• Brief Report •

Modified thin manual Descemet stripping endothelial keratoplasty with air-guided, non-pachymetric donor lenticule dissection: outcomes of graft thickness and complication rate

Abdo Karim Tourkmani, Andrew M J Turnbull, Parwez N Hossain, Aristides Konstantopoulos, David F Anderson

Cornea and External Eye Disease Service, Department of Ophthalmology, University Hospital Southampton, Southampton SO16 6YD, UK.

Correspondence to: Abdo Karim Tourkmani. Cornea and External Eye Disease Service, Department of Ophthalmology, University Hospital Southampton, Tremona Road, Southampton SO16 6YD, UK. harto31@hotmail.com

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Abstract

● **AIM:** To describe a modified technique of donor lenticule dissection for thin manual Descemet stripping endothelial keratoplasty (TM-DSEK).

● **METHODS:** Donor material was soaked in balanced salt solution (BSS) for 30min, before being mounted on an artificial anterior chamber (AAC). Rather than BSS, the AAC was filled with filtered air, resulting in a visible reflection at the corneal endothelium-air interface. This reflection served as a landmark for the depth of the dissection, facilitating the creation of a thin lenticule with low risk of perforation. Dissection was commenced at a standardized depth of 500 microns, with no initial pachymetry necessary. Totally 29 donor corneas were dissected by a novice TM-DSEK surgeon. Dissection time, central graft thickness at 2mo and complications were analysed.

● **RESULTS:** Results were similar to other endothelial keratoplasty techniques, despite the cases being performed by a novice DSEK surgeon. Mean dissection time was 7min (range 6-10). One graft perforation occurred (3.45%), but the air tamponaded the break and enabled dissection to be restarted and completed from a different location. Mean central graft thickness after at least two months follow-up was 106 microns (range 25-170).

● **CONCLUSION:** A problem with manual DSEK is the risk of graft perforation by attempting to dissect too thin a lenticule, or creating a thick graft due to fear of perforating. This modified air-guided technique addresses this problem, and is recommended for surgeons either embarking on the learning curve, or who wish to achieve more consistently thin grafts while reducing perforation rates.

● **KEYWORDS:** Descemet stripping endothelial keratoplasty; manual donor lenticule dissection; graft thickness

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INTRODUCTION

Endothelial keratoplasty (EK) has become the procedure of choice for treating corneal endothelial dysfunction. Many corneal surgeons worldwide employ thin manual Descemet stripping endothelial keratoplasty (TM-DSEK), or its automated counterpart, Descemet stripping automated endothelial keratoplasty (DSAEK).

A modification to the standard manual Descemet stripping endothelial keratoplasty (DSEK) technique[1], was reported by our group and named TM-DSEK[2]. Briefly, donor cornea is soaked in balanced salt solution (BSS) for 30min prior to manual dissection of the donor tissue. Donor tissue is mounted on an artificial anterior chamber (AAC) filled with BSS, and central ultrasound pachymetry is taken prior to manual dissection[2]. We herein report a further modification of the TM-DSEK dissection technique, in which dissection is performed after filling in the AAC with air rather than fluid, and the outcomes regarding duration of donor dissection, rates of donor perforation, graft thickness, graft detachment and primary failure. Comparison is made with reports of other DS(A)EK lenticule dissection techniques.

SUBJECTS AND METHODS

Ethical Approval This retrospective study was performed

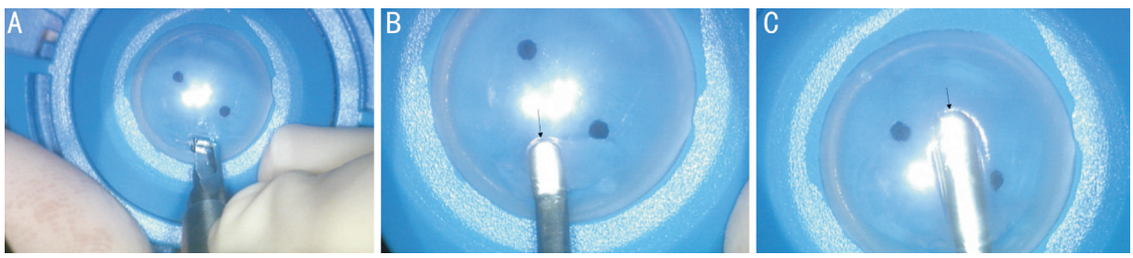

Figure 1 Initial 500 micron depth incision with guarded diamond blade (A); Development of deep dissection plane with Paufique knife; reflection from air-endothelium interface is visible (black arrow; B); Completion of thin manual dissection with Morlet dissector. Reflection is clearly visible (black arrow; C).

within the Corneal and External Eye Disease Service at University Hospital Southampton NHS Foundation Trust, Southampton (UK) according to the tenets of the Declaration of Helsinki. All participants gave written consent form.

