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ORIGINAL RESEARCH

Clinical Outcomes of Descemet Membrane Endothelial Keratoplasty in Saudi Patients

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Purpose: Descemet membrane endothelial keratoplasty (DMEK) is a well-known surgical procedure for managing corneal endothelial diseases. However, the applicability of DMEK across different populations remains unclear. This study aimed to evaluate the outcomes of DMEK in patients from Saudi Arabia and compare them with international standards.

Patients and Methods: This retrospective record review evaluated the medical records of 12 patients who underwent DMEK at King Abdulaziz University Hospital from October 2022 to December 2023. Postoperative outcomes, including best-corrected visual acuity, intraocular pressure (IOP), graft attachment, and rates of rejection and re-bubbling, were evaluated at the 1-month follow-up visit.

Results: Of the 12 patients, 10 were included in the final analysis (mean age, 65.5 ± 8.69 years; men, n = 3, 30%; women, n = 7, 70%). The most common indications for DMEK were pseudophakic bullous keratopathy (50%) and Fuchs' endothelial corneal dystrophy (40%). Postoperatively, the median best-corrected visual acuity improved significantly from 0.5 (range, 0.5–1) to 0.1 (range, 0.1–0.3) (P = 0.039). The median IOP remained stable, with no significant change observed postoperatively. None of the patients experienced graft rejection or failure; however, 20% required re-bubbling. The mean central corneal thickness significantly decreased from 676 ± 103.71 µm preoperatively to 506.2 ± 27.57 µm postoperatively (P < 0.001).

Conclusion: This study demonstrated that DMEK provides effective visual improvement with low complication rates in patients from Saudi Arabia, comparable to the findings obtained in international studies. These findings may encourage wider adoption of DMEK among corneal surgeons in Saudi Arabia.

Keywords: graft attachment, Saudi Arabia, DMEK

Introduction

Endothelial keratoplasty is the standard-of-care procedure for all endothelial corneal diseases. Descemet membrane endothelial keratoplasty (DMEK) has recently become a well-known surgical procedure for managing corneal endothelial diseases, including Fuchs' endothelial corneal dystrophy (FECD) and pseudophakic bullous keratopathy (PBK).[1]

DMEK involves replacing the Descemet membrane and endothelium with a thin graft from the donor's cornea. A graft measuring 10–15 µm in thickness, which consists of endothelium and Descemet membrane, is used for this procedure.[2] DMEK is preferred over standard corneal transplantation procedures because of the rapid rate of visual recovery and superior visual potential with lower rejection rates.[3] Furthermore, the risk of immunological rejection with DMEK is lower than that with previous keratoplasty techniques, and graft rejection is not as common.[4,5] Therefore, DMEK provides superior long-term results.

In addition to the growing body of evidence supporting the efficacy of DMEK in the management of corneal endothelial diseases, recent studies have revealed its superiority over other techniques such as ultra-thin Descemet stripping automated endothelial keratoplasty (DSAEK), particularly in cases of FECD.[6,7]

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Despite the growing evidence of the efficacy of DMEK, its applicability in different populations has not yet been assessed. Specifically, studies evaluating the outcomes of DMEK in the Saudi population are lacking. We present the first series of DMEK surgeries in patients with Saudi Arabia, with the aim of evaluating the outcomes of DMEK surgery in these patients and comparing them with international standards.

Patients and Methods

Patients and Study Design

This retrospective record review was conducted from October 2022 to December 2023 at King Abdulaziz University Hospital (KAUH), a tertiary center in Jeddah, Saudi Arabia. The medical records of 12 patients who underwent DMEK performed by a single surgeon between December 2021 and March 2023 and were followed up for at least 6 months after surgery were reviewed. The study followed the principles outlined in the declaration of Helsinki and was approved by the Biomedical Research Ethics Committee at King Abdulaziz University, Jeddah, Saudi Arabia (Ref 145–23). Patient charts were reviewed solely for research purposes. Researchers were committed to maintaining the confidentiality and privacy of all patient information throughout the study. All patient data remained confidential and no personally identifiable information were disclosed or used outside the scope of this study.

Data Collection

Postoperative outcomes were evaluated at the 6-month follow-up visit. Several factors were analyzed, including the best-corrected visual acuity before and after DMEK, indications for the procedure, episodes of rejection, graft detachment, the re-bubbling rate, and the need for reoperation. Additional data were collected, including patient demographic characteristics, history of chronic diseases, preoperative lens status (phakic, pseudophakic or aphakic), associated procedures, past ocular history (including other ocular procedures), preoperative and postoperative slit-lamp examination findings, preoperative and postoperative intraocular pressure (IOP), and preoperative corneal thickness and cell density, which were assessed using specular microscopy. Information regarding donor age, corneal characteristics, and endothelial cell density was also retrieved.

