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Original research

Effect of venting incisions on graft attachment in Descemet's stripping automated endothelial keratoplasty

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Abstract

Purpose: To investigate the impact of venting incisions on the adherence of graft to the recipient's stroma in Descemet's stripping automated endothelial keratoplasty (DSAEK).
Methods: Fifty-six patients were enrolled in this study. Patients were randomly allocated into two groups. Twenty-eight patients had a DSAEK procedure with venting incisions. The second group was treated by conventional DSAEK with no venting incisions. Slit-lamp examination and anterior segment optical coherence tomography (AS-OCT) were performed in day one and 14 days after surgery to investigate graft attachment. The thickness of cornea and lenticle were also evaluated by AS-OCT. BCVA (logMAR) was measured the day before the surgery and 14 days postoperatively.
Results: Subclinical graft detachment in the first day after surgery was significantly lower in patients who had a DSAEK procedure and venting incisions ($P = 0.02$), but no difference was noted in the rate of clinical graft detachment on day one ($P = 0.24$) and subclinical and clinical graft detachment on day 14 ($P = 0.24$, $P = 0.50$, respectively). The thickness of the cornea and lenticle after the surgery were statistically similar between the two groups ($P = 0.903$, $P = 0.402$, respectively). No difference in the improvement of BCVA was observed between the venting and non-venting group ($P = 0.143$).
Conclusions: Routine use of venting incisions may not be necessary in the standard DSAEK procedures. More studies with larger sample sizes are needed to better confirm the results of this study.

Keywords: DSAEK; Graft attachment; Venting incisions

Introduction

Penetrating keratoplasty (PK) has been considered the gold standard of treating corneal endothelial diseases for many years. However, the replacement of full thickness cornea has been associated with several complications such as graft rejection, high astigmatism and prolonged visual rehabilitation.[1] Endothelial keratoplasty (EK) is an exciting development in the field of corneal transplantation that allows the replacement of diseased endothelium. This procedure was first introduced in 1998 by Melles et al.[2] to overcome the untoward sequelae of full thickness corneal transplantation. Subsequently, Gorovoy[3] described using a mechanical microkeratome for donor tissue dissection. This technique is called Descemet's stripping automated endothelial keratoplasty (DSAEK) and has become the procedure of choice for corneal endothelial transplantation in many centers.[4,5] There is growing evidence that this procedure has many advantages compared to PK.

Graft detachment is the most common complication of DSAEK, which has been reported in up to 82% of cases in

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some series.[6] This calls for a second surgery and more manipulation of the lenticle, which in turn increases the risk of graft failure. To prevent this complication, several measures have been proposed, including: changing the time and pressure of anterior chamber (AC) air tamponade, midperipheral corneal venting incisions, sweeping the corneal surface, and mechanical scraping of the peripheral corneal stroma.[7]

Optical coherence tomography (OCT) is a non-contact, non-invasive imaging technique that allows for high-quality cross-sectional imaging in biologic systems.[8] OCT is not only a valuable method in diagnosing the retinal diseases, but it has shown great promise in anterior segment evaluation of the eye. Direct evaluation of lenticle attachment, shortly after DSAEK by slit-lamp examination, is not very accurate because of corneal edema and surface irregularities. Anterior segment optical coherence tomography (AS-OCT) can be very helpful in this situation. Moreover, because it is a non-contact method, it does not increase the risk of lenticle detachment.

Placement of paracentral venting incisions in the cornea might ease the removal of interface fluid in DSAEK and thus hypothetically reduces the rate of graft detachment.[9] In this study, we have sought to evaluate the effect of venting incisions on lenticle adhesion in DSAEK surgery using AS-OCT and clinical examination.

Methods

A randomized clinical trial was designed to assess the effect of venting incisions on lenticle adhesion in DSAEK. Informed consent was obtained from all patients, and institutional review board approved the study. Fifty-six eyes of fifty six patients with pseudophakic bullous keratopathy and fuchs endothelial corneal dystrophy (FECD) were selected for this study. Twenty-eight patients underwent venting incision during DSAEK, and twenty-eight did not. The latter were used as controls in this study.

