Long-Term Outcomes of Descemet Membrane Endothelial Keratoplasty in Eyes with Prior Glaucoma Surgery

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• PURPOSE: **The purpose of this study was to evaluate the long-term outcomes of Descemet membrane endothelial keratoplasty (DMEK) in eyes that had previously undergone trabeculectomy and/or drainage device implantation.**
• DESIGN: **Retrospective, noncomparative case series.**
• METHODS: **Medical records of 251 consecutive DMEK procedures performed by 1 surgeon (S.X.D.) from 2013 to 2017 were reviewed. Patients with ≥2 years of follow-up were divided into 3 groups: eyes with prior glaucoma surgery (ST), eyes with medically treated glaucoma (MT), and eyes without glaucoma (NG). Main outcomes measured were visual acuity, endothelial cell count (ECC), rates of secondary graft failure (SGF), and postoperative complications.**
• RESULTS: **Ninety procedures (87 eyes) met inclusion criteria. The mean follow-up period of all eyes was 38.4 ± 11.2 months (range, 24.2-64.4 months). At last follow-up, the proportion of eyes reaching a vision of ≥20/40 was higher than that before the DMEK procedure in each group (all $P < .05$). The rate of ECC loss was the highest in the ST group compared to that in the MT and NG groups (63.8% vs 47.6% vs 44.0%, respectively; $P < .05$) as well as the rate of SGF (41.6% vs 0% vs 2.4%, respectively; $P < .05$). The rate of SGF of repeat DMEK was higher than that of primary DMEK ($P < .05$). The rates of postoperative complications were similar among all groups (all $P > .05$).**
• CONCLUSIONS: **In eyes with prior glaucoma surgery, DMEK achieved good long-term visual outcomes but experienced a higher rate of SGF than eyes without such comorbidity. (Am J Ophthalmol 2020;218: 288–295. © 2020 Elsevier Inc. All rights reserved.)**

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THE CONCEPT OF DESCEMET MEMBRANE ENDOTHELIAL keratoplasty (DMEK) was introduced in 2002, and the first case was reported in 2006 by Melles and associates.[1] This procedure is the preferred treatment for corneal endothelial dysfunction by an increasing number of corneal surgeons; more than 10,000 procedures were performed in 2019 in the United States.[2] Compared with Descemet stripping endothelial keratoplasty (DSEK), DMEK results in faster visual rehabilitation, better visual outcomes, and a reduced risk of rejection and secondary graft failure (SGF) in Fuchs' endothelial dystrophy and pseudophakic bullous keratopathy.[3]

Glaucoma is the second most frequent cause of blindness worldwide. The number of patients affected increases as the population ages.[4] A history of glaucoma surgery, namely, trabeculectomy or implantation of drainage devices, has an adverse effect on the survival of penetrating keratoplasty (PK) and DSEK. Previous glaucoma surgery confers increased rates of graft rejection and secondary graft failure (SGF).[5–7] The present authors previously reported that DMEK in eyes that had previously undergone glaucoma surgery resulted in better clinical outcomes than does DSEK.[8] However, the long-term outcomes of DMEK in such eyes are not currently known.[9–11] With the gain in the popularity of DMEK, including in challenging cases, knowledge of the long-term outcomes after DMEK, especially for eyes with complex anatomy, has become critical. Hence, the present study aimed to investigate the long-term clinical outcomes of eyes that had undergone DMEK in eyes with prior glaucoma surgery.

SUBJECTS AND METHODS

APPROVAL FOR THIS STUDY WAS OBTAINED FROM THE Institutional Review board (IRB)/Ethics Committee (University of California, Los Angeles, IRB 15-001250). Collected data were deidentified and entered on an Excel spreadsheet (Microsoft, Redmond, Washington) in a manner compliant with the Health Insurance Portability and Accountability Act. The study adhered to the tenets of the Declaration of Helsinki.