Surgical Technique

All procedures were performed by a single corneal surgeon (M.S) using preloaded DMEK donor tissue stored in corneal preservation solution (Optisol; Bausch & Lomb, Rochester, NY, USA). White-to-white measurements were recorded, and the descemetorhexis area on the corneal surface was marked using calipers. A 2.2-mm beveled temporal clear corneal incision was created, along with 2.1-mm paracenteses at the 2- and 10-o'clock positions.

For triple procedures (DMEK, phacoemulsification [phaco], and intraocular lens [IOL] implantation), the anterior chamber was filled with viscoelastic, and phaco was performed first. After IOL implantation, the Descemet membrane under viscoelastic was stripped using a reverse Sinskey hook to create a central bare stromal bed. Irrigation and aspiration were performed to remove the viscoelastic, ensuring that no remnants adhered to the corneal stroma. When DMEK surgery was performed alone, an anterior chamber maintainer was placed inferotemporally to stabilize the chamber, and a descemetorhexis measuring 0.25 mm larger than the graft size was performed.

After removing the recipient Descemet membrane, trypan blue stain (VisionBlue; DORC International, Zuidland, the Netherlands) was injected into the anterior chamber to confirm the removal of residual Descemet membrane. The infusion was turned on and off, as needed, to control the depth of the anterior chamber, and acetylcholine chloride 1% (Miochol E; Bausch & Lomb) was used to constrict the pupil to ≤3 mm. While maintaining a shallow anterior chamber, an 8.0-mm donor Descemet membrane was carefully introduced into the anterior chamber through a clear corneal incision while avoiding overpressurization. The anterior chamber pressure was adjusted by releasing fluid through a paracentesis, and the injector was withdrawn with the bevel facing downward to prevent wound gaping. The anterior chamber maintainer was then removed, and the tapping technique was used to unfold and position the graft.

Air was injected into the anterior chamber through a paracentesis to secure the graft. Balanced salt solution was added to reduce the size of the air bubble to a diameter slightly larger than that of the graft (approximately 9–10 mm). Corneal

wounds were sutured using 10–0 nylon, as required. No peripheral iridectomy was performed in any of the cases. Cyclopentolate hydrochloride 1% (MINIMS Cyc 1.0; Chauvin Pharmaceuticals, London, UK) and phenylephrine hydrochloride 2.5% (MINIMS PHNL 2.5; Chauvin Pharmaceuticals) were administered to dilate the pupil and prevent pupillary block. The patients remained supine for 2 h before undergoing examinations under the slit lamp. In cases where the anterior chambers were fully filled with air, sufficient air was released via a paracentesis to clear the inferior pupil, and the remaining air bubble was left to self-absorb. Patients were advised to remain in a supine position as long as possible until the following morning. All surgeries were performed as day procedures, and the patients were discharged after the 2-h follow-up examination. Patients were assessed the following day to ensure the DMEK graft was properly attached and that the IOP was within normal limits.

Statistical Analyses

Continuous, normally distributed data were reported as mean ± standard deviation. Non-normally distributed data are reported as median (range), and related groups were compared using the Wilcoxon rank-sum test. Categorical variables were expressed as numbers and percentages. Associations were evaluated using Spearman's rank correlation coefficients. Statistical significance was set at $P < 0.05$. Statistical analyses were performed using SPSS version 25 for Windows (IBM Corp., Armonk, NY, USA).

Results

Demographic Characteristics of the Included Patients

Of the 12 patients who underwent DMEK surgery, two were excluded because of missing data; thus, 10 patients were finally included in this study. The average age of the patients was 65.5 ± 8.69 years; seven (70%) patients were women and three (30%) were men. Eight (80%) patients had a pseudophakic lens status and two (20%) had a phakic lens status. Two (20%) patients had a history of cystoid macular edema, two (20%) had undergone cataract surgery, two (20%) had previous peripheral anterior synechiae, and one (10%) had age-related macular degeneration. Four (40%) patients had hypertension, and three (30%) had diabetes mellitus (Table 1).

Surgery-Related Data

Of the 10 patients, five (50%) had PBK, four (40%) had FECD, and one (10%) had undergone a failed DSAEK. The right side was operated in seven (70%) patients, whereas the left side was operated in the remaining three (30%) patients.

Preoperative Measurements

The median IOP of the operated eye was 16.5 mmHg (range, 9–18 mmHg), whereas the median corneal thickness was 664 μm (range, 497–827 μm). Specular microscopy showed a median corneal endothelium thickness of 674 μm (range, 263–827 μm). The mean age of the donor patients was 64.75 ± 8.38 years, and the median endothelial cell density of the donors was 2928 cells (range, 548–3205 cells) (Table 2).

