Original Article

The outcome of 70/30 taco insertion through a 2.8 mm clear corneal incision in Descemet's stripping automated endothelial keratoplasty - A retrospective analysis

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Purpose: To assess the long-term outcome of graft insertion by taco technique through a 2.8-mm clear corneal incision in patients undergoing Descemet's stripping automated endothelial keratoplasty (DSAEK). **Methods:** This is a retrospective interventional case series of 77 eyes of 75 patients who underwent DSAEK in a tertiary eye hospital. The DSAEK donor grafts were folded to an uneven 70/30 taco and held at a single point using Utrata forceps. All insertions were through a 2.8-mm clear corneal incision except the two aphakic patients requiring combined SFIOL implantation. All patients underwent a comprehensive eye examination preoperatively and were followed up to 6 years postoperatively. Visual outcomes, graft clarity, and complications of all and endothelial cell loss in 22 patients with available postop specular microscopy were analyzed. **Results:** Overall, 59 (76.6%) had clear grafts until the final follow-up. Visual acuity improved in 48 (62.3%) from an average of 1.3 to 0.8 logMAR (P = 0.0001). Vision was maintained in seven and worsened in four eyes. Grafts failed in 18 (23.3%) eyes: seven (9%) were primary failures, two post rejection, four done for failed PK did not clear, four due to worsening of preexisting glaucoma, and one noncompliant failed eventually. Average endothelial cell density reduction was 26.3% (mean preop donor 2419 to postop 1779 cells/mm^2; P = 0.000). **Conclusion:** Our study shows good long-term clinical outcome of DSAEK using Taco technique through a 2.8-mm clear corneal incision in a tertiary hospital.

Key words: DMEK, DSAEK, PK, rebubbling, specular count, taco

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Website: www.ijo.in

DOI: 10.4103/ijo.IJO_663_21

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With the introduction of Descemet Membrane Endothelial Keratoplasty (DMEK), DSAEK has become less popular but is still preferred in eyes with comorbid ocular conditions unsuitable for DMEK. DSAEK graft insertion is done in many ways; Taco is a folding technique introduced by Melles in 2002[1] and popularized by Terry[2] as a 60:40 fold. The earliest report on DSAEK in Asia was from SNEC comparing different insertion techniques that showed the highest rate of primary graft failure and endothelial cell loss (ECL) by the Taco insertion.[3] The study by Price *et al*.[4] compared taco insertion through 3.2 mm with 5-mm incision and showed more than 10% ECL in the 3.2-mm group. We have been performing Taco 70:30 folding technique using Utrata forceps through a 2.8-mm clear corneal incision with good clinical results for many years. Thus, we analyzed our outcomes to assess the suitability in our population.

Methods

This is a retrospective interventional case series of 77 eyes of 75 patients (40 male, 35 female), who underwent DSAEK by a single surgeon (Dr. NVN) from 2012 to 2020. The electronic files of these patients were retrieved and preoperative data including cause for endothelial failure, best-corrected visual acuity (BCVA), IOP by GAT, donor specular counts, postoperative BCVA, IOP, graft status up to final follow-up, specular count when available, and complications were analyzed. Surgery was indicated for endothelial failure in 40 (51.9%) pseudophakic eyes, including three failed penetrating keratoplasty (PK), two (2.5%) aphakic both with PK failure, 28 (36%) Fuchs endothelial dystrophy (FED), three (3.8%) ICE syndrome, three (3.8%) long-standing Descemet's membrane (DM) detachment, and one (1.2%) eye post trauma [Fig. 1]. Our primary outcome measure was graft survival at final follow-up, and secondary outcome measures were visual outcome, complications, and ECL when documented. Visual acuity were measured in Snellen Visual Acuity chart and converted to logarithm of the minimum angle of resolution equivalent units for analysis. This study was approved by the institutional review board and followed the principles of the Declaration of Helsinki.

