

Preferred practice pattern for Descemet membrane endothelial keratoplasty surgeries: A survey of Indian corneal surgeons

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Purpose: This study aims to assess the preferred surgical technique of Descemet membrane endothelial keratoplasty (DMEK) among corneal surgeons in India, and barriers in performing DMEK surgeries amongst the non-DMEK surgeons. **Methods:** An online, questionnaire-based, cross-sectional survey was conducted among members of the Cornea Society of India (CSI) ($n = 500$). Responses on their surgical experience, preferred technique, complications, and outcome of DMEK were collected and analyzed. Barriers in performing DMEK surgeries were assessed amongst the non-DMEK surgeons. **Results:** A total of 100 responses were obtained and response rate for the survey was 20%. DMEK was performed by 55% of the participants of whom only 40% had formal training in this technique. Surgical video-based learning was the most often used self-training method for others. Lack of training was the most common reason for not performing DMEK by the non-DMEK surgeons. Descemet stripping endothelial keratoplasty (DSEK) was the most common endothelial keratoplasty (EK) performed by both DMEK and non-DMEK surgeons. High volume (>50 cases) DMEK surgeries were reported by limited surgeons ($n = 6$). Nearly all the DMEK surgeons prepared the donor tissue by themselves on the day of the surgery, and majority felt that unrolling the graft in the anterior chamber was the most difficult surgical step. Nearly 80% of the DMEK surgeons were more comfortable with DSEK or Descemet stripping automated endothelial keratoplasty (DSAEK) when compared to DMEK. **Conclusion:** DMEK practice in India needs improvement with increased accessibility to DMEK training programs, wet lab facilities, and better support from eye banks.

Key words: Corneal surgeons, descemet membrane endothelial keratoplasty, DMEK, endothelial keratoplasty, keratoplasty

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Endothelial keratoplasty (EK) has seen a rapid evolution ever since its introduction in the mid-1950s by Charles Tillet.^[1,2] The technique of EK has advanced from posterior lamellar keratoplasty (PLK) to deep lamellar endothelial keratoplasty (DLEK), Descemet stripping endothelial keratoplasty (DSEK), Descemet stripping automated endothelial keratoplasty (DSAEK), Descemet membrane endothelial keratoplasty (DMEK), and pre-Descemet endothelial keratoplasty (PDEK).^[1,2] According to the various reports, DSEK/DSAEK and DMEK are the most commonly performed EKs.^[3] Reports from the Eye Bank Association of America and German keratoplasty registry report (2018) have revealed a constantly rising trend of DMEK surgeries.^[3,4] However, the world over, DSEK/DSAEK remains the most commonly performed EK. A steep learning curve, difficult surgical technique, a deficit of suitable donor tissue, and apprehension of postoperative complications are some of the reasons for the slow uptake of DMEK despite its described advantages over DSEK/DSAEK.^[5-10]

Several steps of DMEK are considered technically challenging. These include preparation of DMEK roll, inserting graft in anterior chamber, unfolding the DMEK roll, and

obtaining the correct orientation.^[5-7] With a limited number of fellowship programs for DMEK, the training of surgeons is often difficult.^[5,6,11] Learning through alternative methods like attending live surgery demonstrations, practicing in a wet lab facility, assisting a trained DMEK surgeon, or being assisted in the initial cases by a senior colleague, and surgical video-based learning have been described in the literature.^[5-7,12,13] Koo *et al.*^[7] surveyed cornea surgeons based in the United States (US) who had started DMEK surgery within the last two years. The results highlighted the importance of mentorship and guidance of an experienced surgeon during the first few cases to reduce the rate of primary graft failure. Varadaraj *et al.*^[6] conducted a similar study and described the preferences for DMEK surgery among US surgeons.