Outcomes of DMEK

All patients underwent DMEK surgery. Of the included patients, six (60%) underwent DMEK alone, two (20%) underwent DMEK+phaco+IOL, one (10%) underwent DMEK+iridoplasty+synechiolysis, and one (10%) patient underwent DMEK+synechiolysis (Table 3). All patients had an attached DMEK graft on postoperative day 1. The median IOP was 17.5 [range, 10–52] mmHg at 6 months. None of the patients experienced rejection episodes, and two (20%) required re-bubbling. None of the patients experienced graft failure or required reoperation. The median visual acuity improved from 0.5 logMAR (range, 0.5–1.0 logMAR) preoperatively to 0.1 logMAR (range, 0.1–0.3 logMAR) postoperatively ($P = 0.039$). The mean corneal thickness was significantly lower postoperatively (506.2 ± 27.57 μm) than that measured preoperatively (676 ± 103.71 μm; $P < 0.001$). No statistically significant difference was found between the preoperative and postoperative IOP measurements. Two (20%) patients experienced re-bubbling (Table 3). Surgery-related data and postoperative outcomes for the different types of surgery are presented in Table 3.

Table 1 Patient Characteristics and Outcomes

Age (Years)	Sex	Side	Hypertension	Diabetes	Preop Lens Status	Preop BCVA (logMAR)	Preop IOP (mmHg)	Preop Corneal Thickness (μm)	Surgery	Donor's age (age)	Postop BCVA (logMAR) at 6 months	Postop IOP (mmHg) at 6 months	Postop corneal thickness (μm) at 6 months
67	Male	Left	Yes	Yes	Pseudophakic	1.00	18	664	DMEK +synechiolysis	62	0.10	18	544
69	Female	Right	No	No	Pseudophakic	2.00	11	827	DMEK	56	0.40	17	496
73	Female	Right	No	Yes	Pseudophakic	0.60	15	662	DMEK +iridoplasty +synechiolysis	76	0.30	17	495
65	Female	Right	No	No	Pseudophakic	0.50	9	656	DMEK	64	0.20	10	539
53	Male	Right	No	No	Phakic	0.50	11	544	DMEK +phaco/IOL	65	0.00	12	504
77	Female	Left	No	No	Pseudophakic	1.00	7	602	DMEK	77	0.30	10	458
57	Female	Right	No	No	Pseudophakic	0.50	12	843	DMEK	52	0.1	11	512
83	Female	Right	Yes	Yes	Pseudophakic	1.2	9	657	DMEK	58	0.30	14	534
83	Male	Right	Yes	No	Phakic	0.40	9	755	DMEK +phaco/IOL	58	0.10	11	505
69	Female	Left	Yes	No	Pseudophakic	0.30	18	550	DMEK	58	0.10	13	475

Abbreviations: Preop, preoperative; BCVA, best-corrected visual acuity; IOP, intraocular pressure; Postop, postoperative; DMEK, Descemet membrane endothelial keratoplasty; phaco, phacoemulsification; IOL, intraocular lens implantation.

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Table 2 Preoperative Measurements (n = 10)

Preoperative Measurements			
Intraocular pressure (mmHg)		16.5 [9–18]	
Central corneal thickness (μm)		664 [497–827]	
Corneal endothelium thickness (μm)		674 [263–827]	
Donor age (years)		64.75±8.38	
Endothelial cell density of donor (cell count)		2928 [548–3205]	
Comparison of preoperative and postoperative measurements			
Variable	**Preoperative**	**Postoperative**	**P-value**
Visual acuity (logMAR)	0.5 [0.5–1]	0.1 [0.1–0.3]	0.039
Intraocular pressure	16.5 [9–18]	17.5 [10–52]	0.176
Central corneal thickness	676±103.71	506.2±27.57	<0.001

Notes: Values are presented as median [range] or mean ± standard deviation.

Table 3 Surgery-Related Data and Outcomes (n = 10)

Type of Surgery	
DMEK alone	6 (60)
DMEK+phaco+IOL	2 (20)
DMEK+iridoplasty+synechiolysis	1 (10)
DMEK+synechiolysis	1 (10)
Postoperative outcomes on day 1	
Attached cornea	10 (100)
Postoperative outcomes at 6 months	
Intraocular pressure	17.5 [10–52]
Episodes of rejection	0 (0)
Re-bubbling rate	2 (20)
Graft failure	0 (0)
Need for regrafting	0 (0)

Notes: Values are presented as n (%) or median [range].
Abbreviations: DMEK, Descemet membrane endothelial keratoplasty; phaco, phacoemulsification; IOL, intraocular lens.

The rate of graft detachment did not show a statistically significant correlation with the use of DMEK alone or DMEK combined with other procedures.