Operative procedure

All the grafts were prepared by the surgeon since precut facility is not available. The grafts were prepared using an automated

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Received: 23-Mar-2021 Revision: 15-Aug-2021
Accepted: 23-Aug-2021 Published: 23-Dec-2021

Cite this article as: Narayanan N, Jain N, Ravi P, Natarajan V. The outcome of 70/30 taco insertion through a 2.8 mm clear corneal incision in Descemet's stripping automated endothelial keratoplasty - A retrospective analysis. Indian J Ophthalmol 2022;70:95-9.

lamellar therapeutic keratoplasty system (ALTK; Moria SA) and a 350-mm Carriazo–Barraquer microkeratome blade. The donor disc was cut with 8-mm Katena corneal trephine, and only in the five post-PK eyes, a 7.5-mm size was used. Grafts were inserted through a 2.8-mm superior clear corneal incision in all except two aphakic patients who had Hoffman pocket SFIOL first followed by Taco disc insertion through partly sutured large limbal incision. In the 24 FED patients requiring triple procedure, a 2.2-mm clear corneal phaco was first done and then the section was extended to 2.8 mm to facilitate taco insertion. In all patients, the host DM striping was done using reverse Sinskey hook to the same size as the graft. For Taco preparation, a small amount of OVD was instilled on the inner endothelial side and then the graft was folded to an uneven 70:30 ratio. Using Utrata forceps, the graft was held gently at the fold, leaving the anterior tip of the fold free. With titanium-toothed forceps, only the outer lip of the clear corneal section was opened to cautiously nudge the free tip of the Taco fold inside [Fig. 2a]. With a little push forward, the free tip opened the inner lip at which point the rest of the section was fully occupied by the taco fold, preventing free fluid egress from the chamber [Fig. 2b]. As the tip of the taco approaches the pupil, a gentle lifting up motion ensured that the leading edge of the graft was not taken behind the inferior iris [Fig. 2c]. Then, the grasp on the taco was released, letting go of the graft completely, followed by gradually pulling the forceps out. With reasonable chamber formation and advantageously uneven fold, spontaneous unfolding happened often and needed only minimal manipulation in the rest [Fig. 2d and Supplemental Digital Content 1]. In none of the cases, AC maintainer or venting incisions were used. The grafts were secured with air tamponade at first with a full fill for 10 min and then reduced to just larger than the size of the disc. Initially, incisions were sutured along with inferior peripheral iridectomy through limbal stab incision; later, both were reserved only for complicated cases. All the patients were kept under observation for 10 min on the operating table, where handheld slit-lamp examination was performed to ensure adequate apposition and then in the ICU maintaining supine position for 1 h before shifting them to the ward. As the air injection was not a full fill, burping was not necessary.

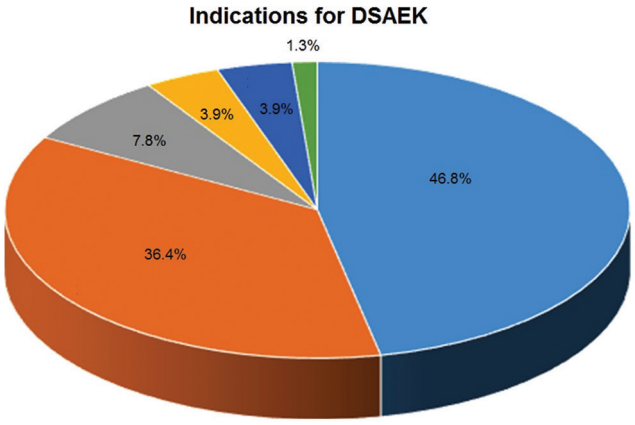

Figure 1: Indications for DSAEK

Postoperative care

On the night of the surgery, for patients without specific contraindications, one tablet of acetazolamide 250 mg was given once. All patients received postoperatively prophylactic antibiotic eye drop 6 times per day for 1 week and topical prednisolone acetate 1% (Pred Forte; Allergan, Inc, Irvine, California, USA) initially 10 times per day and then with weekly tapering maintained at once a day regimen indefinitely. Patients needing antiglaucoma medication (AGM) and other adjuvant therapy were advised accordingly.