Various corneal surgeons have independently described their surgical technique of DMEK and its long-term outcome; however, limited literature is available on the corneal surgeons' preferred surgical practice pattern for DMEK.^[8,14,15] Varadaraj and Koo *et al.* reported the experience of DMEK surgeons in the US, and results from elsewhere are limited.^[6,7] In India, there are

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limited opportunities for formal training programs for DMEK, a deficit of good quality donor corneas, and a limited number of cases suitable for DMEK due to delays in presentation. Hence, it is expected that the learning experience of DMEK surgeons and their preferred surgical practice pattern may be different when compared to other developed countries. In the current study, a survey was conducted among members of the Cornea Society of India (CSI) to estimate the number of surgeons performing DMEK and gather information regarding their DMEK training, experience, preoperative case selection, surgical technique, and postoperative complications and its management. Questions were also directed to the non-DMEK surgeons to understand the barriers in performing DMEK and methods to facilitate the adoption of this technique.

Methods

A questionnaire-based, cross-sectional study was conducted among members of the CSI after approval from the institutional review board. The study adhered to the tenets of the Declaration of Helsinki.

A 33-question survey was developed using the SurveyMonkey website (Supplementary Content 1) after validation by three experts in the field of keratoplasty. The questions pertained to the surgeon's experience in keratoplasty, method of DMEK training, the experience of DMEK surgeries, preoperative case selection, donor tissue selection, preferred surgical technique for DMEK, postoperative complications, and challenges with DMEK. Various questions were directed toward specific surgical steps of DMEK. The questionnaire was pilot tested on 20 participants who had proficiency in the English language. The questionnaire was revised based on the findings of the pilot study.

A link to the validated questionnaire was emailed to all the cor-net group members, which is the official interactive forum for members of the Cornea Society of India. The email requested that the survey participants should be corneal surgeons based in India (Supplementary Content 2). The unique response link allowed completing the survey only once. The responses were collected, and data were exported to an Excel sheet. Statistical analysis was performed using SPSS software.

Results

Participant characteristics

A total of 500 cornea specialists were contacted through email, of which 100 responded (response rate of 20%). The majority of the participating ophthalmologists worked in a hospital setup (61%) while 39% worked in a private setup. [Table 1] The area of practice for 98% of participant cornea specialists was urban-suburban and only 2% were working in rural areas. The reported experience of performing keratoplasties was variable. One-third had an experience of >10 years, 45% of 5–10 years, and 22% of <5 years. Penetrating keratoplasty had been the most commonly performed procedure by the participant cornea specialist (Weighted average (WA) = 2.93) followed by the DSEK/DSAEK, anterior lamellar keratoplasty, and DMEK. Of the 100 participating cornea specialists, 55% ($n = 55$) stated that they performed DMEK. On the Chi-squared test, greater duration of experience (>10 years) of performing keratoplasties did not have a significant association with the surgeon performing or not performing DMEK ($P = 0.0998$). On enquiring about the type of EK performed by the participants,

DSEK (WA = 2.13) was the most common procedure followed by DSAEK (WA = 1.24) and DMEK (WA = 1.04). Of the 55 DMEK surgeons, only 7.6% and 4.4% stated that it comprised 25%–50% and >50% of all their cases undergoing EK, respectively.

DMEK training

Only 40% of the surgeons who performed DMEK had received formal training or fellowship in DMEK surgery. The rest reported surgical video-based learning (54.6%) and wet lab training (18.2%) as important methods of self-training [Table 2]. Overall, a lack of formal training was the most common cause described by surgeons for not performing DMEK (48.9%). However, interestingly, one-third (31.3%) of the participating surgeons who had received training in DMEK did not perform this surgery. They stated anxiety related to donor cornea insertion or achieving correct orientation (30%) and donor cornea preparation (20%) as the major concerns for this inhibition. The majority of surgeons who did not perform DMEK suggested that short-term surgical training under an experienced surgeon (68.9%) would help perform DMEK while others felt wet lab training (13.3%) and assistance from senior surgeon trained in DMEK (13.3%) would be helpful in initiating DMEK surgery in their practice.

DMEK experience

Among the surgeons who performed DMEK ($n = 55$), 63.6% ($n = 35/55$) reported an experience of <2 years in performing this technique and only 12.7% ($n = 7/55$) had >5 years of experience [Table 2]. A total of 43.6% of surgeons who performed DMEK reported performing <10 DMEK surgeries in a year. A high volume of DMEK surgeries (>50 cases/year) were reported by only six surgeons in this survey while a high volume of DSEK/DSAEK/Ultra-thin (UT) DSAEK was reported by 12 surgeons. On enquiring about the total number of DMEK surgeries performed, 16.4% of the surgeons ($n = 9/55$) who performed DMEK reported an experience of >50 surgeries with only seven surgeons having an experience of >100 surgeries.

