Original Article

Descemet's Membrane Endothelial Keratoplasty and Phacoemulsification: Combined versus Sequential Surgery

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Abstract

Purpose: To compare the outcomes of Descemet's membrane endothelial keratoplasty (DMEK) combined with phacoemulsification versus DMEK following phacoemulsification.

Methods: In this interventional retrospective comparative nonrandomized case series study, patients with Fuchs endothelial corneal dystrophy (FECD) with either cataract or previous cataract surgery with intraocular lens (IOL) implantation were assigned to one of the two groups according to lens status. Group 1 included patients who had cataract and FECD and would undergo triple procedure (phacoemulsification with IOL implantation and DMEK), whereas Group 2 included patients who had FECD and had phacoemulsification with IOL implantation earlier and would undergo DMEK only as a sequential procedure.

Results: Postoperative best corrected visual acuity (BCVA) in both groups at 1 week, 1 month, 3 months, and 6 months revealed a statistically nonsignificant difference between the two groups with mean logMAR BCVA at 6 months of 0.07 ± 0.18 and 0.07 ± 0.19 in Group 1 and Group 2, respectively ($P > 0.05$). The drop in endothelial cell density by the end of the 6th postoperative month was by 39.44% ±7.92 and 38.73% ±8.10 in the triple-procedure group and DMEK only group, respectively ($P = 0.005$). Total postoperative complications rate and the rebubbling rate were statistically similar between both groups with 13.5% and 12.5% rebubbling rate in Group 1 and Group 2, respectively ($P > 0.05$).

Conclusion: Visual outcomes, endothelial cell loss, and rebubbling rate are comparable when DMEK is combined with phacoemulsification or when it is performed as staged procedure, without statistically significant difference in the outcomes.

Keywords: Combined phacoemulsification Descemet's membrane endothelial keratoplasty, Descemet's membrane endothelial keratoplasty, Fuchs endothelial corneal dystrophy

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Introduction

Descemet's membrane endothelial keratoplasty (DMEK) is increasingly becoming the procedure of choice for treating corneal decompensation secondary to corneal endothelial pathology.[1-3] Despite the steep learning curve, DMEK has proven advantageous over other keratoplasty techniques.[4,5]

As many patients may present with cataract and Fuchs endothelial corneal dystrophy (FECD), proper management of both conditions is crucial to achieve satisfactory outcomes. Performing DMEK as a sequential surgery following cataract extraction could be of value in early cases of FECD.[6] Nevertheless, combining DMEK with cataract surgery could provide a faster visual recovery for patients with more advanced FECD.[7]

The role of triple procedure (endothelial keratoplasty combined with cataract extraction) to address endothelial dysfunction with coexisting cataract has been studied with resultant

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rapid visual rehabilitation, predictable refractive outcomes, convenience, and cost-effectiveness of a one-stage procedure, without increased risk of postoperative complications.[8] However, triple procedure could be technically challenging when compared with sequential surgery. In addition, a new study reported less endothelial cell loss with sequential DMEK surgery when compared to triple procedure.[3]

The aim of the study was to evaluate the outcome of both techniques and compare this outcome to investigate if one technique is superior to another.

Methods

This was an interventional retrospective comparative case series study of patients with FECD with either cataract or previous cataract surgery with posterior intraocular lens (IOL) implantation who were admitted at Alexandria University Hospital and completed 6 months of follow-up between January 2018 and January 2020 and met the inclusion criteria of the study.

Inclusion criteria were patients with FECD with cataract or pseudophakia and evidence of corneal decompensation as manifested by the presence of clinical corneal edema and drop in visual acuity corresponding to the corneal condition. Exclusion criteria were previous corneal surgery, corneal scaring or vascularization, glaucoma, posterior segment pathology, and previous intraocular surgery apart from cataract surgery in pseudophakic patients.