Statistical analysis

All statistical analyses were performed using the statistical package for the social sciences (SPSS, Inc., Chicago, IL). Descriptive statistics were computed for continuous variables,

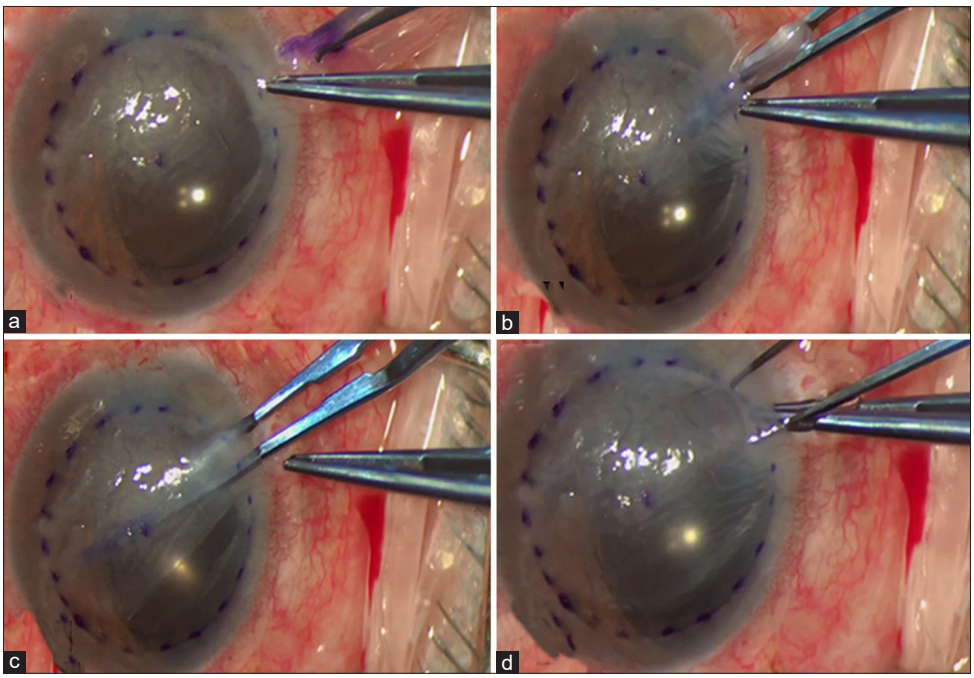

Figure 2: Steps of Taco insertion. (a) Taco at outer lip. (b) Taco past inner lip. (c) Taco above pupil. (d) Spontaneous unfolding

and frequency distribution was used to assess the distribution of categorical variables. Specular counts of the donor and the postoperative cornea were done by trained technicians using a noncontact specular microscope (Konan Medical Carp., Hyogo, Japan). Kaplan–Meier analysis was performed to determine 6-year graft survival. $P < 0.05$ was considered statistically significant.

Results

The average age of the patients was 61.5 years (range: 32–82). Out of the 77 eyes with an average follow-up of 15.45 ± 15.75 months (45 days–73.8 months), 59 (76.6%) maintained clear grafts [Fig. 3]. The Kaplan–Meier proportion of graft survival at 6 years was 51%.[3,4] Among them, 48 (62.3%) had significant vision improvement from average 1.24 ± 0.66 to 0.48 ± 0.41 by logMAR, was maintained in seven (9%), and worsened in four (5.2%) due to nongraft-related reasons such as choroidal neovascular membrane, cystoid macular edema, retinal detachment, and surface corneal infection. Specular microscopy is not a routine postoperative evaluation; thus, it was available in only 22 patients at 4 weeks postop. It showed an average ECL of 26.3% (preop donor average 2419 to postop 1779 cells/mm^2, $P < 0.05$). The mean donor age was 53.32 ± 15.1 years, and the donor corneas were from CU Shah Eye bank, preserved in MK medium or CORNISOL (Aurolab).

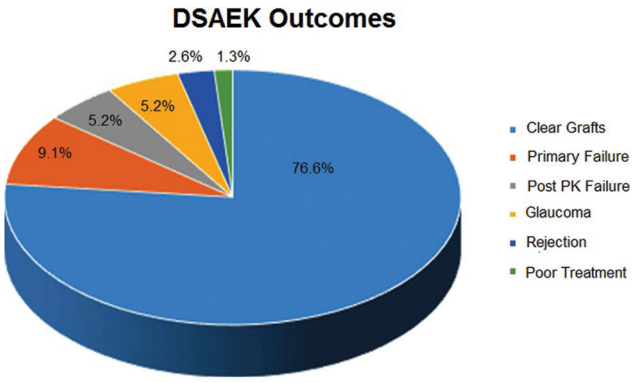

Figure 3: DSAEK grafts outcomes

Complications

The complications encountered include the period of the surgeon's learning curve, cases with comorbid ocular