DMEK donor tissue selection

A majority (40.7%) of DMEK surgeons felt that the lower limit of donor age in DMEK should be 50 years [Table 3]. On enquiring about the preferred upper limit for donor age, a majority (29.6%) reported 70 years. However, out of six experienced surgeons (>50 DMEK surgeries and >5 years of DMEK experience), three suggested 80 years as the upper limit while one suggested that age does not matter. Donor endothelial cell density (ECD) cutoff of 2500 cells/mm² was preferred by the majority (40%, $n = 22/55$) followed by 2200 cells/mm² [Table 3].

DMEK case selection

When asked about the patient exclusion criteria for DMEK, a majority (69.1%) reported corneal decompensation with ACIOL/SFIOL/aphakia as an exclusion criterion [Table 4]. For cases presenting with corneal decompensation and coexistent cataract, 74.6% of surgeons ($n = 41/55$) performing DMEK preferred combined procedure (DMEK Triple) while 16.4% ($n = 9/55$) preferred staged procedure.

DMEK surgical technique

Donor tissue preparation

A majority of DMEK surgeons (94.6%, $n = 52/55$) preferred to prepare their donor corneas in the operation theatre [Table 4].

Table 1: Characteristics of Participating Cornea Surgeons

Demographic Variables	All Surgeons (n=100)	DMEK Surgeons (n=55)	Non-DMEK Surgeons (n=45)	P
Practice setup n (%)				0.99*
Hospital with teaching college	32 (32%)	18 (32.7%)	14 (31.1%)	
Hospital not attached to teaching college	25 (25%)	13 (23.6%)	12 (26.7%)	
Solo practice	22 (22%)	12 (21.8%)	10 (22.2%)	
Group practice	17 (17%)	9 (16.4%)	8 (17.8%)	
Others	4 (4%)	3 (5.5%)	1 (2.2%)	
Location of practice n (%)				0.2*
Urban	83 (83%)	47 (85.4%)	36 (80%)	
Suburban	15 (15%)	8 (14.6%)	7 (15.6%)	
Rural	2 (2%)	0 (0%)	2 (4.4%)	
Keratoplasty experience (years) n (%)				0.2*
<5	22 (22%)	9 (16.4%)	13 (28.9%)	
5-10	45 (45%)	24 (43.6%)	21 (46.7%)	
11-20	22 (22%)	16 (29.1%)	6 (13.3%)	
>20	11 (11%)	6 (10.9%)	5 (11.1%)	
Type of keratoplasty performed (WA)				
PKP	2.93	3.22	2.58	
ALK/DALK	1.77	2.02	1.47	
DSEK/DSAEK/UTDSAEK	2.15	2.46	1.72	
DMEK	1.49	1.72	1.10	
PDEK	1.04	1.00	1.07	
KPro	1.10	1.16	1.03	
Proportion of EK (WA)				
DSEK	2.13	2.21	2.02	
DSAEK/UTDSAEK	1.24	1.19	1.29	
DMEK	1.04	1.62	0.26	
PDEK	0.12	0.15	0.13	

WA - Weighted average; PKP - Penetrating keratoplasty; ALK - Anterior lamellar keratoplasty; DALK - Deep anterior lamellar keratoplasty; DSEK - Descemet stripping endothelial keratoplasty; DSAEK - Descemet stripping automated endothelial keratoplasty; UTDSAEK; DMEK - Descemet membrane endothelial keratoplasty; PDEK - Pre-Descemet endothelial keratoplasty; KPro - Keratoprosthesis. * Chi-squared test