Patients were assigned to one of the two groups according to lens status. Group 1 included patients who had cataract and FECD and who would undergo combined procedure (phacoemulsification with IOL implantation and DMEK) (combined PhacoDMEK group), whereas Group 2 included patients who had FECD and had phacoemulsification with IOL implantation earlier and would undergo DMEK only as a sequential procedure (staged PhacoDMEK group).

All patients underwent a complete ophthalmologic examination before and following the procedure which included best corrected visual acuity (BCVA), biomicroscopic slit-lamp examination, fundus examination, intraocular pressure (IOP) evaluation, and central corneal thickness (CCT) measurement, Zeiss IOL Master® (Carl Zeiss AG, Oberkochen, Germany) to evaluate the axial length and anterior chamber depth (ACD), and biometry.

The study follows the Declaration of Helsinki and was approved by the Alexandria University Ethics Committee. All patients read and signed informed consent document for the surgical procedure as well as for inclusion in the study. The surgeries were performed by four different corneal surgeons with different levels of experience. One was a fellow performing the surgeries under full, consultant supervision, and the rest were consultants.

The procedure in both groups started with DMEK graft tissue preparation using submerged cornea using background away technique.[9] The procedure was done under general anesthesia or sub-Tenon's block in both groups according to surgeon and patients' preference. Patients in Group 1 with cataract had their cataract removed first with standard phacoemulsification technique after pupil dilation using tropicamide 1% (Mydracyl®, Alcon Eye Care Ltd) and phenylephrine 2.5% (Falcon Pharmaceuticals Ltd., Alcon Laboratories Inc., Fort Worth, Texas). Cyclopentolate to dilate the pupil was avoided as in our experience; it makes the pupil stubborn to respond to miotic agents, making graft manipulating difficult over wide pupil with instability of iris lens diaphragm. Cohesive viscoelastic was used as it is easier to remove from the eye. Following cataract extraction, hydrophobic IOL was injected. This was followed by complete meticulous viscoelastic washout before inserting the graft into the eye. Intracameral acetylcholine (Miochol-E; Novartis, Stein, Switzerland) was used at the conclusion of cataract surgery to achieve pupillary constriction.

In both groups, a main incision was made with 2.8 mm keratome in addition to two side ports. An inferior peripheral iridectomy (PI) was made with the aid of a vitreous cutter to prevent future pupillary block. This was followed by descemetorhexis which was done under balanced salt solution cover in Group 2 or cohesive viscoelastic in Group 1 patients with the aid of a reverse Sinskey hook (Bausch and Lomb Surgical, St. Louis, MO, USA) and completed with Descemet scraper (Geuder AG, Heidelberg, Germany). Air injection into the anterior chamber was used to highlight any retained recipient Descemet's membrane.

The graft was loaded into a glass injector (Geuder AG, Heidelberg, Germany), adopting a nontouch underwater technique. Before inserting the graft tissue, correct orientation of the graft tissue was ensured by examination of the tissue while inside the injector under the microscope with tilting and rotating the injector. Once the graft was inside the eye, it was centralized and unfolded. When the graft was in a satisfactory position and unfolded, the anterior chamber was filled completely with air through one of the side ports. Then, the patient was advised to keep the supine position for 24 h.

All patients received topical moxifloxacin eye drops four times per day (QDS) for 2 weeks and 1% dexamethasone eye drops QDS for 3 months, then gradually tapered. All patients were examined 2 h following the surgery with the slit-lamp to check the size of the air bubble, graft attachment, measure the IOP, and exclude presence of pupillary block. This was followed by the 1st day postoperative same checks, in addition to anterior segment optical coherence tomography (OCT) scans (Heidelberg Engineering GmbH, Heidelberg, Germany) which were used to ensure graft attachment. In case of complete air fill covering the inferior PI, partial air release from the anterior chamber via one of the side ports was performed with Rycroft 30 G cannula after application of proxymetacaine 0.5% and povidone iodine 5%. Graft detachment was classified according to the need for rebubbling and the percentage of area

