Contralateral Eye Comparison of Descemet Membrane Endothelial Keratoplasty and Descemet Stripping Automated Endothelial Keratoplasty

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• PURPOSE: **To compare objective and subjective outcomes after Descemet membrane endothelial keratoplasty (DMEK) and Descemet stripping automated endothelial keratoplasty (DSAEK) in the fellow eye of the same patients.**
• STUDY DESIGN: **Single-center, retrospective case series.**
• METHODS: **Seventeen patients with bilateral Fuchs endothelial dystrophy who underwent DSAEK earlier in 1 eye, and later underwent DMEK in the contralateral eye, composed study population. A chart review was completed to obtain follow-up data for at least 6 months after each surgery. Outcome measures included best spectacle-corrected visual acuity (BSCVA) and endothelial cell density (ECD). Subjective questionnaires were used to assess patients' satisfaction.**
• RESULTS: **Preoperative BSCVA (logMAR) was similar in both groups, 0.66 ± 0.4 in DMEK and 0.59 ± 0.4 in DSAEK ($P = .6$). The DMEK group showed better BSCVA than the DSAEK group at the 6-month time point (0.25 ± 0.1 and 0.39 ± 0.1, for DMEK and DSAEK, respectively, $P = .02$). Preoperative ECD (cells/mm^2) was similar in both groups (2647 ± 249 and 2768 ± 404, $P = .3$) in DMEK and DSAEK, respectively. There was statistically significant difference found in ECD at 6 months (2227 ± 565 for DMEK and 1780 ± 433 for DSAEK, $P = .049$). Subjective level of average satisfaction after DMEK was 6 and after DSAEK was 4.87 ± 1.19 ($P = .002$).**
• CONCLUSIONS: **DMEK provided better visual outcome and lower endothelial cell loss than DSAEK and a higher level of patient satisfaction when assessed at 6 months after surgery. Our results comparing the 2 procedures in the same patients support the benefits of DMEK, and suggest the need for long-term studies observing this new surgical procedure. (Am J Ophthalmol 2015;159:155–159.**

FUCHS CORNEAL ENDOTHELIAL DYSTROPHY IS A common disease requiring corneal transplantation. The pathology is localized to the Descemet membrane and endothelial layer and performing posterior lamellar corneal transplants has become the surgical treatment of choice for these patients.[1] The treatment aims to replace diseased host endothelium with a lamellar donor graft bearing healthy endothelial cells. Various techniques of endothelial keratoplasty vary in the way to prepare donor tissue and result in disparate thickness of tissue, and vary in the way the tissue is introduced and handled inside the recipient eye.

Descemet stripping automated endothelial keratoplasty (DSAEK) uses an automated microkeratome to prepare donor disc consisting of endothelial layer, Descemet membrane, and thin layer of posterior stroma.[2] The newer procedure, Descemet membrane endothelial keratoplasty (DMEK), involves manual preparation of donor graft consisting only of endothelium and Descemet membrane.[3] Differences in handling of donor tissue and in ways of introducing the DSAEK and DMEK grafts into a recipient's anterior chamber, as well as different thicknesses of these grafts, may result in different postoperative outcomes in rate of healing and endothelial cell survival.

The aim of our study is to report the objective (visual acuity and endothelial cell density) and subjective (patient satisfaction questionnaires) outcomes in a cohort of patients that underwent DSAEK in 1 eye and DMEK surgery in their other eye.

METHODS

A RETROSPECTIVE MEDICAL CHART REVIEW OF PATIENTS who underwent a DSAEK in 1 eye and DMEK in the fellow eye secondary to Fuchs corneal endothelial dystrophy at Toronto Western Hospital was performed between 2012 and 2013. Only patients who had at least 6 months postoperative follow-up were included. This retrospective observational case series received Research Ethics Board approval by the University Health Network (Toronto Western Hospital, Toronto, Ontario, Canada) and was conducted in compliance with the tenets of the Declaration of Helsinki.

The data collected in this study included demographic characteristics, best spectacle-corrected visual acuity (BSCVA), associated operative procedures, intraoperative

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and postoperative complications, corneal donor characteristics, and endothelial cell density (ECD) using noncontact specular microscope (Robo, KSS 300; Konan Medical, Hyogo, Japan). Patients completed questionnaires on their last follow-up visit, grading their recovery rate, symptoms, and satisfaction with both surgeries on a scale of 1–6 (Figure).