Nearly all surgeons who prepared the donor tissue themselves preferred to prepare the tissue on the day of the surgery ($n = 54/55$). Among these surgeons who prepared the tissue on the same day, two-thirds ($n = 36/54$) prepared the DMEK roll before the surgery while one-third ($n = 18/54$) prepared it during the surgery. On enquiring about the preferred time taken to stain the DMEK roll, 36.4% of DMEK surgeons ($n = 20/55$) reported one minute. This was followed by 2 minutes (29.1%, $n = 16/55$), 30 seconds (20%, $n = 11/55$) and >2 minutes (14.6%, $n = 8/55$). The majority of DMEK surgeons (69.1%, $n = 38/55$) preferred an 8-mm size for DMEK graft followed by 7.5 mm (25.5%, $n = 14/55$). Only three surgeons reported the use of 8.5-mm graft size in their surgeries. None of the surgeons used graft sizes of <7.5 mm or >8.5 mm.

Host preparation

When enquired about the host Descemet membrane endothelium complex stripping, 56.4% of DMEK surgeons ($n = 31/55$) opined on performing this step under an ophthalmic viscoelastic device (OVD) while 43.6% ($n = 24/55$) opined on performing this step under air. The majority of DMEK surgeons reported performing descemetorrhesis with a size greater than that of the graft (70.9%, $n = 39/55$) while 23.4% of surgeons ($n = 13/55$) preferred the same size descemetorrhesis as that of the graft. On the contrary, three surgeons preferred descemetorrhesis size smaller than the graft. On enquiring, if peripheral iridotomy (PI) was performed in all cases of DMEK, 90.9% of DMEK surgeons ($n = 50/55$) reported in favor of PI. When asked about

the method used for PI, 92.7% of the DMEK surgeons ($n = 51/55$) performed an intraoperative PI while 7.3% ($n = 4/55$) performed a preoperative laser PI. Vitrector (45.5%) and Vannas scissors (41.8%) was used for making an intraoperative surgical PI by a majority of the DMEK surgeons.

Graft Insertion and Tamponade

Indigenous injectors (IOL cartridge attached to a syringe) were used for the DMEK roll insertion by approximately half of the DMEK surgeons (52.7%, $n = 29/55$). Others reported the use of Geuder Glass Injector (29.1%), Modified Jones Tube (10.9%), and glass pipette (7.3%). On enquiring about the agent for tamponade after graft insertion, the majority of DMEK surgeons reported the use of air (94.6%, $n = 52/55$). Only three surgeons reported that they used iso-expansile concentration of SF6 for tamponade after graft insertion.

Postoperative complications

A graft detachment rate of <10% was stated by approximately two-third (65.5%) of the DMEK surgeons while 14.5% stated a graft detachment rate of >25%. Only three surgeons reported >50% graft detachment rate. On being asked about the management of cases that developed partial graft detachment following DMEK, the majority of DMEK surgeons informed re-bubbling with air (52.7%, $n = 29/55$) but nearly one-third of surgeons (34.5%, $n = 19/55$) preferred to observe. Iso-expansile gas for re-bubbling was used by only 12.7% of DMEK surgeons (20% SF6-3.6%; 14% C3F8-9.1%). On enquiring about

the management of cases that developed postoperative total graft detachment, approximately two-third answered that they preferred to re-bubble the graft (65.5%, $n = 36/55$). However, nearly one-third of DMEK surgeons (34.5%) informed that they preferred to proceed directly for re-graft (immediate re-graft - 23.6%; Re-graft after 3–4 weeks - 10.9%).

Challenges with DMEK

The most challenging step of DMEK perceived by the surgeons was unrolling of the DMEK graft in the anterior chamber (58.2%, $n = 32/55$). This was followed by achieving correct orientation of the graft (23.6%, $n = 13/55$), DMEK roll preparation (12.7%, $n = 7/55$), and DMEK roll insertion in the anterior chamber (5.5%, $n = 3/55$). The perceived difficulties by DMEK surgeons in various steps of DMEK have been expressed in terms of difficulty severity scale in Fig. 1. Unfolding the DMEK graft was found to be very difficult by 16.4%, moderately difficult by 47.3%, and little difficult by 30.9% of the DMEK surgeons.