of detachment. For detachments which involved the visual axis or involved 30% and more of the graft area, rebubbling was indicated, while graft detachments which was peripheral and involved <30% of the graft area were observed. These patients' follow-up visits were changed to be every week till complete graft attachment was ensured. For patients who had DMEK graft detachment more than 30% or involving the visual axis, rebubbling was done on slit-lamp with the help of 30 G cannula (Rycroft) connected to 1 ml air-filled syringe after instillation of topical minims proxymetacaine 0.5% eye drops 0.5 ml unit dose (Bausch and Lomb UK Ltd) and minims povidone iodine 5% (Bausch and Lomb UK Ltd).

Follow-up visits were scheduled 1 week, 1 month, 3 months, and 6 months postoperatively. In these visits, BCVA with Snellen (converted to logMAR for statistical analysis) and macula OCT scans (Heidelberg Engineering, Heidelberg, Germany) were done routinely at the 4th postoperative week. CCT measurement and endothelial cell density (ECD) were evaluated with specular microscopy (CBD/Tomey EM-3000, Phoenix, AZ, USA).

Specular microscopy examination was done by a single examiner to evaluate the ECD taking the average of three measurements. The patient was positioned correctly with the chin placed on the chin rest and forehead rested against the forehead rest. The patient was instructed to fixate on the red target inside the device until the instrument automatically took a clear image of the corneal endothelium. In addition, complete slit-lamp examination and IOP monitoring was done with recording of any complications.

All outcome measures were tested for normality. Descriptive statistics for normally distributed variables were reported as mean values and standard deviation. The median and range were reported for variables that were not normally distributed. Data analysis was done using SAS software (Version 9.1; SAS Inc, Cary, NC). Statistically significant *P* value was at $P \leq 0.05$.

Results

This study was conducted on 77 eyes of 77 patients who attended the Ophthalmology Department Outpatient Clinic at Alexandria Main University from January 2018 to January 2020 and met the inclusion criteria.

Patients were assigned to one of the two groups according to lens status. Group 1 (combined PhacoDMEK) included 37 eyes of 37 patients, whereas Group 2 (staged PhacoDMEK) included 40 eyes of 40 patients. Age range in the studied patients was between 40 years and 91 years, with a mean of 60.05 ± 8.19 and 63.38 ± 8.62 in Group 1 and Group 2, respectively ($P > 0.05$). Table 1 demonstrates the demographic patients data.

There was an improvement in the mean logMAR BCVA in both groups starting from the 1st postoperative week. The improvement in logMAR BCVA was statistically significant in both groups at 1 month, 3 months, and 6 months of follow-up ($P < 0.001$) with no statistically significant difference between both groups by the end of the 6th postoperative month. Figure 1 demonstrates change in logMAR BCVA overtime.

Refractive outcome in terms of the mean diopter (D) spherical equivalent by the end of the follow-up visit was +0.42 D ± 0.58 and +0.55 D ± 0.48 in combined procedure and in staged DMEK group, respectively. No significant difference was found between the two groups by the end of the 6th postoperative month ($P = 0.288$). One patient from Group 1 and two patients from Group 2 were excluded from this analysis due to inability to get autorefractor measures because of corneal edema caused by primary graft failure.

There was statistically significant reduction in CCT in both groups postoperatively ($P < 0.001$) with mean CCT measurements of 542.7 ± 11.87 and 534.71 ± 8.61 in Group 1 and Group 2, respectively, by the end of the 6th postoperative month. Patients with primary graft failure were excluded from 6-month postoperative thickness analysis. Figure 2 shows changes in corneal thickness overtime.