A total of 251 consecutive DMEK procedures were performed for 173 patients by 1 surgeon (S.X.D.) between

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October 2013 and September 2017. Eyes with a minimum of 2 years of follow-up were included in the study. A total of 90 eyes of 87 patients met the inclusion criteria and were divided into 3 groups: eyes that had previously undergone trabeculectomy or received implantation of a glaucoma drainage device (surgically treated [ST] group), eyes that had undergone only medical treatment for glaucoma (MT group), and eyes with no history of glaucoma (NG group). The diagnosis, the classification of severity, and the choice of glaucoma management were made by the glaucoma specialist who referred the patients. The main outcomes were changes in the best corrected distance visual acuity (BCVA), the central corneal thickness (CCT), and the endothelial cell count (ECC). Primary graft failure and SGF rates were also estimated. When a SGF occurred, the ECC at the last follow-up was the ECC evaluated at the time of the failure diagnosis. ECC at the last follow-up visit were available for 88 of 90 eyes (97.8%). Secondary outcomes were the occurrence of significant intraoperative and postoperative complications that included the rate of air injection, elevated intraocular pressure (IOP), secondary glaucoma surgery, cystoid macular edema, and rate of rejection.

• **SURGICAL PROCEDURE AND POSTOPERATIVE MANAGEMENT:** All DMEK procedures were performed as previously described, and all patients received monitored anesthesia and retrobulbar block.[5,8,12] Prestripped tissue obtained from eye banks was used in all cases. Surgical peripheral iridectomy at 6 and 12 o'clock positions was performed. A previously described "touch, no-touch technique"[12] was used: a 30-gauge cannula was used to manually unfold the Descemet membrane scroll on the Descemet's side without touching the endothelium. A complete air fill was maintained for 10 minutes, and a 90% air fill was left in place after the procedure in all cases but 2 (both in the ST group). In those 2 cases, a 20% sulfur hexafluoride 6 fill was used.

• **ADDITIONAL PROCEDURES:** If necessary, the tube shunt was trimmed and/or anterior synechiae were lysed before tissue insertion. In combined DMEK and cataract surgery, cataract extraction was performed by phacoemulsification before the insertion of the graft, as previously described.[13]

• **POSTOPERATIVE MANAGEMENT:** Patients were instructed to remain supine for 1 to 2 hours in the recovery area, and an examination was performed to inspect for graft attachment, elevated IOP, and angle closure. If the IOP was high, a small amount of air was released from the paracentesis site. The patient was then instructed to remain supine for 48 hours and was examined on postoperative days 1, 7, and 30 and every 2 to 3 months thereafter. A topical fluoroquinolone was administered 4 times daily starting 2 days before surgery and continued for 1 week postoperatively or until any epithelial defect was healed. Topical prednisolone acetate was administered 4 times daily with a slow taper to 3 times a week, over 4 to 6 months. Other drops, including glaucoma medications, were resumed the day after the surgery. If rebubbling was needed, it was performed under aseptic conditions in a minor procedure room.

• **DATA COLLECTION:** BCVA (according to Snellen chart measurment), IOP measurements, and the results of slit lamp biomicroscopy were collected at each visit. In addition, the following data were recorded: the preoperative status of the patient, the indication for surgery, the lens and the glaucoma surgery status, the type and number of coprocedures performed at the time of the DMEK, the intraoperative complications, and the postoperative complications. Intraocular pressure was measured by applanation tonometry, TonoPen (Reichert Technologies, Buffalo, New York), or pneumotonometer. Preoperative IOP was defined as the average IOP measured at the 2 most recent visits prior to the date of endothelial keratoplasty. Increased IOP following DMEK was defined as an IOP ≥24 mm Hg or an increase in IOP that was more than 8 mm Hg greater than the preoperative measurement and lasted more than 1 week.

CCT was evaluated by a handheld pachymeter. Endothelial cell counts were evaluated by specular microscopy (Konan Medical, Irvine, California). Donor ECC were obtained from eye banks. Primary graft failure was defined as the failure of the graft to attach or persistent corneal edema after the first postoperative month, despite an attached graft. SGF was defined as a corneal decompensation following an initially functional graft. Graft rejection was defined as any increase in CCT or change in endopigment with or without the presence of cells in the anterior chamber.

