Long-Term Outcomes of Descemet Membrane Endothelial Keratoplasty in Postvitrectomized Eyes With the Use of Pars Plana Infusion

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Purpose: To evaluate the use of pars plana infusion as part of Descemet membrane endothelial keratoplasty (DMEK) in eyes of patients who underwent vitrectomy.

Methods: A retrospective chart review was conducted of patients at Toronto Western Hospital (Toronto, Canada) who had undergone DMEK with pars plana infusion, with a minimum follow-up of at least 12 months. Collected data included postoperative best-corrected visual acuity (BCVA), intraoperative complications, and postoperative complications such as graft detachment, rejection and failure, and rate of endothelial cell loss.

Results: Fifteen eyes of 14 patients were included in this study. The mean follow-up time was 23.9 ± 5.7 months. Four grafts required rebubbling within the first month of surgery, and one graft required repeat DMEK right away. Two grafts failed secondarily at 24 months, and there was one episode of graft rejection. Five eyes had retinal complications including retinal detachment, retinoschisis, and cystoid macular edema. BCVA improved significantly from 1.7 ± 0.77 logarthim of the minimum angle of resolution (LogMAR) (mean Snellen 20/1000) preoperatively when compared with postoperative BCVA at 6 months (0.95 ± 0.74 LogMar, mean Snellen 20/180, $P = 0.02$, n = 10), 12 months (0.93 ± 0.6,$P = 0.01$, mean Snellen 20/170, n = 11), and 24 months (1.01 ± 0.68, mean Snellen 20/200 $P = 0.046$, n = 7).

Conclusions: Although pars plana infusion is a helpful technique for DMEK in vitrectomized eyes, such cases are still quite difficult to perform compared with standard DMEK and use of an infusion may increase the risk of retinal complications. Descemet Stripping Automated Endothelial Keratoplasty may be the preferred technique in these challenging vitrectomized eyes.

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Descemet membrane endothelial keratoplasty (DMEK) has become increasingly favored in the treatment of corneal endothelial dysfunction because of its well-established advantages over Descemet stripping automated endothelial keratoplasty (DSAEK).[1] DMEK promotes faster and better visual recovery than DSAEK with reduced rejection rates.[2,3]

Despite its advantages, however, DMEK does pose unique surgical challenges, most notably the difficulties that can be encountered in unfolding the graft. Optimal control of the anatomy of the anterior chamber, iris-lens diaphragm, and vitreous is crucial for successful unfolding. In previously vitrectomized eyes, the posterior support provided by the vitreous is lacking. Consequently, the anterior chambers in these eyes can become very deep intraoperatively, which complicates graft unfolding.[4] Furthermore, once the graft is unfolded, the injected air bubble used to tamponade the graft against the host stroma may be less effective because of the easily fluctuating iris-lens diaphragm.

Such challenges might dissuade surgeons from proceeding with DMEK in vitrectomized eyes. Our group previously published the 6-month results of a technique using a pars plana infusion to stabilize the posterior segment during DMEK surgery to help better control the depth of the anterior chamber.[4] The purpose of the present study is to present the longer-term outcomes of this surgical technique.

METHODS

This is a retrospective study conducted by means of a chart review of vitrectomized patients who underwent DMEK surgery with the use of pars plana infusion. Given the purpose of looking at long-term results with this technique, only patients with at least 1 year of follow-up were included. This study was conducted in compliance with the tenets of the Declaration of Helsinki and received Research Ethics Board approval from University Health Network (Toronto Western Hospital, Toronto, Canada).

Preoperative demographics that were recorded included gender, age at the time of surgery, and which eye was

operated on. Other preoperative data included the indication for surgery, concomitant eye conditions, preoperative lens status, and visual acuity.

Operative data included donor endothelial cell density (ECC), graft size, combination procedures alongside the DMEK, status of the vitreous, and any intraoperative complications.

Data from the postoperative period included best-corrected visual acuity (BCVA), ECC, the presence of graft detachment, need for a rebubble, rejection episodes, graft failures, and any other postoperative complications.