The age of corneal graft donors in the two groups was not statistically significantly different between them with an age range from 37 to 74 years old in the triple-procedure group and a mean of 59.16 ± 8.50 years. However, in the other group, the age range was between 44 and 72 years with a mean age 60.93 ± 6.89 years. The donor ECD ranged from 2400 to 3100 cells/mm^2 in the combined procedure group with a mean of 2701.2 ± 164.0 cells/mm^3, whereas in the staged DMEK group, the range was between 2500 and 3000 cells/mm^3 with a mean of 2671.8 ± 132.5 cells/mm^3 ($P = 0.005$). The difference in ECD between both groups was not statistically significant after exclusion of patients with primary graft failure. By the end of the 6th postoperative month, ECD was down by 39.44% ± 7.92 and 38.73% ± 8.10 in Group 1 and Group 2, respectively. Figure 3 depicts percentage of endothelial cell loss at different follow-up periods.

Intraoperative complications took place in one patient in Group 1 in the form of graft extrusion during graft insertion. The graft was reloaded again into the injector and inserted into the eye. The total postoperative complications rate was quite similar in both groups with a 21.6% in Group 1 and 25% in Group 2 ($P = 0.792$). Table 2 shows comparison between the two studied groups according to postoperative complications rate.

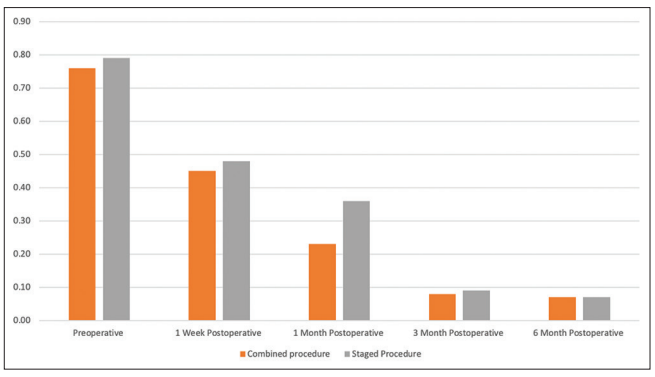

Figure 1: Change in logMAR best corrected visual acuity overtime

There were no graft rejections episodes noticed during the initial 6 months of follow-up period. Primary graft failure was noticed in one eye in Group 1, and it was defined as failure of the corneal edema to clear from the 1st operative day. This patient had rebubbling for graft detachment three times at 1 week, 10 days, and 14 days, postoperatively. Despite the attachment of the graft after the third rebubbling, the cornea failed to clear, and diagnosis of primary graft failure was made, and a schedule for a redoDMEK was done by the third operative month. On the other hand, the DMEK only group had two patients diagnosed with a primary graft failure. One of them presented with graft detachment and needed rebubbling at 1 week and another rebubbling at 2 weeks postoperatively. In the other patient, despite having the graft attached from the 1st postoperative day, the cornea failed to clear. In both patients, a diagnosis of primary graft failure was made, and both were scheduled for a redo endothelial keratoplasty. Graft failure rate did not show a statistically significant difference between the two groups ($P > 0.05$).

The amount of air left in the anterior chamber on the 1st postoperative day was between 25% and 90% in Group 1 and between 20% and 80% in Group 2 ($P = 0.157$), and no cases of pupillary block took place.

Overall graft detachment rate was more or less identical in both groups with 13.5% and 12.5% rebubbling rate in Group 1 and Group 2, respectively. Three patients in each group needed

Table 1: Demographic data and patients characteristics

	Group 1 ($n=37$), n (%)	Group 2 ($n=40$), n (%)	Test of significant	P
Sex				
Male	19 (51.4)	18 (45.0)	χ^2=0.311	0.577
Female	18 (48.6)	22 (55.0)		
Age (years)				
Minimum-maximum	44.0-81.0	46.0-91.0	t=1.730	0.088
Mean±SD	60.05±8.19	63.38±8.62		
Median	62.0	62.0		
Axial length (μm)				
Minimum-maximum	21.0-28.70	21.20-27.80	t=0.707	0.561
Mean±SD	23.31±1.60	23.06±1.45		
Median	23.0	22.60		
Anterior chamber depth (mm)				
Minimum-maximum	2.60-3.40	2.60-3.40	t=0.524	0.602
Mean±SD	3.02±0.21	3.0±0.19		
Median	3.0	3.0		
Biometry (diopters)				
Minimum-maximum	10.0-25.0	7.0-26.0	t=0.354	0.724
Mean±SD	21.19±2.98	20.89±4.32		
Median	21.50	22.0		