Slit-lamp evaluation of graft status and AS-OCT imaging were performed for all patients one day before surgery and one day and two weeks after DSAEK. The thickness of the cornea and the graft was evaluated by AS-OCT. The status of graft attachment was evaluated clinically by slit-lamp examination and AS-OCT. Subclinical graft detachment was defined as the lack of adherence of the posterior lamellar graft to the stromal bed which was not evident on slit-lamp examination and was detected using AS-OCT. All AS-OCT examinations were performed in at least 2 meridians (90° and 180°) by the same experienced technicians.

BCVA (logMAR) of patients were measured one day before the procedure and two weeks after the surgery.

The main outcome measure was the rate of graft detachment in the venting and non-venting group. Graft detachment was arbitrarily defined as separation of at least 20% of the chord length of lenticle from the host cornea. Secondary outcome measures were the effect of venting incisions on corneal thickness, lenticular thickness, and visual acuity following DSAEK.

Surgical technique

All surgeries were performed by an experienced faculty member and a trained cornea fellow. DSAEK was performed according to the protocol described by Gorovoy.[2] Precut donor tissues were provided by Iranian Eye Bank and had an endothelial cell density of at least 2000 cells/mm^2. The posterior lamellar grafts were then punched with a 7.75−8.5 mm Hessburg-Barron trephine (Katena Products, Inc., NJ, USA), ensuring a 0.5 mm difference between the desired graft size and the graft bed diameter of the corneal tissue. A temporal peritomy and a scleral tunnel incision of 4.5 mm, 1 mm posterior to the limbus was made. After filling the AC with Healon (Advanced Medical Optics, Santa Ana, CA), descemetorhexis was performed over the central 8 mm using a reverse Sinskey hook and a Descemet stripper. Midperipheral venting incisions were placed 3 mm from the corneal center at 45°, 135°, 225°, and 315° using a 15-degree stab knife. The length of incisions was approximately 15°. The viscoelastic was washed out from the eye with standard automated irrigation and aspiration technique. The donor tissue was folded in a taco configuration with 60% edge placed anteriorly into the chamber by an aid of single point touch forceps. The temporal incision was closed with 10/0 nylon sutures. An air bubble was injected into the AC to unfold the donor tissue, and the graft was positioned by a reverse Sinskey hook. To support the graft, an air bubble was retained to partially fill the AC. The case was finished with subconjunctival injection of betamethasone. The patient was kept in a supine position for at least 12 h.

Statistical analysis

Analysis was made using SPSS statistics software V.20.0 (IBM, New York, USA). A P value < 0.05 was considered statistically significant. Normality of the data was assessed using Shapiro-Wilk test. A Chi-square test was performed to evaluate the association of lenticle adhesion and venting incisions. A student t-test was also used to compare the rate of subclinical and clinical graft detachment, improvement in visual acuity, corneal thickness, and lenticular thickness between the two groups.

Results

In total, 56 patients (58.9% male and 41.1% female) were enrolled in this study. Mean age was 71.8 ± 12.4. The improvement of BCVA (logMAR) turned out to be statistically uniform between the venting and the non-venting group (0.692 ± 0.367 in the venting group and 0.589 ± 0.360 in the non-venting group, $P = 0.143$). The BCVA (logMAR) of patients in the last visit were 0.777 ± 0.260 in the venting group and 0.848 ± 0.360 ($P = 0.159$) in the non-venting group. Statistical analysis also revealed that venting incisions during DSAEK does not significantly affect corneal thickness and lenticular thickness on one day and 14 days

Table 1
Results of comparison of mean variables (results are expressed as mean ± standard deviation).