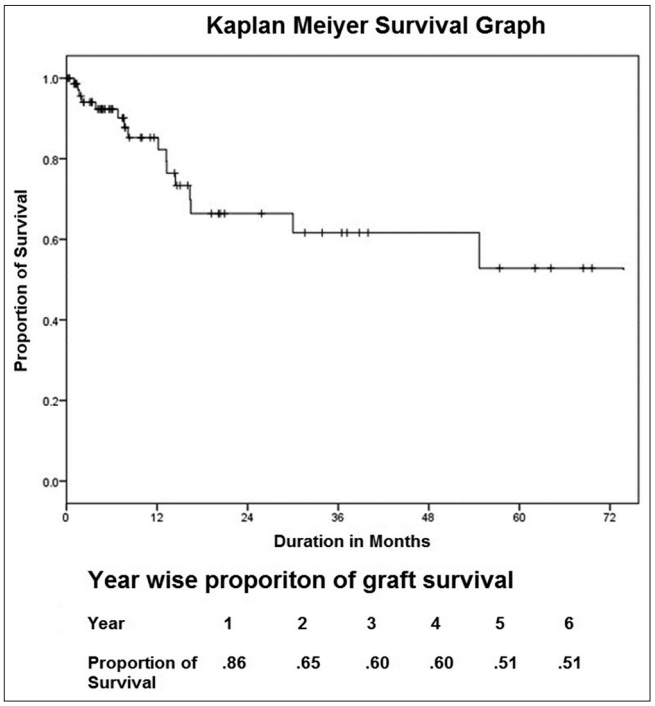

Figure 4: Kaplan–Meier proportion of survival graph for DSAEK graft

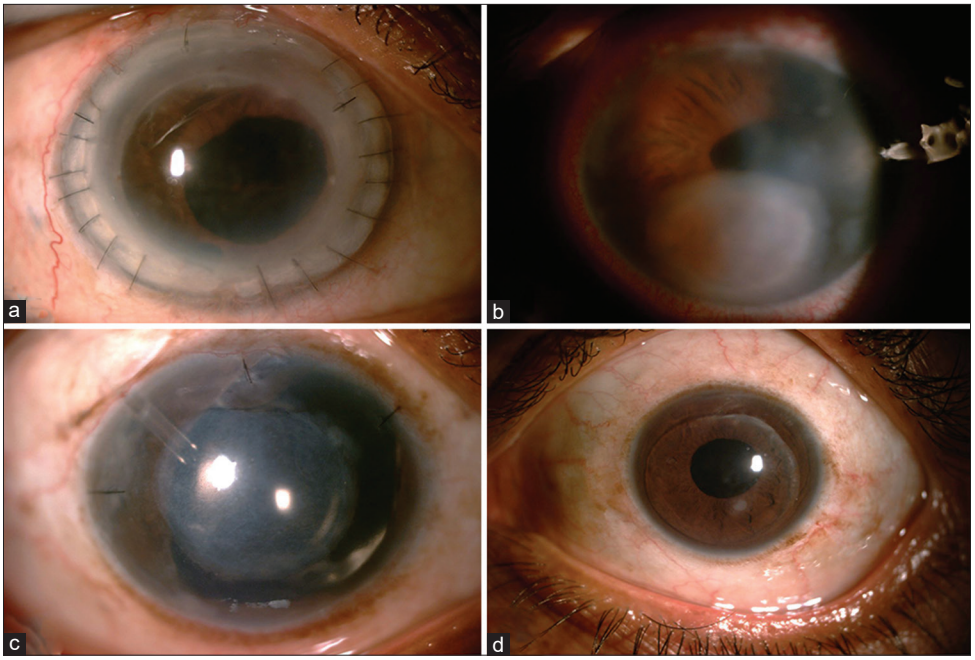

Figure 5: Complicated cases: (a) DSAEK with SFIOL after PK, (c) Failed DSAEK in ICE Syndrome, (b) Shrunken DSAEK graft, (d) Interface haze post DSAEK