*Statistically significant at $P \leq 0.05$. *T*: Student *t*-test, *P*: *P* for comparing between the studied groups, SD: Standard deviation, $\chi 2$: Chi square test

Table 2: Comparison between the two studied groups according to postoperative complications

Complications	Group 1 ($n=37$), n (%)	Group 2 ($n=40$), n (%)	χ^2	P
Steroid response/glaucoma	0	1 (2.5)	0.937	1.000 (FE)
Persistent epithelial defect	0	1 (2.5)	0.937	1.000 (FE)
Cystoid macular edema	2 (5.4)	1 (2.5)	0.433	0.605 (FE)
Pupillary block	0	0	-	-
Rejection	0	0	-	-
Primary failure	1 (2.7)	2 (5.0)	0.271	1.000 (FE)
Graft detachment				
30% and more (requiring rebubbling)	5 (13.5)	5 (12.5)	0.017	1.000 (FE)
Peripheral<30%	4 (10.8)	6 (15.0)	0.298	0.739 (FE)
Rebubbling	5 (13.5)	5 (12.5)	0.017	1.000 (FE)
1 rebubble	3 (8.1)	3 (7.5)	0.010	1.000 (FE)
2 rebubble	1 (2.7)	2 (5.0)	0.271	1.000 (FE)
3 rebubble	1 (2.7)	0	1.095	0.481 (FE)
Total complications rate	8 (21.6)	10 (25.0)	0.122	0.792

P: *P* for comparing between the studied groups, FE: Fisher's exact, $\chi 2$: Chi square test

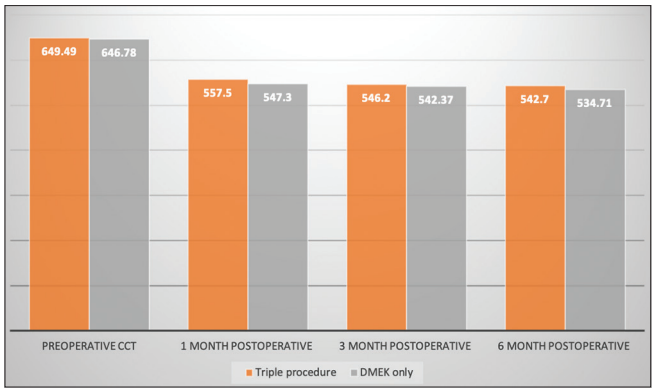

Figure 2: Change in corneal thickness overtime

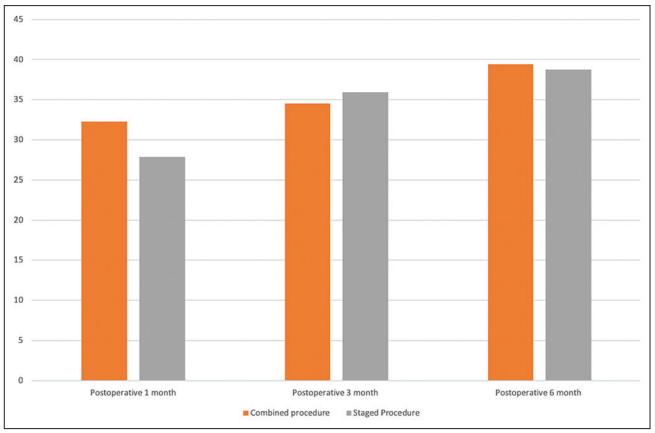

Figure 3: Percentage of endothelial cell loss at different follow-up periods

air rebubbling one time, while two rebubblings were required for one patient and for two patients in the triple-procedure group and DMEK only group, respectively. Peripheral graft detachments with an area of <30% were noticed in four patients in group one and six patients in group two. All these patients had their grafts attached without a need for rebubbling.