• **STATISTICAL ANALYSIS:** Baseline was defined as the visit before surgery. Baseline ECC was defined as the donor ECC. Analyses were performed by procedures, except for the analysis of BCVA, which was performed by eyes. VAs were converted to the logarithm of minimum angle of resolution (logMAR) whenever necessary. The Kruskal-Wallis test was used to compare the differences in mean values of continuous variables with a skewed distribution between groups. The Wilcoxon signed-rank test was used to compare paired continuous data. The Fisher exact test was used to compare differences in the percentage of categorical variables between groups. Kaplan-Meyer survival analysis was performed to calculate the cumulative success probability of graft survival. Statistical analysis was performed by a biostatistician (F.Y.) using SAS version 9.4 software (SAS, Cary, North Carolina). A P value $<.05$ indicated statistical significance.

RESULTS

• **DEMOGRAPHIC DATA AND PATIENT CHARACTERISTICS:** A total of 90 consecutive DMEK procedures performed in 87 eyes of 80 patients met the inclusion

TABLE 1. Demographics and Preoperative Status of Patients Undergoing DMEK

	All	ST Group	MT Group	NG Group	*P* value[a]
n procedures (%)/n eyes/n patients	90 (100)/87/80	38 (42.2)/35/35	11 (12.2)/11/10	41 (45.6)/41/35	
Mean ± SD follow-up, months	38.4 ± 11.2	38.2 ±11.0	36.3 ±11.3	39.1 ± 11.5	0.78
Mean ± SD age at, months	71.6 ± 11.4	71.9 ± 14.7	71.8 ± 6.3	71.4 ± 8.7	0.28
Indication for surgery[b]					**< 0.01**
Fuchs' dystrophy	41 (47.1)	2 (5.7)	7 (63.6)	32 (85.4)	-
PBK	31 (35.6)	24 (68.6)	2 (18.2)	5 (12.2)	-
Failed PK	2 (2.3)	1 (2.9)	1 (9.1)	0 (0.0)	-
Failed DSEK	9 (10.3)	6 (17.1)	0 (0.0)	3 (7.3)	-
Failed DMEK	4 (4.6)	3 (8.6)	1 (9.1)	0 (0.0)	-
HSV/CMV endotheliitis	9 (10.3)	7 (20.0)	0 (0.0)	2 (4.9)	-
Preoperative visual acuity[b]					
Snellen chart		20			
≥20/25	4 (4.6)	0 (0.0)	0 (0.0)	4 (9.8)	0.18
≥20/40	28 (32.2)	6 (17.1)	6 (54.5)	16 (39.0)	**0.02**
≥20/200	65 (74.7)	22 (62.9)	10 (9.1)	33 (80.5)	**0.04**
Mean ± SD, logMAR	0.69 ± 0.65	0.90 ± 0.72	0.42 ± 0.48	0.57 ± 0.55	**0.03**
Preoperative glaucoma evaluation[c]					
Mean ± SD IOP, mm Hg	12.3 ± 3.3	10.9 ± 3.9	12.6 ± 2.5	13.5 ± 2.4	**< 0.01**
C/D ratio					
≤ 0.3	41 (45.6)	0	1 (9.1)	40 (97.6)	**< 0.01**
0.4-0.5	5 (5.6)	1 (2.6)	4 (36.4)	0 (0.0)	-
0.6-0.7	11 (12.2)	9 (23.7)	2 (18.2)	0 (0.0)	**< 0.01**
≥ 0.8	33 (36.7)	28 (73.7)	4 (36.4)	1 (2.4)	**< 0.01**
Glaucoma drops					0.26[d]
0	49 (54.4)	8 (21.1)	0 (0.0)	41 (100.0)	-
1	12 (13.3)	7 (18.4)	5 (45.5)	0 (0.0)	-
2	15 (16.7)	11 (28.9)	4 (36.4)	0 (0.0)	-
3	12 (13.3)	9 (23.7)	3 (27.3)	0 (0.0)	-
4	3 (3.3)	3 (7.9)	0 (0.0)	0 (0.0)	-
Previous trabeculectomy	21 (23.3)	21 (55.3)	0 (0.0)	0 (0.0)	-
1	18 (20.0)	18 (47.4)	0 (0.0)	0 (0.0)	-
≥ 2	3 (3.3)	3 (7.9)	0 (0.0)	0 (0.0)	-
Previous tube shunt	26 (38.9)	26 (68.4)	0 (0.0)	0 (0.0)	-
1	17 (18.9)	17 (44.7)[e]	0 (0.0)	0 (0.0)	-
≥ 2	9 (10.0)	9 (23.7)[f]	0 (0.0)	0 (0.0)	-

