Transitioning from PK to DMEK in a Public Hospital in Southern Brazil: first series of 24 consecutive cases.

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Endothelial keratoplasty (EK) is probably the most exciting development in corneal transplantation since the introduction of monofilament sutures and the operating microscope. Since the advent of penetrating keratoplasty surgery more than 100 years ago, we have recognized the undesirable postoperative consequences of penetrating corneal surgery.[1] These adverse sequelae include increased high astigmatism, unpredictable refractive outcomes, prolonged visual rehabilitation and vulnerability to trauma. In cases of corneal edema from endothelial dysfunction, ophthalmologists have conceptualized the theoretical benefits of selectively transplanting only the posterior cornea with healthy endothelium. In 1950, Barraquer proposed performing lamellar transplantation of the posterior cornea in cases of corneal edema. He described a procedure in which he trephined just the posterior central cornea after manually dissecting a rectangular flap similar to that used in Laser-Assisted In Situ Keratomileusis (LASIK). Ultimately a corresponding round lenticule of donor posterior corneal tissue containing healthy endothelium was transplanted into this opening.[2] Despite the outstanding idea, the results of this technique were never described and the procedure was forgotten for some decades.

In 1998 Jones and Culberston described a new procedure to transplant the corneal endothelium via an anterior approach. This time the results were described and verified that an edematous human cornea could be cleared through the transplantation of a posterior lenticule containing a healthy corneal endothelium.[3]

In 1998, Melles described a modification of the endothelial keratoplasty technique in which, through a posterior approach, deep stroma, Descemet's membrane and endothelium were transplanted without manipulation of the anterior cornea.[4] This technique was further enhanced with the description of descemetorrhexis of the recipient cornea, which facilitated the reproducibility of the surgery.[5] In the same way, inspired by the recently published papers on the new technique, Terry studied the procedure and contributed significantly to establishing the technique by developing several instruments that facilitated the surgery's reproducibility.[6,7] However, the manual preparation of the donor cornea was still a hindrance and, in 2006, Gorovoy introduced preparation of the lamella with an automated microkeratome, which served to popularize the technique thereby increasing the number of surgeons who could reproduce it.[8] Despite this advantage, the technique required expensive equipment including an automated microkeratome and artificial anterior chamber, creating a challenge for its implementation in areas with limited financial resources. However, in 2006, we observed a new donor cornea preparation technique that did not require expensive instrumentation and had the advantage of only removing Descemet's membrane and endothelium, thus making endothelial keratoplasty possible in places with few public resources, such as Brazil.[9] Moreover, the results were better when compared to the technique at the time.[10] After implementing the technique in 2015, we describe herein the results of our first 24 cases of DMEK performed in a public hospital in southern Brazil.

MATERIALS AND METHODS

A total of 24 consecutive DMEK eyes from 22 patients were analyzed retrospectively. The surgeries were performed at our institution between May 2015 and March 2016. Final postoperative evaluation ranged from 3 to 12 months.

DMEK tissue preparation

The corneoscleral rim is placed in a punch cutting block and a partial 9.5mm or 10mm trephination is performed.

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The endothelial side is dyed with trypan blue for 20 seconds. Under the submerged cornea using backgrounds away (SCUBA) technique with Optisol GS, the peripheral ring is manually removed and then Descemet's membrane is detached from the periphery for almost the entire circumference. After that, Descemet's is detached approximately two thirds full and then a full thickness 3mm punch is performed. Descemet's is repositioned and the corneoscleral button is turned upside down. The 3mm button is then removed and the "S" stamp marking is applied to Descemet's using a gentian blue pen. Finally, the corneoscleral button is turned upside down again and a new partial 8mm trephination is performed. The new peripheral ring is removed and the donor lamella is totally detached from the posterior stroma. The double-roll is prepared in a receptacle containing trypan blue and Optisol GS to be aspirated into the injector.

Injector preparation

We chose to use an adapted injector for the surgery; specifically, we used an intraocular lens (IOL) cartridge for the Emerald C® injector (Abbott). We cut off the tip of the cartridge and connected the cartridge to a silicone line that was plugged into a 3ml plastic syringe.