Totally 29 human donor corneas were prepared for use in DSEK in 29 consecutive eyes with the modified air-guided manual dissection technique. All donor corneas were supplied by the National Health Service Blood and Transplant service (NHSBT) in transport medium containing dextran and were placed in BSS (Alcon Labs, Fort Worth, TX, USA) for 30min immediately before surgery. A small amount of viscoelastic (Healon; AMO, Santa Ana, CA, USA) was placed in the centre and on the edges of the base of the AAC (Barron artificial anterior chamber; Katena Products, Denville, NJ, USA) to protect the donor corneal endothelial cells. The AAC was subsequently filled with filtered air instead of BSS.

Due to the dissection plane being visualised better by the reflection at the corneal endothelium-air interface (rather than endothelium-fluid interface)[3], central pachymetric measurement of the donor cornea was deemed unnecessary. An initial incision of 3.5-4.0 mm width and 500 microns depth was performed with a guarded diamond knife near the donor corneal limbus in all cases (Figure 1A). A stromal pocket was initially dissected with a Paufique knife (Duckworth & Kent Ltd., UK) and the depth of the initial pocket was estimated using the endothelium–air interface reflection as a landmark (Figure 1B). When the desired depth of the dissection was acquired, a Morlet dissector (Duckworth & Kent Ltd.) was used to complete the limbus to limbus lamellar dissection (Figure 1C). The donor cornea was trephined to a diameter of 8.50-8.75 mm and the rest of the TM-DSEK surgery was performed according to our standard technique[4]. All patients were admitted for one night, to facilitate supine posturing for 24h while the intracameral air bubble remains *in situ*.

Both lenticule dissection and donor insertion were performed in each case by a novice TM-DSEK surgeon. Indications for surgery were Fuchs' endothelial dystrophy (FED; *n*=23), endothelial decompensation within a previous penetrating keratoplasty (*n*=4), pseudophakic bullous keratopathy (*n*=1) and failed DSAEK secondary to herpetic disciform keratitis (*n*=1). Thin manual non-Descemet stripping endothelial keratoplasty (TM-nDSEK) was used in three of the eyes that had endothelial failure within an old penetrating keratoplasty. Descemet stripping was performed in the other 26 cases. Five cases had combined cataract surgery with lens implant at the time of surgery. The rest of the cases were pseudophakic.

Time required for donor dissection, perforation rate, graft thickness at two months with high-resolution optical coherence tomography (SPECTRALIS Anterior Segment Module OCT, Heidelberg Engineering, Germany), graft detachment rate, upside-down grafts and primary failure were analysed and compared with the reports of other dissection techniques.

RESULTS

Totally 29 consecutive donor corneas were dissected with the non-pachymetric, air-guided method. Case No.14 was excluded from analysis of graft thickness or postoperative complications due to loss to follow up after one week. Case No.28 was excluded from analysis of graft thickness due to being complicated by primary failure and requiring a repeat DSEK graft. Both cases were still included in the analysis of dissection time and intraoperative complications.

Mean dissection time of the donor cornea was 7±1.17 (range 6-10)min. Mean graft thickness after two months was 106±37 (range 25-170) microns. Perforation rate was 3.45% (1/29). Postoperative graft detachment occurred in 6.90% (2/29), leading to primary failure in one case that subsequently underwent redo TM-DSEK. The redo DSEK graft was excluded from this study as this was performed by different surgeons (Anderson DF and Turn bull AMJ). An upside-down graft (donor endothelium against host stroma) was identified in one case on the first postoperative day (3.45%; 1/29). This was corrected surgically on the same day. All cases with at least two months follow-up maintained well-functioning grafts with good corneal clarity (Table 1).

DISCUSSION

For the many surgeons who have not adopted DMEK, DS(A)EK continues to be the procedure of choice for managing corneal endothelial dysfunction.

Results of modified TM DSEK technique

Table 1 Summary of cases

Patient No.	Indication	Combined with cataract surgery	Dissection time (min)	Graft perforation	Graft detachment	Upside down	Failure	Central graft thickness (microns)	Follow-up period (mo)
1	FED	No	7	No	No	No	No	132	9
2	FED	No	8	No	No	No	No	122	8
3	FED	No	6	No	No	No	No	161	12
4	FED	No	8	No	No	No	No	54	6
5	FED	No	9	No	No	No	No	97	2
6	FED	No	6	No	No	No	No	121	18
7	FED	No	8	No	No	No	No	65	6
8	FED	No	6	No	No	No	No	58	12
9	FED	No	6	No	No	No	No	135	6
10	FED	No	6	No	No	No	No	117	3
11	Failed PKP	Yes	7	No	No	No	No	135	18
12	FED	No	6	No	No	No	No	85	12
13	FED	No	8	No	No	No	No	77	2
14	PBK	No	8	No	N/A	N/A	N/A	N/A	Lost to follow-up after 1wk
15	Failed DSEK (HSK)	No	10	Yes	No	No	No	25	6
16	FED	No	8	No	No	No	No	170	6
17	FED	No	8	No	No	No	No	77	9
18	Failed PKP (keratoconus)	Yes	6	No	No	No	No	87	6
19	FED	No	7	No	No	No	No	81	2
20	FED	No	6	No	No	No	No	132	12
21	FED	No	7	No	No	No	No	156	9
22	FED	Yes	6	No	No	No	No	127	9
23	FED	No	6	No	No	No	No	111	2
24	FED	No	6	No	No	No	No	117	12
25	FED	No	7	No	No	No	No	64	2
26	FED	No	8	No	No	Yes	No	123	9
27	FED	Yes	6	No	Yes	No	No	82	9
28	Failed PKP (FED)	Yes	6	No	Yes	No	Yes	N/A	N/A
29	Failed PKP	No	7	No	No	No	No	154	9
Mean±standard deviation			7±1.17					106±37	