Surgical Technique

Corneal donors were provided by the Eye Bank of Canada, Ontario Division. All corneas were preserved in storage solution (Optisol; Bausch and Lomb, Rochester, NY).

The corneal graft was prepared before the patient was brought into the operating room. Descemet membrane and endothelium were peeled using the modified Melles technique, as previously described (Melles et al[5]). An "F" mark was used to aid with intraoperative graft orientation and was applied through a stromal window by the surgeon.[6,7] Graft diameter ranged from 7.5 to 8.5 mm based on the preoperative assessment of the patient's cornea.

Attention was then brought to the patient. All surgeries were performed by the same corneal surgeon (D.S.R.). After topical application of tetracaine, a subtenon's block was administered inferonasally and consisted of a 50:50 mix of lidocaine 2% without epinephrine and bupivacaine 0.5%. A 23-gauge trocar was inserted into the vitreous cavity 3.0 mm from the limbus. A 23-gauge posterior infusion line was then connected to the trocar. A 2.4 mm temporal clear corneal incision was made using a keratome. Two paracenteses were created using a 15-degree blade at the 10 o'clock and 2 o'clock positions. Other paracenteses were created as needed during the course of the surgery. Ink-marked calipers were used to mark the corneal diameter of the descemetorhexis. Cohesive viscoelastic was injected into the anterior chamber, and a reverse sinskey hook was used to complete the descemetorhexis. Vision Blue (D.O.R.C., Zuidland, The Netherlands) was used to ensure that no remnant descemet tags remained in the eye and any tags were removed.

The DMEK graft was injected into the eye with the use of a glass pipette (Geuder AG, Heidelberg, Germany) or an intraocular lens (IOL) injector. The pars plana infusion was turned on and off with the foot pedal as needed to pressurize the eye and to encourage anterior chamber shallowing to facilitate graft unfolding and positioning. A tapping technique was used for unfolding. Once the graft was unrolled in the intended location, the pars plana infusion was stopped and the eye was filled with air. Balanced salt solution was used to pressurize the eye as needed and to hydrate the wounds. The trocar was then removed from the eye. 10-0 nylon and 7-0 vicryl were used as needed for any leaking corneal incisions or sclerotomy sites (Ethicon Inc, Somerville, NJ). Phenylephrine hydrochloride 2.5% and cyclopentolate hydrochloride 1% (Minims; Chauvin Pharmaceuticals Ltd, United Kingdom) one drop each were instilled into the patient's eye before patching.

After surgery, the patient lay supine for 2 hours. The patient was then examined at a slit lamp to ensure graft attachment and that the bubble was of adequate size to promote attachment but not so big that there was risk of pupil block. A 30-gauge needle was used to remove or add air as needed. The patient was seen the following day. Patients were started on 0.1% dexamethasone sodium phosphate and 0.3% tobramycin (Tobradex; Alcon, Mississauga, ON, Canada) 4 times daily. This was discontinued at 1 week, and 0.1% dexamethasone sodium phosphate (Maxidex; Alcon) drops were tapered from 4 times daily to once daily over the course of 4 months. Patients were instructed to remain in a supine position "as much as possible" over the first few postoperative days.

RESULTS

Fifteen eyes of 14 patients (6 men and 9 women) were included in this study, aged 73 ± 14.2 years. There were 6 men and 9 women. Indications for DMEK included pseudophakic bullous keratopathy (6), failed DSAEK (3), failed DMEK (1), and failed penetrating keratoplasty (1). Twelve eyes were pseudophakic, and 3 eyes were aphakic. Nine of the eyes were already vitrectomized before surgery, and 4 eyes underwent pars plana vitrectomy as part of the DMEK surgery (Table 1).

Several of the patients underwent combined surgeries as part of the DMEK operation, including IOL exchange (6), pupilloplasty (1), and tube trimming (1) (Table 1). All surgeries were uneventful, aside from one combined case with IOL scleral fixation in which the DMEK part was aborted because the tissue was lost into the vitreous cavity.