Discussion

Over the last decade, endothelial keratoplasty has emerged as the preferred treatment for endothelial diseases.[8] DMEK results in more rapid and superior visual recovery with lower rejection rates in comparison with previous methods; thus, it has become an attractive therapeutic option for endothelial corneal disorders.[7,9,10] Several studies worldwide have

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reported the results of DMEK surgery among their patients.[11,12] The current study reports the results of DMEK surgery performed on 10 patients in Saudi Arabia by the same surgeon.

At the postoperative follow-up, the median visual acuity improved to 0.1 logMAR (range, 0.1–0.3 logMAR), which is consistent with the outcomes of previous studies. For instance, Rodríguez-Calvo-de-Mora et al[12] reported a large case series of patients who underwent DMEK and found that the median visual acuity was 0.1 logMAR. Conversely, Showail et al[11] reported a median visual acuity of 0.3 logMAR.

In the present study, the IOP readings obtained before and after surgery did not differ significantly (P = 0.176). During the 6-month follow-up period, none of the patients experienced a high IOP, but they did not undergo prophylactic peripheral iridotomy (PI) or use anti-glaucoma drops. The results of our study support the findings of several previous studies that assessed DMEK procedures where PI was not performed either before or during surgery (PI-less DMEK). In PI-less DMEK, the pupil must be dilated at the end of the surgery, and all patients have to be checked at 2 h post-operatively to ensure the air is above the inferior edge of the dilated pupil to prevent pupillary block. Previous investigations concluded that PI-less DMEK was a safe, easy-to-use, and effective modification that saves time and reduces complications associated with PI.[13–15] Our study confirmed that this modified procedure can also be used for the Saudi population.

In the current study, no patient experienced graft rejection, graft failure, or the need for regrafting. In the study by Showail et al,[11] primary graft failure occurred in 15 eyes, 13 patients underwent repeat DMEK, and three patients experienced acute graft rejection. Meanwhile, in the study by Melles et al,[8] the incidence of partial graft detachment was 15.8%. Moreover, 26 eyes required another intervention within the first 6 months, 15 underwent re-bubbling, and 11 underwent repeat DMEK or DSAEK.

Twenty percent of the patients included in the present study required re-bubbling after DMEK, which is consistent with the findings of previous studies. In a case series reported by Showail et al,[11] the total re-bubbling rate was 15.4%, whereas Guerra et al[16] reported a 33% re-bubbling rate among their patients. In the study by Dunker et al[17] 19% of the patients experienced re-bubbling, and these patients had a significantly greater rate of graft failure.

Six patients in our study underwent DMEK alone, two underwent DMEK+phaco+IOL, one underwent DMEK +iridoplasty+synechiolysis, and one underwent DMEK+synechiolysis. On the first postoperative day, all patients had attached corneas. Graft detachment did not significantly correlate with the use of DMEK alone or in combination with other surgeries. However, earlier studies have yielded inconsistent results. For example, a study by Kladny et al[18] found that the eyes of patients who underwent triple DMEK had higher rates of graft detachment and re-bubbling. In contrast, a study by Heinzelmann et al[19] found no differences in these rates between patients who underwent DMEK alone and those who underwent triple DMEK.

In our study, the mean postoperative central corneal thickness (CCT) was significantly lower than the preoperative value (P < 0.001). This is consistent with the findings of a study by Lockington et al,[20] which reported a significant 23.4% reduction in the CCT at 3 months postoperatively, which is an expected outcome of successful DMEK. This result is further supported by Jens et al,[21] who demonstrated a substantial postoperative decrease in both stromal and total corneal thicknesses.

Our study had some limitations. One of the biggest limitations was the small sample size. However, our outcomes were comparable to those of previously published studies involving large international cohorts. Unfortunately, the DMEK procedure is not popular in Saudi Arabia and has not been widely adopted by many surgeons owing to a lack of experience.[22] We hope that the results of our study will encourage more surgeons to adopt the DMEK technique for their patients in Saudi Arabia.

Conclusion

We reported the outcomes of the first consecutive series of DMEK cases at a single center in Saudi Arabia. To the best of our knowledge, this is the first study to examine the outcomes of DMEK in patients from Saudi Arabia. We have highlighted and described the outcomes of patients from Saudi Arabia who underwent DMEK. The findings of this study may encourage local corneal surgeons to adopt DMEK as a standard surgical technique for endothelial keratoplasty.

Abbreviations

CCT, central corneal thickness; DMEK, Descemet membrane endothelial keratoplasty; DSAEK, Descemet stripping automated endothelial keratoplasty; FECD, Fuchs' endothelial corneal dystrophy; IOP, intraocular pressure; KAUH, King Abdulaziz University Hospital; PBK, pseudophakic bullous keratopathy; PI, peripheral iridotomy.

Ethics Approval and Informed Consent

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and was approved by the Research Ethics Committee of KAUH (Ref: 145-23). Informed patient consent was not required owing to the retrospective nature of the study.

Disclosure

The authors report no conflicts of interest related to this work.

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