C/D = cup-to-disk ratio; CMV= cytomegalovirus; N = number; DMEK = Descemet membrane endothelial keratoplasty; DSEK = Descemet stripping membrane keratoplasty; HSV = herpes simplex virus; logMAR = log of minimum angle of resolution; PBK = pseudophakic bullous keratopathy; PK = penetrating keratoplasty; SD = standard deviation.

Bold indicates significant *P* value (<.05).

[a]Fisher exact test for qualitative data. Kruskall-Wallis test for continuous data.

[b]Per eye.

[c]Per procedure.

[d]MT versus ST, 2 or fewer drops versus more than 2 drops.

[e]5 eyes with previous trabeculectomy.

[f]2 eyes with previous trabeculectomy.

criteria and were included (Table 1). The minimum follow-up period ranged from 24.1 to 64.4 months. The mean follow-up of all eyes of 38.4 ± 11.2 months was comparable among the ST, MT, and NG groups ($P = .78$). Fuchs' endothelial corneal dystrophy was a more frequent indication for DMEK in the NG group, whereas pseudophakic bullous keratopathy, failed DSEK, and a history of viral endotheliitis were the frequent indications in the ST group ($P < .01$). Glaucoma was significantly more severe in the ST group than in the MT group, as indicated by the higher percentage of eyes with a cup-to-disc ratio ≥0.8 ($P < .01$). IOP was equally well controlled in both the ST and MT groups; in both groups, similar percentages of eyes required 2 or fewer eye medications prior to DMEK ($P = .68$). Most eyes in the

TABLE 2. Concomitant Procedures and Complications after DMEK

	All	ST Group	MT Group	NG Group	
	n = 90	n = 38	n = 11	n = 41	*P* Value[a]
Concomitant procedures					
Cataract extraction with PCIOL	28 (31.1)	4 (10.5)	3 (27.3)	21 (51.2)	**< .01**
Lysis of corneal adhesions	21 (23.3)	17 (44.7)	1 (9.1)	3 (7.3)	**< .01**
Tube shunt trimming	6 (6.7)	6 (15.8)	0 (0.0)	0 (0.0)	-
Anterior vitrectomy	4 (4.4)	4 (10.5)	0 (0.0)	0 (0.0)	.25
Retro-corneal membrane peel	4 (4.4)	2 (5.3)	1 (9.1)	1 (2.4)	.68
Postoperative complications					
Intraocular pressure elevation	30 (33.3)	10 (26.3)	6 (54.5)	14 (34.1)	.21
Air injection	16 (17.8)	6 (15.8)	2 (18.2)	8 (19.5)	.93
Secondary graft failure	14 (15.6)	12 (31.6)[b]	1 (9.1)	1 (2.4)	**< .01**
Cystoid macular edema	12 (13.3)	6 (15.8)	0 (0.0)	6 (14.6)	.33
Endothelial rejection	9 (10.0)	6 (15.8)[c]	2 (18.2)[c]	1 (2.4)	.09
Secondary glaucoma surgery	6 (6.7)	5 (13.2)	1 (9.1)	0 (0.0)	**.05**
Primary graft failure	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	-

PCIOL= posterior chamber intra-ocular lens implantation.
Bold indicates significant *P* value (<.05).
[a]Fisher exact test. Values in bold face indicate.
[b]Three eyes following rejection episodes, including 1 eye with an history of viral endotheliitis.
[c]Self-stopped topical corticosteroids treatment in 1 eye.