Only one patient in Group 2 developed steroid response high IOP which was noticed by the end of the 1st postoperative month. It was managed by shifting the patient to fluorometholone eye drops QDS instead of dexamethasone eye drops and addition of latanoprost eye drops once at bed time.

A patient in Group 2 developed persistent epithelial defect (PED). This patient was managed by debridement of the loose corneal epithelium, preservative free lubricating drops (hydroxymethyl cellulose), and a bandage contact lens. Complete healing took place after 2 weeks of treatment.

Cystoid macular edema (CME) developed in two patients in Group 1 and in one patient in Group 2. These patients were diagnosed with macular OCT scans at their 1st postoperative month visit, and they were put on Ketorolac eye drops TDS for 6 weeks in addition to their usual regimen of dexamethasone eye drops. CME resolved in all patients with this treatment.

Discussion

DMEK is gradually replacing Descemet stripping endothelial keratoplasty (DSEK) and penetrating keratoplasty (PK) in the management of corneal decompensation secondary to corneal endothelial dysfunction.[2,3] Cataract surgery in patients with FECD can accelerate or lead to immediate postoperative corneal decompensation, making DMEK combined with cataract surgery a reliable surgical treatment option especially for patients with advanced FECD.[6,7]

However, there are several challenges when performing DMEK combined with cataract surgery as compared with staged surgery, which may make some surgeons consider sequential surgery rather than combined procedure. First, scoring of the recipient endothelium in staged procedure in pseudophakic eyes is usually done under air without the use of viscoelastic which is used in triple procedure. The use of viscoelastic could lead to graft detachment and/or graft/host interface haze.[10] Second, ACD fluctuation is more pronounced in combined procedure, which may make graft unfolding and centration difficult or lead to more damage to the endothelial cells due to instability of the inserted IOL.[5] Third, IOL calcification has been reported with various corneal transplant procedures, including DSEK and DMEK with a weak correlation to pupil size and the area of calcification.[11] Accordingly, pupil dilation in triple procedure may be correlated with larger area of IOL calcification when compared to DMEK alone.[12]

For these reasons, some surgeons may prefer to perform cataract surgery before DMEK to avoid these challenges. Furthermore, it could avoid the patient the immediate need of a corneal graft if corneal decompensation does not ensue following cataract surgery.[13] On the other hand, there is growing evidence of the safety and good outcome of performing cataract surgery following DMEK, which may be advantageous in terms of accurate biometry calculation and allowing young phakic patients to retain their accommodation for a long period before having their cataract surgery done.[14]

The main concern with proceeding with endothelial keratoplasty alone in a patient with insignificant cataract is the acceleration of cataract formation, which was reported to be as high as 76% at the end of 1 year in a single study.[15,16]

This study shows a comparable good outcome of combining cataract surgery with DMEK without any associated increased risk of complications when compared with staged procedure. In this study, the tissues used for transplantation were obtained from donors with comparable age in the two groups to avoid any difference that could affect either graft preparation or graft survival during the follow-up when comparing both groups. The donors' age in our study was similar to the donors' age of corneal tissue in Godin *et al*.'s study and Bennett *et al*.'s study.[17,18]

Fast visual rehabilitation and rapid improvement in visual acuity are one of the biggest advantages of DMEK surgery over DSEK and PK.[4] It was found that visual outcomes in both

groups were nonsignificantly different as both groups showed steady significant improvement in BCVA during follow-up visits. The improvement in visual acuity in both groups was identical to previous reports. In one study conducted by Chaurasia *et al*., they found that at 6 months postoperatively, the median corrected distance visual acuity was 20/25 in single-DMEK procedure group and 20/20 in triple-DMEK group.[5] In another recent study, average decimal BCVA has improved to 0.91 in DMEK-only and 1.01 in triple-DMEK groups with no statistically significant difference by the end of 1 year postoperatively.[3]