FED: Fuchs' endothelial dystrophy; PBK: Pseudophakic bullous keratopathy; HKS: Herpes simplex keratitis; PKP: Penetrating keratoplasty.

There are limitations to the previously reported TM-DSEK and other DS(A)EK techniques, such as the risk of iatrogenic damage to donor tissue[5] and difficulties when trying to obtain a graft of appropriate thickness in a consistent manner. While establishing the precise relationship between graft thickness and postoperative visual quality has proved controversial, there is consensus that thinner grafts are associated with better final visual outcomes, as they offer a more faithful replication of normal corneal anatomy[6]. In this study, we obtained at least non inferior results with our modified technique compared to the previously reported TM-DSEK technique, with a reduced time for graft preparation. Taking into consideration that all surgeries of this study were performed by a corneal fellow, this could mean that this new modification is safer in terms of donor tissue handling.

Perforation of donor corneal tissue occurred in one case (3.45%), comparable to the rate of 5 in 114 (4.38%) reported by Price *et al*[7] with manual dissections. For this case, the air bubble served to tamponade the perforation in a more robust, stable fashion than BSS. This serendipitous finding allowed for dissection to be restarted 90 degrees away from the initial incision, and completed in a more superficial plane. This could represent a major advantage, by facilitating the rescue of lenticule perforations and avoiding the risk of wasting valuable donor tissue.

Dissection time of the donor cornea is an important consideration, as longer manipulation of donor tissue may be related to increased endothelial cell loss and/or a higher rate of primary graft failure[5]. The dissection time for our standard TM-DSEK dissection technique was reported as 6.8min (range 5.0-

10.5min)[2]. The time for our modified dissection technique is 7.0min (range 6.0-10.0min). This refers only to the time for dissection of the donor tissue, whereas the total time required to harvest the endothelial lenticule is longer in the standard technique than the modified technique, as the former requires central donor corneal pachymetry to be performed. In the modified, air-guided technique, this step is not required.

Mean central graft thickness was 106 microns (range 25-170 microns). This is comparable to the results published by other authors. Wacker *et al*[8] reported a mean graft thickness of 155 microns in a sample of 52 eyes undergoing primary DSEK for FED, 34 of which completed a 5-year follow up period. In the publication of our standard TM-DSEK technique, Tsatsos *et al*[2] reported a mean graft thickness of 90.7 microns (range 48-137 microns) in 10 cases of TM-DSEK at one month postoperatively. With regards to automated dissection techniques, Javadi *et al*[9] reported mean graft thickness of 98 microns in 29 eyes undergoing DSAEK for FED and 107.6 microns for 18 eyes having DSAEK for pseudophakic bullous keratopathy. Thus, the mean graft thickness achievable *via* our manual technique is at least non-inferior to that achievable through the use of a microkeratome.

Graft detachment occurred in 2/29 cases (6.90%), one of which was a combined phacoemulsification with intraocular lens (IOL) implant and TM-nDSEK for cataract and failed penetrating keratoplasty, and another a combined phacoemulsification with IOL implant and TM-DSEK for FED. In the former, the graft did not attach following one rebubbling. Patient was temporarily lost to follow-up due to other medical comorbidities. After one month, the patient was fit enough to re-attend, but by this time the initial graft had failed. This was the only case of primary graft failure in this series, requiring a redo TM-DSEK. The latter was successfully managed with a single rebubbling. Both detachments could have happened in relation to viscoelastics use for phacoemulsification. This is comparable to that of other studies, where the rate has been reported to be from 4% to 21%[10-11].

In summary, we report a modification to the previously reported standard TM-DSEK dissection technique, using filtered air rather than BSS within the AAC. This enhances visibility of the dissection depth, potentially allowing thinner, more predictable lenticule preparation. It also improves efficiency by negating the need for pachymetry. These results from a novel surgeon were comparable to results reported by more experienced surgeons performing other manual DSEK or DSAEK techniques. This suggests that it could be safer with regards to donor tissue handling, especially in the hands of an inexperienced endothelial keratoplasty surgeon; or those striving to achieve thinner grafts with a reduced risk of iatrogenic perforation.

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Conflicts of Interest: Tourkmani AK, None; **Turnbull AMJ,** None; **Hossain PN,** None; **Konstantopoulos A,** None; **Anderson DF,** None.

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