ST group had previously undergone implantation of a drainage device (n = 16; 68.4%). During the DMEK procedure, cataract extraction was performed more frequently in the NG group ($P < .01$) (Table 2), whereas lysis of anterior synechiae was more frequent in the ST group ($P < .01$).

• **VISUAL OUTCOMES:** The median preoperative BCVA was worse in the ST group than in the MT and NG groups and improved in all groups postoperatively (Figure 1, left panel). The proportion of eyes achieving 20/40 or better BCVA in the ST group was significantly greater at the last follow-up (15 eyes; 40.0%) than at the preoperative visit (6 eyes; 16.0%; $P < .05$) (Figure 1, right panel). Three eyes (8.0%) in the ST group reached a BCVA of 20/20 at the last follow-up. In comparison, 20/20 BCVA was achieved by 4 eyes (36.0%) in the MT group and by 20 eyes (49.0%) in the NG group ($P < .01$). Fifteen eyes (40.0%) in the ST group achieved 20/40 or better vision compared with 8 eyes (72.0%) in the MT group; and 36 eyes (88.0%) in the NG group achieved the same level of improvement ($P < .01$).

• **ECC COUNTS AND CCT:** The percentage of ECC loss was greater in the ST group than in the MT and ST groups at all postoperative time points (All $P < .05$, Figure 2). After the initial postoperative loss, the ECC loss stabilized in the MT and NG groups ($P = .25$ and $P = .24$, respectively), whereas the ECC loss was significant in the ST group ($P = .04$).

Preoperative CCT was the highest in the ST group ($P < .01$). The CCT decreased on average by 21.4% initially and remained stable thereafter. No significant differences were seen among all groups ($P > .05$) (Supplemental Figure 1 [supplemental material available at www.ajo.com]).

• **GRAFT SURVIVAL:** The percentage of procedures which experienced SGF at 4 years was greater in the ST group than in the MT and NG groups (41.6% vs. 0% vs. 2.4%, respectively) (Figure 3, left panel). There were no differences in the SGF rates at the last follow-up visit between the eyes with a tube shunt (34.7%) and the eyes that had undergone trabeculectomy (33.3%) ($P = .71$) (Supplemental Figure 2), but the sample was small (26 tube shunts, 12 trabeculectomies). The graft survival rate was significantly lower in cases of repeat/secondary DMEK than in cases of primary DMEK (Figure 3, right panel).

• **COMPLICATIONS:** Rates of primary graft failure, air injection, cystoid macular edema, endothelial rejection, IOP elevation, and additional glaucoma surgery were comparable among the 3 groups (Table 2).

DISCUSSION

THIS STUDY IS THE LARGEST TO EVALUATE THE LONG-TERM outcomes of DMEK in eyes with prior glaucoma surgery. The study confirms that DMEK can be successfully performed in these complex eyes and can achieve very good visual outcomes that could allow these patients to