Table 1: Complications of DSAEK

Complications	Frequency	Percentage
No Complication	49	63.6%
Rebubbling	7	9.1%
Interface Haze	1	1.3%
Graft Dislocation	1	1.3%
Infective keratitis	1	1.3%
Primary Failure	7	9.1%
Post PK Failure	4	5.2%
Glaucoma	4	5.2%
Rejection	2	2.6%
Noncompliance	1	1.3%
Cystoid macular edema	1	1.3%
Retinal detachment	1	1.3%
Choroidal neovascular membrane	1	1.3%

abnormities, previous intraocular surgery, and DSAEK combined with complex procedures [Table 1]. Among the 18 (23.3%) graft failures, which are defined as irreversible loss of optical clarity, seven (9%) had primary failure, two (2.5%) post rejection, four (5.1%) had worsening of preexisting glaucoma, four (5.1%) post PK did not clear, and one (1.2%) eventually failed after stopping topical steroids [Fig. 4]. Overall, seven (9%) needed rebubbling; most were complicated cases such as post glaucoma surgery, post PK, vitrectomized, and ICE syndrome. A single air injection attached all discs except in one patient who underwent DSAEK with SFIOL for failed therapeutic PK. This patient had undergone PK, IOL explantation with vitrectomy for post-phaco fungal endophthalmitis initially. Post DSAEK, he needed four air injections for successful disc reattachment, which eventually resulted in clear cornea [Fig. 5a]. Interestingly, he had a habitual head nodding while speaking that was recognized and stopped after the 4th rebubbling, which lead us to believe that head nodding could have caused earlier detachments.

One ICE syndrome patient underwent triple procedure post AGV implant. Intraoperatively, disc insertion was difficult due to severe AC shallowing with IOL vaulting. The graft went into a primary failure due to probable excessive intraoperative manipulations[3] and subsequently, a PK was done [Fig. 5b].

Three patients with uneventful surgery and perioperative time came back with complications during various postoperative periods. A post-trabeculectomy patient was briefly lost to follow-up and reported 3 months later with dislocated shrunken graft needing PK [Fig. 5c]. The second patient came at 6 months with a new onset of 2-mm interface haze in the periphery. With initial intensive topical prednisolone acetate 1% (Pred Forte; Allergan, Inc, Irvine, California, USA) followed by gradual weekly tapering, she is maintaining good vision with stable haze for more than 3 years now [Fig. 5d]. The third was a 60-year-old male who reported with acute onset of pain at 3 months postop. His graft was fine but he developed a surface corneal ulcer from multidrug-resistant *Corynebacterium amycolatum* that resolved only after adjuvant corneal collagen crosslinking.

Discussion

Though DMEK has gained worldwide popularity, rightfully due to exact anatomical replacement with faster and better visual recovery than DSAEK,[5] there are certain challenging situations when DMEK is not preferred, such as in aniridia, post-glaucoma valve implants, and unicameral or vitrectomized eyes. Thus, it is important for corneal surgeons to learn DSAEK and be familiar with different insertion techniques. Taco technique offers the added benefit of insertion through smaller incisions such as the clear corneal phaco incision in cases needing triple procedures.

The main concern specific to Taco technique is endothelial cell damage from mechanical bending while folding. During folding, maximal damage is at the site of forceps grasp, while the crease area suffers stress leading to tensional homeostasis. This produces focal devitalized cells and endothelial detachments exposing bare DM as shown by Khan's study.[6] Both the pressure of folding and the duration of the fold must be minimized to reduce this damage.

According to the major Asian publication from the Singapore corneal transplant study group that compared different techniques of graft insertion in DSAEK,[3] the highest failure rates, including 25% due to primary failure and 60% of ECL by 6 months, were noted in Taco techniques. Though Taco was used only in their initial 20 DSAEK cases, which could include general procedure learning curve, they encountered rapid AC collapse upon insertion through the scleral tunnel, iris prolapse with AC maintainer, and difficulty in unfolding the graft in the chamber. They attributed these to their patient's specifics such as smaller eyes, shallower chambers, and higher positive vitreous pressures. In their study demographics, only 8.5% were Indians, 62.2% were Chinese, and the rest were Malay.

Lee *et al*.[7] calculated stepwise ECL such as partial trephination of donor eye (17.1%), folding of the disc with OVD (16.4%), and the combination of forceps compression, endothelial touch inside the chamber, and AC shallowing (54.1%). An experimental study on porcine eyes showed no significant quantitative difference in ECL between taco, drag using forceps, or drag with suture, but each had a different specific pattern of endothelial damage.[8]

A careful approach to Taco tissue handling can reduce the overall intraoperative endothelial damage. The OVD cushion prior to folding the disc reduces endothelial damage due to internal contact at the point of forceps hold. The platforms of most of the insertion forceps meet only at one spot; thus, adequate pressure of holding at their meeting point to avoid crushing of tissue being held is useful. The Utrata forceps with fine angled tips specifically designed for gentle pinch is another factor to be considered.