• **SURGICAL TECHNIQUES:** All donor tissue we used were stored in corneal storage solution (Optisol; Bausch & Lomb, Rochester, New York, USA) and received from the Eye Bank of Canada, Ontario division.

The DSAEK lenticule was prepared immediately before transplantation as previously described.[4] Briefly, the donor disc was cut with the Moria ALTK microkeratome system equipped with a 300 mm head and associated artificial anterior chamber (AC) (Moria, Antony, France). After dissection and 8.5 mm punch with a corneal trephine, an anchoring 10/0 Prolene stitch on a long curved needle (CIF-4; Ethicon, New Jersey, USA) was placed on the donor disc at the 6-o'clock position. Then, the donor was placed on the Busin glide and inserted into the AC. The AC was filled with air for 10 minutes and then part of the air was removed and replaced with balanced salt solution (BSS).

DMEK grafts were prepared as previously described.[3] After preparation, the 8.5 mm donor Descemet membrane was loaded into the Emerald IOL cartridge (Abbott Medical Optics, Santa Ana, California, USA) and inserted into the anterior chamber through clear corneal (2.8 mm) incision. Tapping technique together with intracameral short bursts of BSS were used to unfold and position the graft.[5] The AC was then filled with air and 1 drop of cyclopentolate hydrochloride 1% (MINIMS Cyc 1.0; Chauvin Pharmaceuticals Ltd, UK) and of phenylephrine hydrochloride 10% (MINIMS PHNL 10; Chauvin Pharmaceuticals Ltd) were instilled to prevent pupillary block.

All patients stayed strictly supine for 2 hours and then "as much as possible" at home until the next morning. All patients were examined 2 hours after surgery and, if necessary, some of the air was released if the bubble was completely filling the AC and pupillary block was deemed to be likely. All eyes underwent pressure-patching overnight. The following day, 0.1% dexamethasone sodium phosphate and 0.3% tobramycin antibiotic (Tobradex; Alcon, Mississauga, Ontario, Canada) eye drops were administered 4 times daily for 1 month. Then, antibiotic drops were discontinued and 0.1% dexamethasone sodium phosphate (Maxidex; Alcon) eye drops were tapered down to once daily during a 3-month period.

• **STATISTICAL ANALYSIS:** The data are presented as mean ± standard deviation (SD). Paired 2-tailed Student *t* test and the Wilcoxon rank-sum test were used to assess differences in respective parameters. The distributions of values within each data set were evaluated graphically. A *P* value of .05 was selected for the threshold of statistical significance. Analyses were performed using Excel (Microsoft Corp, Redmond, Washington, USA) and SAS 9.3 (SAS Institute Inc, Cary, North Carolina, USA).

How is your vision? Please grade 1–6
1 = very bad, 2 = bad, 3 = fine, 4 = good, 5 = very good, 6 = excellent
Right eye: Left eye:

How difficult was postoperative period after one operation versus the other? Grade 1–6
1= very comfortable, 6= very uncomfortable
Right eye: Left eye:

What period of time did it take to resume normal activities (ie, back to work)
Right eye: Left eye:

Please rate your level of satisfaction from surgery.
On a scale of 1–6 (1 = least satisfied, 6 = most satisfied)
Right eye: Left eye:

Having undergone the 2 types of surgery, if given a choice, which one would you prefer?
The right eye surgery The left eye surgery

FIGURE. Patient questionnaire evaluating outcomes of Descemet membrane endothelial keratoplasty and Descemet stripping automated endothelial keratoplasty.

RESULTS

THIRTY-FOUR EYES OF 17 PATIENTS (9 FEMALE AND 8 MALE) aged 72.6 ± 11.3 years (range 42–87 years) were included. All patients were previously diagnosed with Fuchs endothelial dystrophy. Seven eyes that underwent DMEK and 6 eyes that had DSAEK were pseudophakic with posterior chamber intraocular lenses. Nine eyes from the DMEK group and 10 eyes from the DSAEK group underwent phacoemulsification with posterior chamber intraocular lens implantation concurrent with the keratoplasty. One eye from each group was phakic without cataract at time of keratoplasty.

There were no differences between the groups in terms of complications types and rates. Three eyes from each group showed partial dehiscence of the posterior lamellar graft and required air reinjection during the early postoperative period. Two eyes from each group had high intraocular pressure on the first postoperative day and required reopening of corneal incisions for decompression. None of the eyes had acute rejection.