Surgical Technique

All eyes were operated on under peri-bulbar anesthesia. Before surgery, topical pilocarpine was applied in pseudophakic patients and tropicamide plus epinephrine in phakic patients who underwent combined phacoemulsification and IOL implantation. Two side ports were made; the anterior chamber filled with air, an 8.5-9.00mm descemetorhexis was then performed with a reverse Sinskey hook. A 3mm scleral tunnel incision was made at the limbus for the insertion of the graft. An inferior peripheral iridodomy was also performed. The donor Descemet's roll was stained with 0.06% trypan blue solution, aspirated into the injector manufactured as previously described, and placed into the recipient anterior chamber. The graft was then spread out over the iris, and an air bubble was injected underneath the graft to position it onto the recipient posterior cornea making sure that the "S" stamp was correctly positioned. The anterior chamber was left completely filled with air for 20 minutes, followed by an air-BSS exchange to pressurize the eye while leaving about 70% of an air bubble in the anterior chamber.

Measurements and Statistics

Patients were examined before surgery and 1, 3, 6 and 12 months after DMEK. Best spectacle-corrected visual acuity (BSVCA) and central corneal thickness were recorded.

Statistical analysis was performed using SPSS for Windows software (version 18.0, SPSS, Inc, Chicago IL). *P* values less than 0.05 were considered statistically significant.

RESULTS

We analyzed 24 eyes of 22 patients with a mean age of 73.4 ± 9 years, 72.7% of them women. The indications for keratoplasty were aphakic or pseudophakic bullous keratopathy in half of the cases and Fuchs dystrophy in the remaining cases. In 50% of cases, a simultaneous phacoemulsification with IOL implantation was performed. The "S Stamp" was utilized in all but the first 4 cases. These data are shown in Table 1.

Table 1. Patients characteristics

Age (yrs)	
Mean ± SD	73.4±9
Range	59-91
Gender	
Male, n (%)	6 (27.3%)
Female, n (%)	16 (72.7%)
Indication for keratoplasty	
Bullous keratopathy, n (%)	11(50%)
Fuchs Distrophy, n (%)	11 (50%)
Lens status (%)	
Phakic	50
Pseudophakic	50
Combined phaco surgery (%)	50%
"S" Stamp technique (%)	83%

Excluding four cases with low visual acuity potential due to macular or optic nerve disease, there was an increase in BSCVA from 0.2 ± 0.2 before surgery to 0.6 ± 0.3 postoperatively. Similarly, there was an improvement of central corneal thickness from 671 ± 81 µm preoperatively to 489 ± 17 µm postoperatively. Figure 1 shows a preoperative case with bullous keratopathy (A) and 2 months postoperative following DMEK surgery (B). Table 2 describes each case in detail and Table 3 summarizes the main results.

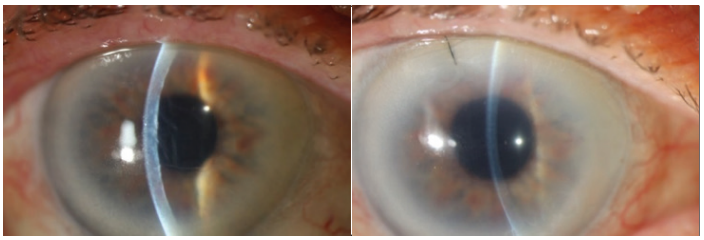

Figure 1A: *E(A) pre-operative bullous keratopathy & (B) 2-months post-DMEK*

Table 2. Description of the cases.

					Preoperative			
Patient	Gender	Age, yr	Diagnosis	Phaco-DMEK	BCVA	Reintervention	Comorbidity	Final BCVA
1	Male	77	Bullous keratophaty	No	CF	Re-bubble	Maculopathy	0.05
2	Male	91	Bullous keratophaty	No	0.1	Re-DMEK	Glaucoma	0.33
3	Female	81	Fuchs distrophy	Yes	0.4	No	No	1,0
4	Female	74	Bullous keratophaty	No	0.2	No	No	0.5
5	Male	69	Fuchs distrophy	No	0.25	No	No	0,66
6	Female	87	Bullous keratophaty	No	CF	No	Maculopathy	0,2
7	Male	77	Fuchs distrophy	Yes	0.4	Re-DMEK	No	0,8
8	Female	60	Fuchs distrophy	Yes	0.2	No	Haze by previous H-PRK	0.5
9	Female	77	Bullous keratopathy	No	CF	Re-bubble	No	0.5
10	Female	84	Bullous keratopathy	No	CF	Indicanted Re-DMEK	No	CF
11	Female	76	Fuchs distrophy	No	0.25	No	No	0.6
12	Female	78	Bullous keratopathy	Yes	CF	Re-DMEK	Previous PK	0.5
13	Female	80	Fuchs distrophy	Yes	CF	No	No	1.0
14	Female	68	Fuchs distrophy	Yes	0.2	No	No	0.8
15	Female	68	Fuchs distrophy	Yes	0.2	Re-bubble	No	0.2
16	Male	62	Bullous keratopathy	Yes	CF	PK	Descemet striae by trauma	0.33
17	Male	73	Bullous keratopathy	No	CF	No	Previous PK	1.0
18	Female	64	Fuchs distrophy	Yes	CF	Vitrectomy	Glaucoma	CF
19	Female	71	Bullous keratopathy	No	CF	No	No	CF
20	Female	59	Bullous keratopathy	No	CF	No	No	0.1
21	Female	80	Fuchs distrophy	Yes	0.5	No	No	0.5
22	Female	76	Fuchs distrophy	Yes	0.5	No	No	0.5

Table 3. Main results.