When asked about their comfort in performing DMEK compared to DSAEK, the majority of surgeons reported that they were more comfortable in performing DSAEK/DSEK, while 10.9% described equal comfort levels with both the procedures. Only five surgeons (9.1%) stated being more comfortable with DMEK when compared to DSEK/DSAEK.

Discussion

DMEK as a technique for EK has gained immense popularity among cornea surgeons during the last decade. Comparative studies between DSAEK/UTDSAEK and DMEK have shown better results with DMEK.^[10] However, various surgeons show hesitancy in shifting from DSAEK to DMEK. The lack of formal training programs, steep learning curve, risk of donor tissue damage, and postoperative complications in DMEK are some of the reasons for this hesitancy.^[6,7] In addition, a lot of variabilities have been observed in the surgical technique of DMEK from surgeon to surgeon.^[14–16] The current study aims to assess the barriers in performing DMEK, suggest methods to resolve and analyze the preferred techniques of DMEK amongst corneal surgeons in India.

In the current study, a total of 100 responses were obtained from the cornea specialists of India. Of the 100 participants, 55% performed DMEK. Another survey-based study conducted among cornea surgeons ($n = 118$) in the US reported that 59% of cornea specialists ($n = 70$) performed DMEK.^[6] Hence, the proportion of cornea specialists performing DMEK appears to be similar in India when compared to the US. However, a similar study from Canada suggested that 78% of their cornea specialists performed DMEK.^[11]

In our study, DSEK was the most performed EK by both non-DMEK as well as DMEK performing surgeons. Only 12% of the cornea surgeons who performed DMEK reported that DMEK constituted >25% of their total EKs. It is important to note that even though the majority of participating surgeons (83.6%; $n = 46$) had keratoplasty experience of >5 years, only a small subset of DMEK surgeons reported an experience in DMEK of >5 years duration (12.7%; $n = 7$) or performing >50 cases of DMEK (16.3%; $n = 9$). Hence, although many surgeons in India perform DMEK, DSEK is still the most performed type of EK and the list of experienced DMEK surgeons is limited.

In contrast, over one-third of the DMEK surgeons in the US have >10 years of experience in DMEK, suggesting that the uptake of this technique in the US was relatively early.^[6] This is also attributed to the fact that in our country, the indications for keratoplasty are different, and the cases who require full thickness graft far outnumber the cases which require EK.

In the current study, lack of formal training was the most common reported cause by cornea surgeons for not performing DMEK, and a short-term surgical training under an experienced surgeon would be most helpful in performing DMEK. Surgical video-based learning was the most common alternative method of learning. Limited options for formal training in DMEK have led surgeons to resort to various methods of self-training.^[12,13,17] Watching surgical videos on YouTube, wet lab-based training, and watching live surgeries in conferences can be useful and have been reported in literature for self-training.^[12,13,17]

Donor age cutoff for DMEK is still debatable.^[18–20] The majority of studies suggest that young donor tissues result in tight DMEK rolls which increases the chance of intraoperative manipulation and hence should be avoided. However, a few recent studies have shown comparable results between young

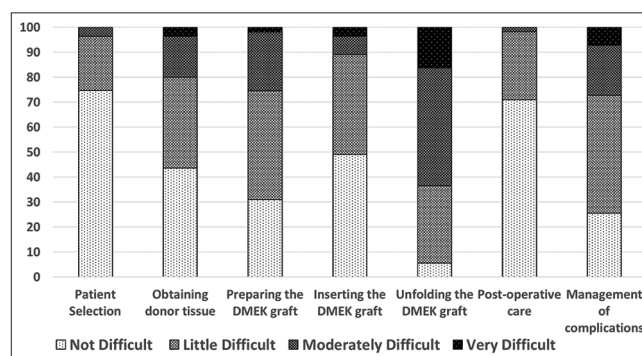


Figure 1: Surgeons' perceived difficulty severity scale for various surgical steps of DMEK