Table 1 presents donor characteristics in both groups. The mean age of the donors was older and the time from death to keratoplasty was longer in the DMEK group than in the DSAEK group; both findings were statistically significant. Time from death to corneal processing and ECD, as was evaluated by the eye bank, were similar in both groups.

Visual acuity before the keratoplasty, at the 3-month time point, and at the 6-month time point after the surgery, is presented in Table 2. Mean preoperative BSCVA was similar in DMEK and DSAEK groups (0.66 ± 0.4 logMAR and 0.59 ± 0.4 logMAR, respectively [$P = .6$]). Both groups showed improvement in visual outcomes with

TABLE 1. Donor Characteristics in Eyes After Descemet Membrane Endothelial Keratoplasty and Descemet Stripping Automated Endothelial Keratoplasty

	DMEK (Mean ± SD)	DSAEK (Mean ± SD)	*P*
Donor age (y)	67.8 ± 4.9	55.3 ± 14.8	.007
Time from death to preservation (h)	19.2 ± 5.2	20.5 ± 7.0	.9
Time from death to use (d)	7.0 ± 2.1	4.9 ± 3.1	.01
ECD (cells/mm^2)	2647 ± 249	2768 ± 404	.3

DMEK = Descemet membrane endothelial keratoplasty; DSAEK = Descemet stripping automated endothelial keratoplasty; ECD = endothelial cell density.

TABLE 2. Best Spectacle-Corrected Visual Acuity in Descemet Membrane Endothelial Keratoplasty and Descemet Stripping Automated Endothelial Keratoplasty Groups

BSCVA	DMEK (Mean ± SD)	DSAEK (Mean ± SD)	*P*
Preoperative (logMAR)	0.66 ± 0.4	0.59 ± 0.4	.6
1 month postop (logMAR)	0.61 ± 0.4	0.52 ± 0.2	.5
3 months postop (logMAR)	0.36 ± 0.2	0.38 ± 0.1	.2
6 months postop (logMAR)	0.25 ± 0.1	0.39 ± 0.1	.02

BSCVA = best spectacle-corrected visual acuity; DMEK = Descemet membrane endothelial keratoplasty; DSAEK = Descemet stripping automated endothelial keratoplasty; Postop = postoperative.

statistically significantly better BSCVA in the DMEK group than in the DSAEK group (0.25 ± 0.1 logMAR and 0.39 ± 0.1 logMAR, respectively [$P = .02$]) at the 6-month time point.

Table 3 shows endothelial cell density change within 6 months follow-up time. Because of the missing data of ECD for several patients at the 3-month time point, it was not included in this report. Mean preoperative ECD of donor corneas for DMEK and DSAEK groups was similar (2647 ± 249 cells/mm^2 and 2768 ± 404 cells/mm^2, respectively [$P = .3$]). Within the first 6 months mean ECD decreased to 2227 ± 565 cells/mm^2 in the DMEK group, representing a mean rate of endothelial cell loss of 15.8% ($P = .007$). In the DSAEK group, mean ECD decreased to 1780 ± 433 cells/mm^2, representing mean loss rate of endothelial cells of 35.6% during the first 6 months ($P < .001$); the difference between both groups at the 6-month time point showed statistical significance ($P = .049$).

When patients were asked to evaluate visual outcomes on a scale of 1–6 (where 1 is very bad and 6 is excellent), the DMEK eye was rated 5.13 ± 0.83 vs 3.93 ± 1.16 for DSAEK ($P = .003$), indicating a significantly higher subjective rating of vision in DMEK eyes. When patients were asked to rate how difficult was the postoperative period (1 is very comfortable whereas 6 is very uncomfortable), no statistical difference was found between both procedures; DMEK was rated 1.27 ± 0.70 vs 2.00 ± 1.25 for DSAEK ($P = .06$). No statistical difference was found with regard to the time needed to resume normal activity (ie, back to work) after each surgery; average number of weeks after DMEK was 2.73 ± 2.25 while time after DSAEK was 3.33 ± 2.41 weeks ($P = .49$). Assessment of patients' level of satisfaction after each surgery from 1–6 (where 1 is least satisfied and 6 is most satisfied) showed a significantly higher level of satisfaction after DMEK surgery than after DSAEK; the average satisfaction after DMEK was 6 and after DSAEK was 4.87 ± 1.19 ($P = .002$). Finally, patients were asked which surgery they would prefer if given a choice; 12 of 15 patients (80%) said they would choose DMEK, while the remaining 3 patients (20%) indicated no difference in preference.