	Venting group	Non-venting group	*P* value
Age	72.89 ± 11.87	70.68 ± 13.03	0.509
Preoperative BCVA (logMAR)	1.469 ± 0.490	1.437 ± 0.344	0.591
BCVA 14 days after DSAEK (logMAR)	0.777 ± 0.260	0.848 ± 0.360	0.159
Preoperative corneal thickness (μm)	780.39 ± 176.57	827.89 ± 212.70	0.367
Corneal thickness 1 day after DSAEK (μm)	584.43 ± 111.05	756.39 ± 851.66	0.294
Corneal thickness 14 days after DSAEK (μm)	499.03 ± 106.18	502.07 ± 76.48	0.903
Lenticular thickness 1 day after DSAEK (μm)	161.75 ± 54.66	148.46 ± 43.88	0.320
Lenticular thickness 14 days after DSAEK (μm)	129.03 ± 38.58	121.00 ± 32.36	0.402

DSAEK: Descemet's stripping automated endothelial keratoplasty.

postoperatively. Table 1 summarizes the demographic data and early outcome of DSAEK in the two groups.

Subclinical and clinical graft detachment

As mentioned earlier, graft detachment was defined as separation of at least 20% of the chord length of lenticle from the host cornea. On the first postoperative visit, none (0.0%) of the patients in the venting group and 5 (17.9%) of patients in the non-venting group showed subclinical graft detachment on AS-OCT ($P = 0.02$) (Fig. 1). None (0.0%) of the patients in the venting group and 2 (7.1%) of patients in the non-venting group had clinical graft detachment on the first day after surgery ($P = 0.24$). A re-bubbling procedure within 48 h was planned for the patients with clinical graft detachment on the first visit. Fourteen days after surgery, none (0.0%) of the patients in the venting group and 2 (7.1%) of the patients in the non-venting group showed subclinical graft detachment ($P = 0.24$). Moreover, none (0.0%) of the patients in the venting group and 1 (3.6%) of the patients in non-venting group had clinical graft detachment on day fourteen after surgery ($P = 0.50$). The patient with clinical graft detachment on the last visit successfully underwent a Re-DSAEK with venting incisions 3 months later. Table 2 shows the rate of graft detachment in the venting and non-venting group.

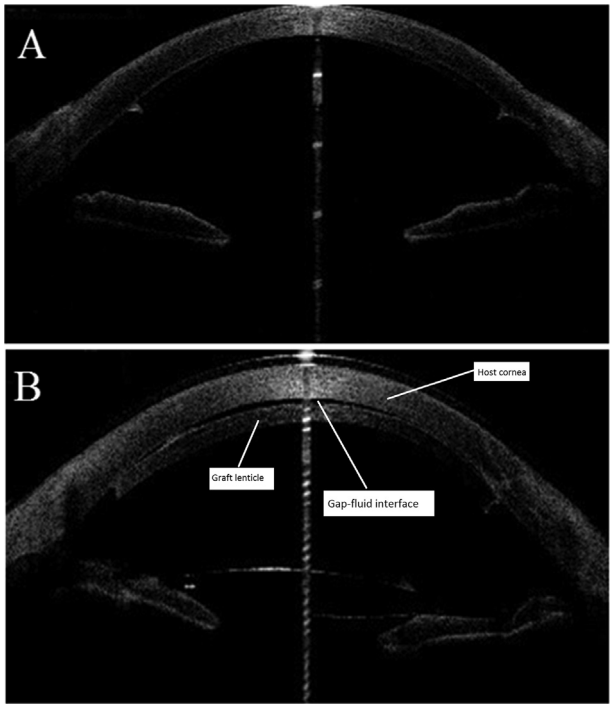

Fig. 1. Image of anterior segment optical coherence tomography (AS-OCT) of recipient and a donor graft one day after surgery in a patient who had a Descemet's stripping automated endothelial keratoplasty (DSAEK) with venting incisions (A) and without a venting incision (B). An interface gap is visible in Fig. 1B implicating a subclinical graft detachment.

Discussion

In endothelial keratoplasty procedures as described by Melles et al.,[2] no fixation sutures are applied. Instead, an air bubble is used to hold the posterior donor lenticle in place. Several studies have shown that the air compression alone is not sufficient to remove the interface fluid in this procedure.[5,7,9] As a result, making paracentral venting incisions in the recipient cornea was suggested as a technique to enhance the donor tissue adherence.[10]

Posterior graft detachment has been reported to be the most common complication of DSAEK.[6] A posterior detachment implies the absence of adhesion of posterior donor lenticle to the recipient stroma.[6] Graft detachments are usually treated with lenitule repositioning and rebubbling in AC. This results in further manipulation of the graft and endothelial cell

Table 2
Comparison of graft detachment between the two groups.