Table 2: Surgical Experience in DMEK of Participating DMEK Surgeons

	N-55
Received formal training in DMEK	
Yes	22 (40%)
No	33 (60%)
Method of learning DMEK	
Residency program	0 (0%)
Fellowship	6 (10.9%)
Short-term surgical training	9 (16.4%)
Wet lab training	14 (25.5%)
Observership	4 (7.3%)
Surgery performed under guidance of experienced surgeon	3 (5.5%)
Surgical video-based learning	18 (32.7%)
Others	1 (1.8%)
Experience of DMEK (years)	
<1	7 (12.7%)
1-2	28 (50.9%)
3-5	13 (23.6%)
6-10	4 (7.3%)
>10	3 (5.5%)

Table 3: Preferred Criteria for Donor Tissue Selection in DMEK

Donor Tissue Characteristics	Response of DMEK Surgeons (n=55) (%)
Preferred lower limit for donor age cut off (years)	
45	29.6%
50	40.7%
55	16.7%
60	9.3%
Age does not matter	3.7%
Preferred upper limit for donor age cut off (years)	
65	29.6%
70	27.8%
75	14.8%
80	12.9%
Age does not matter	14.8%
Donor endothelial cell density cut off (cells/mm ²)	
2200	27.3%
2300	9.1%
2400	23.6%
2500	40%

and old donor tissues in DMEK.^[21,22] Hill *et al.*,^[22] reported that younger donors (<50 years) exhibit similar un-scrolling time, re-bubble rate, and endothelial cell loss when compared with older donors (>70 years). In the current study, the preferred lower age limit for donor tissue was 50 years, the upper age limit was 70 years, and ECD was 2500 cells/mm². Using these cut-offs often limits the availability of donor tissue; hence there is a need to promote the use of younger and older donor tissues, especially among experienced surgeons.

DMEK donor tissue preparation requires surgical expertise. It is often a cause of apprehension, especially for novice surgeons, due to the risk of inadvertent tissue damage. Availability of pre-stripped, pre-marked, and pre-loaded donor tissue may be helpful for beginners as it reduces the apprehension involved with donor tissue preparation. Varadaraj *et al.*^[6] suggested that nearly all of the surgeons (97.1%; n = 68/70) in their study used pre-stripped/pre-punched/pre-loaded donor tissue. On the contrary, in the present study, a majority of the surgeons (94.6%, n = 52/55) in India prepare their DMEK roll in the operating room themselves. Such a difference in practice may be due to the variation in eye bank facilities available across countries. Recent studies have suggested comparable clinical outcomes with the use of pre-loaded DMEK grafts when compared with a surgeon-prepared donor graft.^[23,24] Hence, improving the eye bank standards and making pre-stripped/pre-loaded donor tissue available to surgeons may decrease the stress of graft preparation and facilitate the surgery by shortening the operating time.

In the current study, the majority of surgeons described unrolling the DMEK graft and achieving correct orientation in the anterior chamber as the most difficult step. Training in a wet lab facility using simulator models and an artificial anterior chamber with latex diaphragm has been described in the literature for practicing various techniques to complete this step successfully.^[13,17,25] Also, the majority of DMEK

Table 4: Preferred Descemet Membrane Endothelial Keratoplasty Technique

	n (%)
Patient exclusion criteria (multiple responses)	
Hazy media	26 (47.3%)
ACIOL/aphakia/SFIOL	38 (69.1%)
Operated glaucoma surgery (Trab/Tube)	29 (9.1%)
Time for staining the DMEK roll	
30 seconds	11 (20%)
1 minute	20 (36.4%)
2 minutes	16 (29.1%)
>2 minutes	8 (14.6%)
Donor Preparation	
Self-prepared in OT	52 (92.5%)
Eye bank pre-stripped tissue	1 (2.5%)
Eye bank pre-stripped and pre-trephined	1 (2.5%)
Eye bank pre-loaded tissue	1 (2.5%)
Host Descemet membrane-endothelium complex is stripped under	
Air	24 (43.6%)
OVD	31 (56.4%)
Size of descemetorrhesis	
Same as graft size	13 (23.6%)
Greater than the graft size	39 (70.9%)
Smaller than the graft size	3 (5.5%)
Size of DMEK graft (mm)	
7	0 (0%)
7.5	14 (25.5%)
8	38 (69.1%)
8.5	3 (5.5%)
>8.5	0 (0%)
PI performed in all cases	
Yes	50 (90.9%)
No	5 (9.1%)
Method for inferior PI	
Preoperative laser iridotomy	4 (7.3%)
Intraoperative PI with Vannas	23 (41.8%)
Intraoperative PI with Vitrector	25 (45.5%)
Intraoperative PI with MVR blade	3 (5.5%)
Technique for DMEK roll insertion	
Indigenous injector (IOL cartridge attached to syringe)	29 (52.7%)
Gueder glass injector	16 (29.1)
Glass pipette	4 (7.3%)
Modified Jones tube	6 (10.9%)
Tamponade agent used after graft insertion	
Air	52 (94.6%)
20% SF6	3 (5.5%)
14% C3F8	0 (0%)
Management of postoperative partial graft detachment (<1/3rd)	
Observe	19 (34.5%)
Re-bubble with air	29 (52.7%)
Re-bubble with 20% SF6	2 (3.6%)
Re-bubble with 14% C3F8	5 (9.1%)
Management of postoperative total graft detachment	
Re-graft immediately	13 (23.6%)
Re-graft after 3-4 weeks	6 (10.9%)
Re-bubble	36 (65.5%)