Mild hyperopic shift following endothelial keratoplasty is one of the previously reported refractive changes following the surgery secondary to the decreased swelling in the posterior stroma and an associated steepening of the posterior corneal curvature.[19] In our study, both groups showed hyperopic shift with a mean spherical equivalent of +0.42 ± 0.58 and +0.55 ± 0.48 in the triple procedure and in the DMEK only group, respectively. This is similar to Ham *et al*. who reported a mean hyperopic shift of +0.32 D ± 1.01 D at 6 months following DMEK surgeries on 50 eyes.[19]

Improvement of corneal edema and reduction of corneal thickness is one of the parameters used to evaluate endothelial function and graft success.[3,20] In our study, both groups showed statistically significant reduction in CCT by the end of the 6th postoperative month. All patients in both groups showed significant clearance of the corneal edema except patients who were diagnosed with primary graft failure.

Endothelial cell loss is one of the main factors determining graft survival, and it can be accelerated with more graft manipulation during the surgery or prolonged surgical time.[21] In our study, endothelial cell loss does not differ significantly between both groups, and there was no statistically significant difference between both groups. The change in ECD is similar to a previous study by Chaurasia *et al*. who described median endothelial cell loss of 27% versus 26% at 3 months and 27% versus 25% at 6 months in single-procedure group and combined group, respectively.[5] The percentage of endothelial cell loss agrees with another study, which showed 39% endothelial cell loss at 6 months.[6] However, in a recent study comparing the two procedures, it was found that there was significantly less endothelial cell loss after the DMEK-only procedure in pseudophakic eyes compared with triple-DMEK in patients with FECD at 1-month and 1-year follow-up.[3] They explained this finding to the more anterior chamber manipulation and the pronounced postoperative inflammation after combined surgery when compared to DMEK-only. In our experience, manipulation of the graft could be the main factor which led to endothelial cell loss, and this could be related mainly to surgeon experience rather than the procedure itself. In our study, graft manipulation and surgical technique adapted when performing both procedures was quite identical with the exception of the extra step of cataract surgery preceding the standard DMEK surgery.

Total postoperative complication rate was quite similar between both groups with 21.6% in Group 1 and 25% in Group 2. There was one case of graft tissue extrusion during insertion in Group 1. This patient had normal postoperative course without evidence of graft failure or detachment. This low incidence of intraoperative complications is similar to a retrospective multicenter case series of 431 eyes that underwent DMEK by 18 different surgeons. In a study conducted by Monnereau *et al*., they reported 1.7% incidence of intraoperative complications which included difficulties in insertion, positioning, unfolding of the graft, and small anterior chamber bleed.[22] In addition, other previous studies have proven that combined PhacoDMEK does not impose higher risk of complications as compared to single-staged DMEK surgery.[3,5]

Primary graft failure was noticed in 2.7% of Group 1 patients, and it was defined as failure of the corneal edema to clear from the 1st operative day. On the other hand, the DMEK-only group had 5% of patients diagnosed with a primary graft failure. In case of primary graft failure in DMEK, upside down graft should always be considered. Another important cause is graft manipulation and increased surgical time.[1] In our study, we routinely mark our grafts excluding the possibility of incorrect orientation of the DMEK scroll. The graft failure rate was similar to that previously reported in Chaurasia *et al*.'s study with a rate of 3.1% in the single-procedure group and 3.5% in the triple-procedure group.[5] In a recent retrospective case series study comparing DMEK in pseudophakic eyes as a single procedure versus when combined with cataract surgery in patients with cataract and endothelial dysfunction, there was no cases of graft failure identified during the 1st year postoperative follow-up.[3]