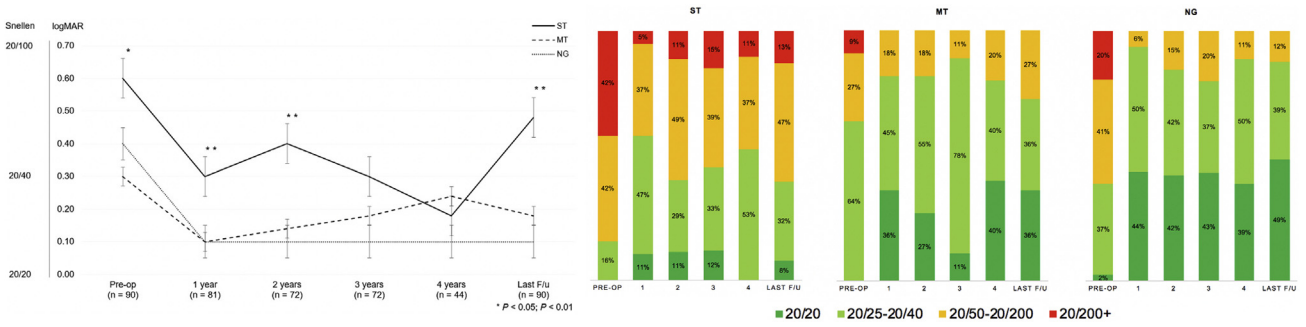

FIGURE 1. Visual outcomes after Descemet membrane endothelial keratoplasty. (Left) Compared with the median visual acuity, at the preoperative time point, the median visual acuity improved in all groups at all postoperative time points ($P < .05$, Kruskal-Wallis exact test). (Right) Visual acuity analysis after Descemet membrane endothelial keratoplasty (DMEK) in eyes with glaucoma that was surgically treated (ST), eyes with glaucoma that were medically treated (MT), and eyes without glaucoma (NG). The percentage of eyes in each visual acuity group is shown at each time point (year).

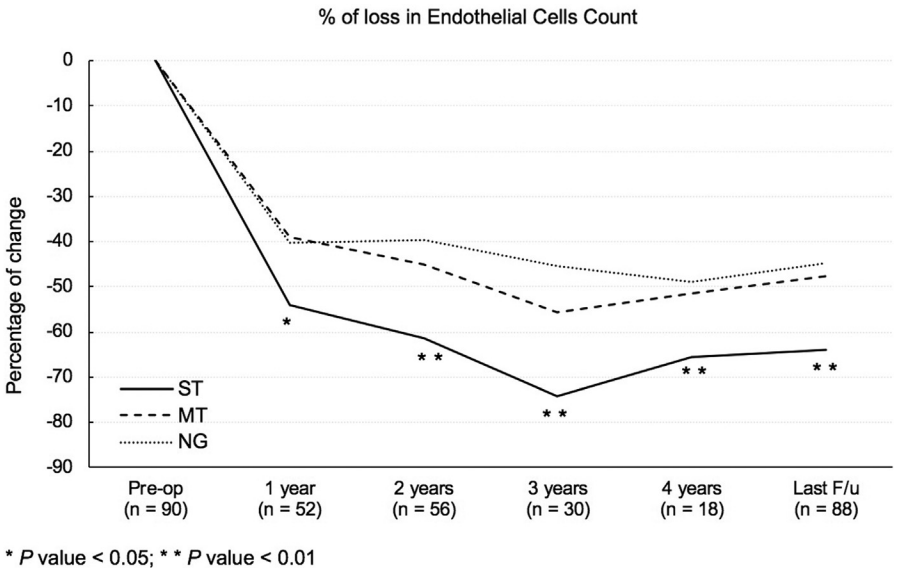

FIGURE 2. Endothelial cell loss after Descemet membrane endothelial keratoplasty (DMEK) in eyes with surgically treated glaucoma (ST), eyes with medically treated glaucoma (MT), and eyes without glaucoma (NG). The percentage of endothelial cell loss was higher in the ST group and continued to increase over time (Kruskal-Wallis exact test; $P < .01$).

function at a higher level.[14–16] However, the SGF rate was higher in the ST group than in the MT and NG groups in this long-term study. A similar observation was reported after PK and DSEK.[7,17] The SGF was mostly due to continuous accelerated ECC loss over time without clinical signs of immune rejection in the ST group. The cause is likely multifactorial. The proximity of the shunt to the cornea is one possible cause. The indication for surgery could be a confounding factor for increased ECC loss and SGF. Viral endotheliitis, for example, if uncontrolled after DMEK, could accelerate the ECC loss and lead to SGF.[18,19] In this study, 9 DMEK procedures were performed in patients who had a history of viral endotheliitis, and all patients received antiviral prophylaxis during the entire follow-up period. None of these eyes experienced viral reactivation during the period before surgery (3 months or longer) or during the follow-up period. It is unlikely that SGF resulted from the reactivation of viral infection in our series.