	Preoperative	Post-operative	P Value
BCVA[ǂ]	0.2±0.2	0.6±0.3	<0.05
Pachymetry (*um*)	671±81	489±17	<0.05

ǂ Cases with low visual potential were excluded.

Detachment of more than one third of the donor lenticule occurred in five cases. Three cases were re-bubbled, with a successful adherence of the lenticule in two of them, improving corneal edema. In the third case, despite the correct positioning of the donor lenticule, there was primary graft failure, and a repeat DMEK was carried out without complications. In the other two cases of premature detachment of the lenticule, it was decided to repeat DMEK because the original surgical manipulation had probably caused significant endothelial cell loss. All repeat DMEKs were performed one to two months after primary surgery. In another case, a patient with previous penetrating keratoplasty and corneal opacity, experienced primary graft failure and we decided to regraft with another penetrating keratoplasty three months later. These results are summarized in Tables 4 and 5.

Table 4. Complications.

	total (%)
Primary failure	4 (16)
>1/3 detachment	5 (20.8)

Table 5. Reintervations.

	total (%)
Re-bubble	3 (12.5)
Re-DMEK	3 (12.5)
PK	1 (4.1)

DISCUSSION

This is the first report describing a series of cases of DMEK performed in a public hospital in Brazil. In our experience, the technique proved to be an inexpensive way to restore the vision of our patients and to avoid the known risks associated with penetrating keratoplasty. Our results are consistent with other authors' series in the technical learning curve, with about 20% of donor lenticule detachment in the first cases.[11] With regards to donor cornea preparation technique, we did not use the "S stamp" technique in the first four cases. Instead, we used endoillumination technique with vitrectomy light probe to try to determine the position of the graft in the anterior chamber. After the introduction of the "S stamp" technique, determining the position of the graft was much easier, possibly resulting in better surgical outcomes. Our impression was confirmed in a study published recently by Veldman et al.[12]

For the donor lenticule insertion, we used our own fabricated injector as previously described. So far, we have not had any complications related to using this device, with the significant advantage of no additional costs to the procedure. A technique for creating a similar injector has been described and, likewise, its use did not cause complications.[13] Some specific DMEK injectors have already been created, and good results regarding endothelial cell safety have been described. However, since they are single-use devices incurring higher cost, we are prevented from using them in our public institution.[14,15]

COST ANALYSIS

In our institution, the advent of DMEK was a unique opportunity to offer endothelial keratoplasty to our patients. Considering our financial constraints, the high cost for the acquisition of a microkeratome or even a single-use artificial anterior chamber, prevented us from performing DSEK or DSAEK. Thus, we were compelled to skip directly from performing penetrating keratoplasty to DMEK, which was a great challenge. Table 6 describes the investment we made to perform DMEK and compared it to the expense we would incur performing DSAEK. It is worth noting that to perform DMEK, we simply needed to add to our penetrating keratoplasty tray a reverse Sinskey hook and an "S" stamp marker, which were purchased with the surgeons' own resources. It is amazing to think that by applying the innovative ideas of brilliant ophthalmologists together with the most minimal of added costs, we could improve our management of corneal endothelial disease.

Table 6. Cost comparison between DSAEK and DMEK.

	Microkeratome Artificial anterior chamber (Moria, France)	Pachymeter (PachPen, PA, USA)	Inverted Sinskey (Odous, Brazil)	"S" Marker (Moria, France)	3mm punch (Paramount, India)
DSAEK	$70.000	$2500	$20	Not necessary	Not necessary
DMEK	Not necessary	Not necessary	$20	$250	$6

CONCLUSION

We found that the DMEK surgical procedure could be reliably performed in a public hospital in southern Brazil where DSAEK procedures were not an option due to the high cost of required equipment. Despite the learning curve and the more challenging surgical procedure, we strongly recommend the use of DMEK in the treatment of corneal endothelial disorders. In our experience, it is reproducible with a low complication rate, offers optimum visual results with significant satisfaction from our patients, and can be performed with no added cost to the hospital.

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