Postoperatively, 7 grafts had detached. One graft fully detached, 2 grafts had a detachment greater than one-third of the surface area, and 4 grafts had a detachment less than one-third of the surface area. Four of these eyes required rebubbling in the office, one of which necessitated 2 rebubbles. The time point of the rebubbles ranged from 1 day to 3 weeks postoperatively. The graft that was fully detached required immediate repeat DMEK. Two patients developed secondary graft failure at 24 months, both of whom elected to proceed with repeat DMEK.

Only one patient in this study developed an episode of graft rejection, and this occurred 7 months postoperatively. This same patient also developed a corneal ulcer 1 month postoperatively that was culture positive for *Streptococcus pneumoniae*.

Several patients developed postoperative retinal complications. Two patients developed retinal detachments, one patient had macular schisis, and 2 patients developed cystoid macular edema (the third patient had preexisting macular edema preoperatively).

The last postoperative follow-up visit was at 23.9 ± 5.7 months and ranged from 12 to 34 months. BCVA improved significantly from 1.7 ± 0.77 logarthim of the minimum angle of resolution (LogMAR) (mean Snellen 20/1000) preoperatively when compared with postoperative BCVA at 6 months (0.95 ± 0.74 LogMAR, mean Snellen 20/180, $P = 0.02$, n = 10), 12 months (0.93 ± 0.6 LogMAR, mean Snellen

TABLE 1. Outline of Baseline Characteristics of Eyes Included in This Study, Including DMEK Indication, Preoperative Vitreous Status, Other Procedures Performed Alongside the DMEK, and Postoperative Retinal Complications, If Present

Patient	DMEK Indication	Concomitant Eye Conditions	Vitreous Status	Indication for Vitrectomy?	Combined Procedures With DMEK	Retinal Complications
A	Failed DSAEK	None	Previous anterior vitrectomy	Phaco complication	ACIOL removal, TS-IOL, PPV	RD, CME
B	FED	Best vitelliform macular dystrophy	Previous PPV	Unknown	PPV	
C	PBK	ACIOL, recurrent uveitis, glaucoma	Intraoperative PPV	As part of IOL exchange	ACIOL removal, TS-IOL, PPV	
DA*	PBK	Trabeculectomy	Intraoperative PPV	As part of IOL fixation	IOL suture to iris, PPV	
DB*	Failed DMEK	Trabeculectomy	Prior PPV	As part of previous complicated DMEK		Macular schisis
E	PBK	CSCR, aphakic	Prior vitrectomy during phaco	Phaco complication	Pupilloplasty	RD
F	PBK	Previous RD, scleral buckle, PPV ×3, IOL removal	Previous PPV	RD	Pupilloplasty, anterior vitrectomy	
G	Failed PKP	Previous PKP and ACIOL, PAS	Unknown	Unknown	IOL exchange, anterior vitrectomy, synechiolysis	
H	Failed DSAEK	GDD	Prior vitrectomy	Unknown	Trim of GDD, PPV,	CME (preexistent)
I	FED	Dropped lens into vitreous, Sulcus IOL	Previous PPV	Phaco complication		
J	FED	Previous RD, PAS, glaucoma	Previous PPV	RD	Synechiolysis	
K	FED	Amblyopia, corneal scarring	Previous anterior vitrectomy	Phaco complication		
L	PBK	ACIOL, GDD	Intraoperative PPV	As part of IOL exchange	IOL exchange, PPV	CME
M	PBK	GDD, IOL removal	Previous PPV	RD	TS-IOL, iris repair, DMEK fell into vitreous cavity, DMEK aborted	
N	Failed DSAEK	Aniridia, aphakia, GDD	Previous PPV	Related to previous surgeries		

*Patients DA and DB are the same patient. DA refers to the patient's first DMEK, and DB refers to the patient's second DMEK.

ACIOL, anterior chamber intraocular lens; CME, cystoid macular edema; FED, fuchs endothelial dystrophy; GDD, glaucoma drainage device; PAS, peripheral anterior synechiae; PBK, pseudophakic bullous keratopathy; PCR = posterior capsular rupture; PKP, penetrating keratoplasty; PPV, pars plana vitrectomy; RD, retinal detachment; TS-IOL, transscleral IOL.