	Venting group	Non-venting group	*P*-value
Subclinical graft detachment 1 day after DSAEK	0 (0.00%)	5 (17.86%)	0.02
Clinical graft detachment 1 day after DSAEK	0 (0.00%)	2 (7.14%)	0.24
Subclinical graft detachment 14 days after DSAEK	0 (0.00%)	2 (7.14%)	0.24
Clinical graft detachment 14 days after DSAEK	0 (0.00%)	1 (3.57%)	0.50

DSAEK: Descemet's stripping automated endothelial keratoplasty.

damage. Therefore, preventing this prevalent complication is important to yield better outcomes in patients undergoing this procedure. Several mechanisms are supposed to be responsible for graft detachment, including reduction of endothelial cell function due to surgical trauma and rubbing the eye in the early postoperative period. Furthermore, hypotony may allow the fluid to enter the graft interface and lead to graft detachment.[1,10,11]

We observed that performing venting incisions reduces the rate of early subclinical graft detachment. As mentioned earlier, filling the AC with an air bubble is the main step in DSAEK, but increasing the air pressure after a steady pressure is achieved does not result in increased egression of interface fluid because the fluid will remain in place until the endothelial pump of the graft removes it from the interface gap.[9,12] In contrast, performing venting incisions may produce a pressure gradient across the donor graft. This might be helpful in clearing the interface fluid, drying the interface gap and stromal roughening that presumably increase graft adhesion.

In a survey performed by Suh[11] et al. regarding the complications of DSAEK, most graft detachments were reported to occur in the first postoperative day. After the graft is apposed against the stromal bed, weak intermolecular forces such as van der Waals forces and hydrogen bonds help to attach the donor tissue to the host cornea. Over time, however, polymer chains start to move between the graft and the host and tissues firmly adhere to each other.[9] This process of molecular interdigitation is called reptation.[13] This explains why graft dislocation is classified as an early complication of DSAEK.[14−17]

In an in vitro study by Vaddavalli[12] et al., factors that might influence graft attachment in DSAEK are evaluated. AS-OCT was used to evaluate the interface gap between the donor and recipient cornea. They concluded that paracentral venting incisions facilitates graft attachment. We observed a similar result on one day after the surgery, but AS-OCT on day 14 showed that there was no difference in graft attachment between the venting and non-venting group. This implies that most cases of subclinical graft detachment resolve during the first weeks after surgery.

Few studies have been published regarding the long-term complications of venting incisions in DSAEK. Cases of deep infectious keratitis from venting incisions that might lead to aggressive keratolysis have been reported.[18] Moshirfar et al.[19] suggested that DSAEK venting incisions may induce corneal irregular astigmatism that is not in the manifest cylinder of patients. This might influence the final visual outcome of patients. The authors recommended placing the venting incisions 7 mm away from the optical zone to minimize this effect. In a larger retrospective study[20] performed by Hovlykke et al., no significant difference in BCVA and manifest refraction was noted between the venting and non-venting group. The topographic data including corneal front surface (CFS) astigmatism and higher order aberrations was also the same between the two groups. In this study, we did not observe any significant difference in the improvement of BCVA between the two groups. However, the topographic data was not available in the current study.

The results of this study should be understood within the context of its limitations. First, this study was performed in a small group of patients; a larger study is needed to fully evaluate the efficacy of venting incisions. We did not assess the interface gap changes in patients who had venting incisions. The topographic changes of cornea and its effect on vision of patients is also an important factor to consider when making venting incisions on cornea. It has been previously reported that venting incisions can influence the topographic features of cornea. Unfortunately the topographic data was not available in our study. We also believe that a longer follow-up is needed to assess the long-term complication of DSAEK venting incisions.

In conclusion, this study shows that the routine use of venting incisions in standard DSAEK procedures may not be necessary. The reduction in graft displacement was not clinically significant, and it does not seem to change the final outcome of the procedure. Further studies are needed to evaluate the long-term effects of making venting incisions on the long-term outcomes of DSAEK such as the topographic features of cornea and vision.

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