ACIOL - Anterior chamber intraocular lens; SFIOL - Scleral fixated intraocular lens; OVD - Ophthalmic viscoelastic device; PI - Peripheral iridotomy; IOL - Intraocular lens; SF6 - Sulphur hexa-fluoride; C3F8 - Perfluoropropane

surgeons (80%) were more comfortable with DSEK/DSAEK when compared to DMEK. In contrast, a study by Koo *et al.*^[7] reported that nearly 51% of DMEK surgeons were equally comfortable with DMEK when compared to DSEK/DSAEK. The stark difference suggests a need for improvement in the DMEK training and practice in India

The major limitations of the study include recall bias and self-selection bias, as seen in any other questionnaire-based survey. Also, the study had a low response rate and lack of information about the non-respondents. Hence, the results may not be generalized to all the cornea surgeons in India. However, the major advantage is that responses were obtained from a large section of DMEK surgeons with variable practice unlike previous studies which described the outcome from dedicated DMEK surgeons. Hence, considering the substantial number of responses received and lack of pre-existing data from this part of the world, the results of this study cannot be completely refuted.

Conclusion

To conclude, the preferred technique of DMEK surgical steps discussed in the study can help surgeons in beginning DMEK surgery. In addition, formal training programs in DMEK, provision of a wet lab training facility, and support from eye banks with pre-loaded tissues can help novice surgeons to easily transition from DSEK/DSAEK to DMEK.

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Conflicts of interest

There are no conflicts of interest.