The endothelial trauma due to contact with the instruments, the conjunctiva, or the tunnel surface while pushing the graft through the incision is also critical. It is known that the smaller the tunnel through which the graft is pushed, the greater the endothelial damage due to exposed endothelial surface sweeping over conjunctiva and squeezing through the section tunnel wall. This eventually leads to endothelial damage, sloughing, and detachment, baring DM. But good wetting of surfaces with saline and smooth passage through the tunnel can lessen this damage.

Patients with comorbid ocular history especially prior PK show higher failure rates. According to Clements J *et al*., 31% of DSAEK post PK had disc dislocation, but excluding patients

with AGV, it was only 24%.[9] This study showed under-sizing the disc to be beneficial though PK suture removal or DM stripping showed no advantage.

In our study, five patients with endothelial failure post PK underwent DSAEK. Out of them, four had peripheral anterior synechiae, three had glaucoma needing medical or surgical treatment, and one with aphakia needed combined SFIOL. All our PK patients had 7.5-mm host DM stripping with equal-sized DSAEK graft. Among them, four (80%) eventually failed and one patient maintained clear cornea reflecting on the complexity of these cases.

The commonest indication for DSAEK in our case series is endothelial failure in pseudophakia (40), while in developed nations it is FED. All the 28 eyes of 26 patients with FED in our study who underwent triple procedure are maintaining clear cornea with good visual recovery, resulting in overall the best outcome. Out of our 75 patients, 14 had glaucoma preoperatively, 11 were on AGM, two underwent trabeculectomy, and one had an AGV implant. Post DSAEK, all continued AGM and two needed additional surgery either trabeculectomy or AGV. One patient developed steroid-induced glaucoma postoperatively but was managed medically. Overall, four (28.5%) out of the 15 glaucoma patients had DSAEK failure and three among them were post PK. Thus, the more the ocular comorbidities, the poorer the DSAEK outcome.

It is known from earlier studies on EK that ECL occurs not just in the initial 1 year but substantial accelerated cell loss continues to occur in the following years.[10] It is a concern that this can lead to critical cell count, challenging the graft survival. The specular microscopy of the central cornea may not reflect the actual status of the paracentral and peripheral endothelial damage due to folding and crushing during surgery. Normally, the paracentral and peripheral zones have denser ECD compared to central cornea. In our study, ECL of 26.3% was calculated for only 22 eyes that had specular count at 1-month post-surgery. But overall, 76.6% maintained clear graft in up to 73.8 months (average: 15.45 ± 15.75) of follow-up is encouraging.

Factors positively influencing our outcome could be younger mean donor age of 53.32, good mean donor ECD of 2419, single surgeon data, single point gentle pinch of the taco fold, free taco tip aiding easy section entry, shorter clear cornea section, smaller graft size of 8 mm or in post PK eyes 7.5 mm, spontaneous unfolding of uneven taco, and moderate rebubbling rates of 9.1%. But both smaller section and unequal taco folding on the other hand can also induce more endothelial damage from crushing and exposure. The drawback of our study is the retrospective nature and that we have only limited data on specular count. Prospective longitudinal studies to analyze differential endothelial cell loss by this procedure with longer follow-up is essential for better understanding.

Conclusion

In conclusion, our study shows that the technique of DSAEK by 70:30 taco insertion through 2.8-mm clear corneal section to be safe for Indian eyes with good graft clarity and visual outcome for up to 6 years of follow-up.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Supplemental Digital Content 1: A video of DSAEK Taco disc insertion through clear corneal incision using Utrata forceps

Summary: The DSAEK folded graft is held using Utrata forceps in a 70/30 ratio and is nudged smoothly through a 2.8-mm clear corneal incision. Once the graft tip reaches the pupillary area, a gentle lift-up motion avoids the graft from entering behind the inferior iris. After the full graft is in the AC, spontaneous unfolding of the graft happens the moment the forceps hold is released. By this time, the forceps is withdrawn out of AC completely. The graft is then stabilized with an air bubble larger than the size of the graft itself.