Prior glaucoma surgery appears to have had a negative effect on endothelial cells after PK, DSEK, and DMEK, as previously reported by the present authors group and others.[7,9–11,17] Chronic endothelial toxicity possibly results from a change in the aqueous humor flow in the anterior chamber and from a chronic proinflammatory, proapoptotic, and prooxidative state after the breach in the blood-aqueous barrier in these eyes. Intermittent uveal or corneal touch could occur because of the shunt device and could

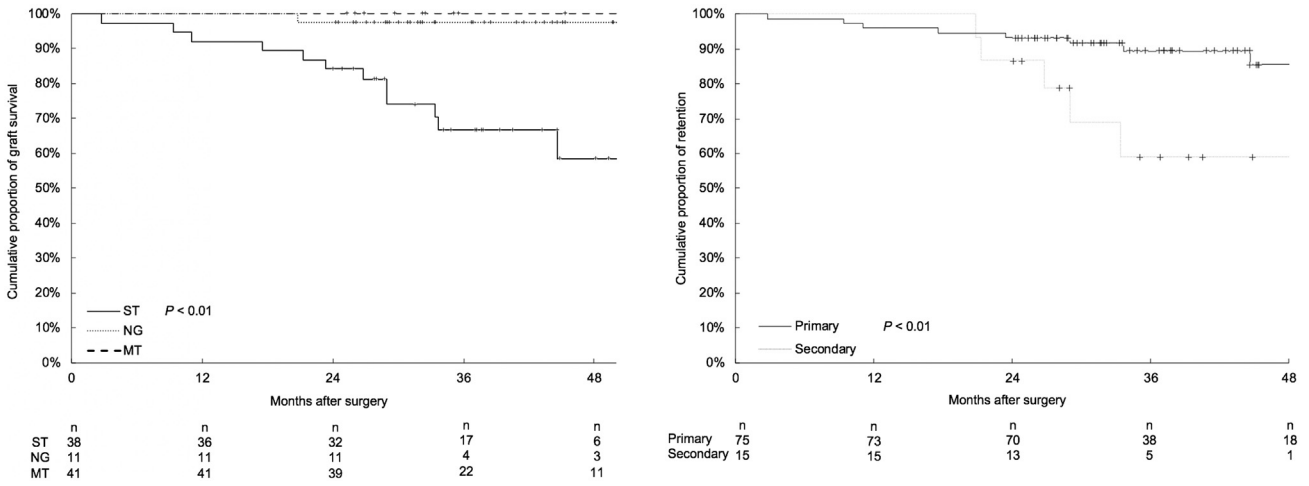

FIGURE 3. Graft survival after Descemet membrane endothelial keratoplasty (DMEK) in eyes with surgically treated glaucoma (ST), eyes with medically treated glaucoma (MT), and eyes without glaucoma (NG). (Left) Overall graft survival rate was lower in the ST group than in the MT and NG groups ($P < .01$). Primary DMEK had a longer survival time than DMEK performed as a second graft ([Right] $P < .01$).

further damage the endothelium.[20–23] Glaucoma and the glaucoma medications might also have played a role.[20] Further study is necessary to investigate ECC loss in different causes of endothelial dysfunction and the effect of altered aqueous humor on the endothelial cells.

The present authors previously reported that compared with DSEK, DMEK had a lower rate of primary graft failure and SGF within 1 year of follow-up.[8] The SGF rate after DSEK in eyes with prior glaucoma surgery varied between 16.0% and 31.0% at 3 and 4 years, respectively.[7,24] The SGF rate after DSEK was found to be higher in eyes with a prior glaucoma shunt device than those that had undergone trabeculectomy.[7] The current study did not find a difference in the long-term SGF rates between these 2 groups after DMEK. The absence of a difference may be due to the small sample size. In addition, whether long-term graft survival after DMEK is similar to that after DSEK in these complex eyes is currently being investigated.