TABLE 3. Endothelial Cell Density in Descemet Membrane Endothelial Keratoplasty and Descemet Stripping Automated Endothelial Keratoplasty Groups

ECD	DMEK (Mean ± SD)	DSAEK (Mean ± SD)	*P*
Donor (cells/mm^2)	2647 ± 249	2768 ± 404	.3
6 months postop (cells/mm^2)	2227 ± 565	1780 ± 433	.049

DMEK = Descemet membrane endothelial keratoplasty; DSAEK = Descemet stripping automated endothelial keratoplasty; ECD = endothelial cell density; Postop = postoperative.

DISCUSSION

BEING A RELATIVELY NEW SURGICAL TECHNIQUE, DMEK gaining its popularity because of good visual outcomes and high levels of patient satisfaction. Although it places new technical challenges before corneal surgeons, this procedure does not require sophisticated microkeratomes, making it more technique and surgeon dependent. In our study we showed that even using older corneal tissue the objective and subjective outcomes are superior in DMEK as compared to the DSAEK procedure.

Previous studies comparing DMEK and DSAEK procedures reported higher rates of earlier postoperative complications in DMEK eyes related to the graft attachment; partial dehiscence of the posterior lamellar graft required air reinjection (rebubbling) in 33%–82% of DMEK cases and in 7%–20% of DSAEK cases.[6,7] In our study the rate of complications and required interventions was similar in both groups, when 3 eyes from each group (17%)

required air reinjection owing to partial graft dehiscence and 2 eyes from each group (11%) required reopening of the corneal incisions (decompression) on the first postoperative day owing to high intraocular pressure.

An interesting observation from our study is the fact that the age of DMEK donors was significantly older than the age of DSAEK donors. This difference is not incidental but was the result of our request from the eye bank to supply us older cornea donors for the DMEK surgery. We observed that manual preparation of the Descemet membrane donor is easer from the older donors and they may not scroll up as tightly as those from younger donors. Despite this age difference, the baseline ECD was similar between both. The time from death to the use of DMEK donor corneas was significantly longer than that of DSAEK corneas (7 days vs 4.9 days), further reflecting the fact that other surgeons preferred to request younger and fresher donor tissue from the eye bank. The fact that ECD at 6 months was higher in the DMEK group is of paramount importance, showing that age differences and death-to-use time did not have a negative influence on endothelial graft survival. The fact that baseline ECD is more important than age for graft survival was reported earlier by the Cornea Donor Study.[8] In our study, at the 6-month time point, the ECD in DMEK eyes was significantly higher than in the DSAEK eyes. The rate of ECD loss at 6 months was lower in the DMEK group (15.8%) as compared to the DSAEK group (35.6%). Such a difference may be related to differences in graft preparation and insertion techniques. Perhaps the curvature mismatch in DSAEK grafts results in folds or ripples in the endothelial layer that results in cell death, in comparison to DMEK, where the thin Descemet membrane grafts are less wrinkled and smoothly apposed to the corneal stroma. Other studies reported no difference in endothelial cell loss and density in these 2 types of endothelial surgeries.[6,7] The range of cell loss at 6 months, as reported by others, is wide, with a range of 19%–33% in DMEK surgeries and 20%–50% in DSAEK surgeries.[9–12] We are planning to perform a long-term study with larger groups to assess whether this difference as observed in this study is observed in large series. It also remains to be seen if this difference is observed in longer-term observational studies.

The questionnaires showed us that subjectively patients prefer DMEK surgery. They reported better subjective visual outcomes and higher general satisfaction from the DMEK surgery. Although perioperative and postoperative pain and difficulties and recovery time were similar, the majority of patients would prefer to have DMEK surgery if given the opportunity to choose.

Objective visual outcomes in our study showed superiority of DMEK surgery and this is in concordance with previous reports.[6,7] A statistically significant difference in BSCVA was observed at the 6-month time point, with average 0.25 logMAR (20/35) in DMEK and 0.39 logMAR (20/49) in DSAEK eyes. It is plausible that higher-order aberrations in eyes that underwent DSAEK caused by excessive stromal tissue and recipient-donor interface mismatch are responsible for these differences.[13]

In conclusion, this study demonstrates that DMEK provides better visual outcomes and higher patient satisfaction as compared to DSAEK. Further studies with larger series and longer follow-up may indicate if endothelial cell survival is better with the DMEK technique.

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Biosketch

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