References

- Price FW, Price MO. Evolution of endothelial keratoplasty. *Cornea* 2013;32(Suppl 1):S28-32.
- Price MO, Feng MT, Price FW. Endothelial Keratoplasty Update 2020. *Cornea* 2021;40:541-7.
- Eye Bank Association of America. 2019 Eye Banking Statistical Report. 2020.
- Flockerzi E, Maier P, Böhringer D, Reinshagen H, Kruse F, Cursiefen C, *et al.* Trends in corneal transplantation from 2001 to 2016 in Germany: A report of the DOG-section cornea and its keratoplasty registry. *Am J Ophthalmol* 2018;188:91-8.
- Zafar S, Parker JS, de Kort C, Melles G, Sikder S. Perceived difficulties and barriers to uptake of Descemet's membrane endothelial keratoplasty among surgeons. *Clin Ophthalmol* 2019;13:1055-61.
- Varadaraj V, Woreta FA, Stoeger CG, Tran KD, Jorgenson R, Srikumaran D. Surgeon preference for endothelial keratoplasty techniques. *Cornea* 2020;39:2-7.
- Koo EH, Pineda R, Afshari N, Eghrari A. Learning descemet membrane endothelial keratoplasty: A survey of U.S. corneal surgeons. *Cornea* 2020;39:590-3.
- Melles GRJ, Ong TS, Ververs B, van der Wees J. Descemet membrane endothelial keratoplasty (DMEK). *Cornea* 2006;25:987-90.
- Marques RE, Guerra PS, Sousa DC, Gonçalves AI, Quintas AM, Rodrigues W. DMEK versus DSAEK for Fuchs' endothelial dystrophy: A meta-analysis. *Eur J Ophthalmol* 2019;29:15-22.
- Singh A, Zarei-Ghanavati M, Avadhanam V, Liu C. Systematic review and meta-analysis of clinical outcomes of descemet membrane endothelial keratoplasty versus descemet stripping endothelial keratoplasty/descemet stripping automated endothelial keratoplasty. *Cornea* 2017;36:1437-43.
- Kisilevsky E, Srikumaran D, Chew HF. Surgeon preferences for endothelial keratoplasty in Canada. *Cornea* 2021;40:1420-5.
- McKee HD, Jhanji V. Learning DMEK from YouTube. *Cornea* 2017;36:1477-9.
- Fogla R, Martinez R. Artificial anterior chamber model using human donor corneas for DMEK surgical training. *Cornea* 2018;37:e17-8.
- Maharana PK, Sahay P, Titiyal JS, Sharma N. Sinsky hook assisted roll preparation (SHARP): A modified technique for Descemet membrane endothelial keratoplasty donor preparation. *Saudi J Ophthalmol* 2019;33:28-33.
- Terry MA, Straiko MD, Veldman PB, Talajic JC, VanZyl C, Sales CS, *et al.* Standardized DMEK technique: Reducing complications using prestripped tissue, novel glass injector, and sulfur hexafluoride (SF6) gas. *Cornea* 2015;34:845-52.
- Sharma N, Sahay P, Maharana PK, Kumar P, Ahsan S, Titiyal JS. Microscope integrated intraoperative optical coherence tomography-guided DMEK in corneas with poor visualization. *Clin Ophthalmol* 2020;14:643-51.
- Sáles CS, Straiko MD, Fernandez AA, Odell K, Dye PK, Tran KD. Partitioning an artificial anterior chamber with a latex diaphragm to simulate anterior and posterior segment pressure dynamics: The "DMEK Practice Stage," where surgeons can rehearse the "DMEK Dance." *Cornea* 2018;37:263-6.
- Gorovoy IR, Cui QN, Gorovoy MS. Donor tissue characteristics in preparation of DMEK grafts. *Cornea* 2014;33:683-5.
- Heinzelmann S, Hüther S, Böhringer D, Eberwein P, Reinhard T, Maier P. Influence of donor characteristics on descemet membrane endothelial keratoplasty. *Cornea* 2014;33:644-8.
- Basak SK, Basak S, Gajendragadkar N. Outcomes of descemet membrane endothelial keratoplasty using cornea from elderly donors aged 80 years and older: In the aftermath of current donor shortage. *Cornea* 2021. doi: 10.1097/ICO.0000000000002902.
- Schaub F, Enders P, Zachewicz J, Heindl LM, Stanzel TP, Cursiefen C, *et al.* Impact of donor age on descemet membrane endothelial keratoplasty outcome: Evaluation of donors aged 17-55 years. *Am J Ophthalmol* 2016;170:119-27.
- Hill JR, Chen S-Y, Bauer AJ, Straiko MMW, Sanchez PJ, Straiko MD, *et al.* Younger donor tissue in descemet membrane endothelial keratoplasty surgery: Clinical outcomes. *Cornea* 2021;40:1024-30.
- Potts LB, Bauer AJ, Xu DN, Chen S-Y, Alqudah AA, Sanchez PJ, *et al.* The last 200 surgeon-loaded descemet membrane endothelial keratoplasty tissue versus the first 200 preloaded descemet membrane endothelial keratoplasty tissue. *Cornea* 2020;39:1261-6.
- Böhm MS, Wylegala A, Leon P, Ong Tone S, Ciolino JB, Jurkunas UV. One-year clinical outcomes of preloaded descemet membrane endothelial keratoplasty versus non-preloaded descemet membrane endothelial keratoplasty. *Cornea* 2021;40:311-9.
- Vasquez Perez A, Liu C. Human ex vivo artificial anterior chamber model for practice DMEK surgery. *Cornea* 2017;36:394-7.