One of the most common complications of DMEK surgery is graft dislocation or detachment. Certain factors can contribute to increase this risk, such as retained viscoelastic, fibrin release, and hyphema.[23] In our study, the overall graft detachment rate was more or less identical in both groups. Meticulous anterior chamber irrigation and washout of viscoelastic and fibrin from the anterior chamber was ensured before inserting the graft, and this could be the reason that both groups have identical average rate. Chaurasia *et al*. reported similar rebubbling rate in both groups (30% and 29%).[5] However, a recent study documented much less graft detachment with only 2.9% and 2.5% graft detachment rate in the DMEK-only and triple-DMEK groups, respectively. The low incidence rate of graft detachment in this study was attributed to the use of intraoperative OCT and suturing of all surgical wounds.[3]

Low incidence of graft rejection is one of the major advantages of DMEK. In this study and during the first 6-month follow-up period, there were no reports of graft rejection in either group, which is consistent with previous studies' findings.[5,22]

CME is one of the complications of any intraocular surgery.[24] In our study, CME took place in 5.4% of patients in the triple-procedure group and 2.5% of patients in the

single-procedure group. This finding is slightly higher than the rate Chaurasia *et al*. reported, which was 1% in the single-procedure group and 1.5% incidence in the other group.[5] Another study reported 2% incidence of CME in 50 case series.[25]

Steroid response is one of the common side effects of steroid drops; however, the incidence does not seem to be high following DMEK surgery. In a multicenter study looking into the outcomes of 18 DMEK surgeons, the incidence of secondary glaucoma in this study was 2.8%, and about half of this percentage was attributed to the use of steroids drops.[22] This is consistent with our finding in the current study as the incidence was 2.5% in the DMEK-only group, while there were no cases of steroid responsiveness in the other group, yet the difference between both groups was not significant. Other studies reported higher incidence of increased IOP with one study reporting 13% and 10% incidence in the staged procedure group and combined procedure group, respectively.[5] This difference in the incidence could be attributed to the nature of studied groups and strength, frequency, period of steroid drops used, and presence of preoperative glaucoma.

There was one reported case of PED in the single-stage group (2.5%), which is similar to Monnereau *et al*.'s findings, which reported a rate of epithelial defects and/or erosion of 3% in their study.[22] This finding could be related to toxicity due to drop use and/or the associated inflammation following the surgery.

Pupillary block is a devastating potential complication following DMEK surgery, which is related to the anterior chamber air fill. It can lead to irreversible optic nerve damage due to high IOP. In our study, there were no reported cases of pupillary block following the procedure in any of the groups, which is attributed to routine PI performed during the procedure and careful postoperative examination to ensure patency of the PI.[26,27] This agrees with a retrospective study conducted in 2016, which reviewed 368 eyes following their DMEK surgeries.[28] Furthermore, Price *et al*. reported no cases of pupillary block glaucoma in their prospective multicenter study.[25]

The main limitations of this study are the limited 6-month follow-up of the patients. In addition, the time between cataract surgery and phacoemulsification was not looked at, which could have given some insight about the time window between cataract surgery and corneal decompensation following the surgery. Due to retrospective nature of the inclusion of pseudophakic patients into the DMEK-only group, matching of the patients based on the firmness of the nucleus, presence or absence of pseudoexfoliation, and other factors related to cataract has not been done. Moreover, the surgeries were not performed by a single surgeon. Some of the DMEK procedures were performed by a fellow under supervision of experienced consultants at the beginning of a learning curve, which could have affected the results.

In conclusion, DMEK, when combined with cataract surgery, has similar outcomes and the same complications rate as DMEK in pseudophakic eyes. Combined procedure could provide a rapid visual rehabilitation for patients presenting with corneal endothelium dysfunction and cataract without any significant increased risk of complications or less favorable outcome.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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