Most eyes in the ST group presented with advanced glaucoma and more severe corneal edema than in the NG and MT groups. Despite those comorbidities, the median BCVA in the ST group was significantly improved during the entire follow-up period (up to 64 months). A total of 40% of patients in the ST group achieved 20/40 or better vision at the last follow-up visit compared with only 18% of eyes prior to the DMEK procedure. Any improvement in vision is beneficial to these patients whose visual field is severely compromised. We previously showed that DMEK resulted in a better visual outcome than did DSEK at 1 year of follow-up.[8] A better visual improvement after DMEK could be maintained long-term in many eyes in the ST group.

Appropriate surgical techniques for eyes with advanced glaucoma and a complex anterior segment are paramount for the success of the DMEK procedure and to a good visual outcome. The unfolding technique may play a key role. The ECC loss was 57.5% at 1 year in the current study, whereas ECC loss was 71% within 1 year using a different unfolding technique.[9] The "touch, no-touch technique" allows the surgeon to have complete control of graft movement in the anterior chamber, avoiding unnecessary and uncontrolled touch of the endothelial side to the tube shunt. Some of the surgically treated eyes had 2 or 3 shunts, which greatly increased the risk of the shunt tip damaging the endothelium. It is unknown whether newer techniques, such as the irrigating cannula-assisted, bubble-in-the-roll, circular graft peripheral staining, or pull-through endothelium-in insertion and unfolding techniques can achieve the same level of control over graft movement and good visual outcomes in these complex eyes.[25–29]

Intraoperative and postoperative IOP management are other key factors affecting the long-term visual outcomes of eyes with advanced glaucoma.[30] It appears that the IOP required to attach the DMEK graft is lower than that required to attach the DSEK graft during the 10-minute period of air tamponade. The IOP was checked in all eyes 1 to 2 hours immediately after surgery. The threshold to decompress the eye was low in order to maintain the IOP at the physiologic level at the time of patient discharge from the surgery center. The glaucoma medication therapy was resumed on postoperative day 1, and IOP was measured at every visit. Postoperatively glaucoma was closely comanaged by a glaucoma specialist to decrease the risk of disease progression. Another advantage of DMEK is that the taper

of topical corticosteroids postoperatively is quicker than that after PK and DSEK. The quicker taper potentially lowers the risk of IOP elevation resulting from the steroid response. However, it is difficult to evaluate glaucoma progression after DMEK because visual field assessment may not be reliable due to the poor visual acuity before surgery. Assessment of glaucoma progression related to the DMEK procedure is indicated to further support the safety of DMEK in these patients in future studies.

The rejection rate in the current study is higher than that previously reported for uncomplicated DMEK (1.0%-2.0%) and is in a similar range reportedly after DSEK (7.0%-14.0%).[3,6,7] A higher rate of rejection reported in the present authors' series may result from more stringent criteria than those commonly reported in the medical literature. Any increase in CCT and/or change in endopigment even without the presence of cells in the anterior chamber or frank keratic precipitates were considered signs of immune rejection. Among the 9 patients with rejection episodes, 2 patients independently stopped the topical corticosteroid therapy shortly after surgery. The true rejection rate may be lower than that reported in the current study.

In conclusion, DMEK for eyes that had previously undergone glaucoma surgery provides good long-term visual outcomes. A continuous ECC loss without immune rejection results in a higher rate of SGF in these eyes with prior glaucoma surgery than in those eyes that had not. Additional studies to investigate the cause of this accelerated ECC loss are necessary for the prevention and treatment of endothelial failure in these eyes.

ALL AUTHORS HAVE COMPLETED AND SUBMITTED THE ICMJE FORM FOR DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST and none were reported.

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