) C:P ratio was 0.85 (0.10) (range, 0.70-1.00). A significant correlation existed between the C:P ratio and the induced hyperopic effect (R²=0.65, P < .001) (Figure 3 and Figure 4). A tapered profile was observed in 3 donor lenticules.

COMPLICATIONS AND ADVERSE EFFECTS

Early postoperative complications included 1 graft dislocation (8%) requiring repositioning/rebubbling without any other need for surgical intervention and 1 pupillary block glaucoma (8%) in another eye treated with medications (cycloplegic agents) and air removal from the anterior chamber 6 hours postoperatively. No late
postoperative complications were found during follow-up. All the grafts remained clear during follow-up visits.

**COMMENT**

Descemet stripping automated endothelial keratoplasty is an effective treatment for endothelial diseases. Compared with traditional PK, DSAEK is a less invasive procedure with more rapid visual recovery.1-7

The higher prevalence of cataract in patients with Fuchs dystrophy is common, especially in elderly patients, and often poses a dilemma for the operating surgeon (namely, whether to perform DSAEK alone or combined with cataract extraction). A combined technique (cataract surgery plus DSAEK) has several advantages over a 2-staged procedure (DSAEK followed by cataract surgery). Combined surgery minimizes endothelial cell loss because the cataract surgery is performed before the endothelial replacement. Furthermore, cataract removal before DSAEK increases the space in the anterior chamber, particularly in the peripheral chamber, which increases the ease of DSAEK tissue insertion and positioning. Even in the case of a relatively noncataractous lens, the presence of an air bubble, manipulations in the anterior chamber, postoperative inflammation, and topical corticosteroid use required after DSAEK surgery will increase the need for post-DSAEK cataract extraction. The main disadvantages of the combined technique are difficult visualization during cataract removal because of corneal edema and inaccurate IOL calculations.

Theoretically, the combination of the 2 procedures might yield additional or increased rates of complications. In a recent study, Covert and Koenig8 reported early (graft dislocations, acute graft rejection, and papillary block glaucoma) without late postoperative complications (6-month follow-up). In the present study, after 1 year of follow-up, no late post-DSAEK complications were found. Furthermore, an improvement in BSCVA was found in all the patients except 1, in whom the BSCVA remained unchanged.

Several studies9-12 show a significant hyperopic shift after DSAEK. In the present study, 11 patients were analyzed to elucidate the magnitude and the possible origin of the refractive post-DSAEK changes. Because preoperative refraction is unreliable in patients with corneal edema, we compared the targeted vs achieved refraction after combined procedures in this study. Furthermore, all the procedures were performed through sclerocorneal tunnel incisions to minimize the possible anterior corneal alterations seen more typically in clear corneal surgery.

Theoretically, the observed hyperopic shift reported after DSAEK can be explained by the shape of the corneal donor lenticule. The meniscus donor graft shape could increase the overall corneal power, resulting in a hyperopic shift. Using AS OCT, a detailed analysis of the graft thickness was performed to study this hypothesis and correlation of graft shape and induced hyperopic effect.12,13 Variability was found in the induced hyperopic shift (from neutral to 3.14 D). The AS OCT graft evaluation revealed a significant correlation between the corneal donor lenticule C/P ratio and the induced hyperopic effect. In addition, a tapered thickness profile was observed in 3 donor lenticules that could further induce abnormalities such as refractive cylinder and higher-order aberrations.

A few potential limitations of this study are the small sample of studied eyes (n = 12), the retrospective nature of the study, and the lack of endothelial cell counts or a comparison group treated with combined PK and cataract extraction. Future prospective comparative randomized studies including more patients are needed to address these limitations.

In conclusion, DSAEK combined with phacoemulsification and IOL implantation in patients with coexisting Fuchs endothelial dystrophy and cataract improved BSCVA, without progressive time-dependent complications during follow-up. Despite the variability in induced hyperopic shift, it seems that the shape of the donor graft lenticule is correlated with the magnitude of the induced hyperopia. Improvements in the shape of the donor graft lenticule might further improve the predictability of patients’ refractive outcomes.

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