20/170, $P = 0.01$, n = 11), and 24 months (1.01 ± 0.68 logMAR, mean Snellen 20/200 $P = 0.046$, n = 7).

Average donor age was 66.1 ± 5.5 years. Preoperative graft ECC was 2739 ± 161 cells/mm2. ECC significantly decreased during the postoperative period, with a 51.95% cell loss at 6 months and 1 year ($P = 0.001$) and a 61.17% cell loss at 2 years ($P = 0.0004$).

DISCUSSION

The challenges that a vitrectomized eye poses for lamellar transplantation apply to both DMEK and DSAEK. Although the issue of graft unfolding is unique to DMEK, the difficulties in adequately pressurizing the eye with air also apply to DSAEK when considering vitrectomized eyes. Multiple approaches have been reported in the literature to aid with DSAEK attachment in such vitrectomized eyes.[8–10] Titiyal et al[8] reported on a case of an aphakic vitrectomized patient in whom a similar pars plana infusion technique, to the one we describe here, was successfully implemented. Other approaches have included the use of a transcorneal suture and a novel graft insertion device.[9,10]

Multiple studies have reported on the additional challenges of DMEK in vitrectomized eyes, given the extra difficulty of graft unfolding. Yoeruek et al[11] looked at the results of 20 vitrectomized eyes of patients who underwent DMEK and compared them with the results of a larger series of DMEK in nonvitrectomized eyes. Their study had a mean follow-up of 11.2 months and concluded that although DMEK in vitrectomized eyes has the potential to restore visual function, complication rates were higher than those in standard DMEK eyes. Thirteen of the 20 eyes were noted to have had "significant intraoperative complications."[11]

Yoeruek and Bartz-Schmidt[12] went on to publish a novel technique to obviate some of the difficulties they had encountered with DMEK in vitrectomized eyes. Yoeruek invented a hydrophilic methacrylate sheet to be inserted into the anterior chamber to create a double anterior chamber of sorts. The hydrophilic sheet was used to create a double anterior chamber, and the DMEK graft was injected into the anterior chamber on top of this diaphragm, which allowed for improved globe stability and thus easier unfolding. Hayashi and Kobayashi[13] reported on a different strategy called the double-bubble technique in which pressurization and unfolding were aided by injecting both a small bubble on top of the graft and a larger bubble inferior to the graft.

Our group had previously reported on the short-term results of using a pars plana infusion to aid in DMEK for

vitrectomized eyes.[4] Use of this infusion helps stabilize the globe to prevent the collapse of the less sturdy vitrectomized eye. The infusion also maintains posterior pressure that pushes the iris-lens diaphragm anteriorly and consequently shallows the anterior chamber as needed for graft unfolding.

Our results indicate that use of a pars plana infusion may indeed help facilitate DMEK surgery in vitrectomized eyes and make it a viable procedure. As expected, complications were encountered, with 4 eyes needing repeat bubbling in the clinic and one eye needing repeat DMEK almost immediately. In the long term, however, only 2 of the grafts were noted to have failed by 24 months and required repeat surgery.

Nonetheless, the rate of retinal complications in our cohort was concerningly high. Given this alone, such vitrectomized eyes may be better served by undergoing DSAEK, for which several alternatives (outlined in the Introduction) have been described to deal with the issue of pressurization related to vitrectomy. In addition, although our series is too small to make definitive conclusions, it also suggests that eyes with previous anterior vitrectomy versus PPV may be at higher risk of retinal detachment after DMEK. Thus, careful retinal evaluation both preoperatively and postoperatively should be performed, with perhaps extra caution in such cases with previous anterior vitrectomy.

Furthermore, although visual acuity might ultimately be superior if DMEK is employed, it is important to realize that these complicated eyes often have reduced visual potential given other comorbidities, which were common in our cohort. DSAEK would likely still result in some visual improvement and would likely reduce the degree of retinal complications encountered in our study.

Although DMEK is technically viable in these challenging vitrectomized eyes, DSAEK likely represents the preferred option. A comparative study between DSAEK and DMEK in vitrectomized eyes would be helpful in establishing further clarity.

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