

PRE-DESCEMET'S ENDOTHELIAL KERATOPLASTY (PDEK)

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Endothelial keratoplasty (EK) has evolved at a brisk pace and the volume of data accumulated over the past 10 years has demonstrated that all the posterior lamellar techniques of endothelial replacement yield far superior visual, topographic, and tectonic results compared with penetrating keratoplasty.¹ We report a novel method of endothelial keratoplasty in which the endothelium and Descemet's membrane (DM) along with the Pre-Descemet's layer (Dua's layer-PDL) is transplanted and term it as Pre-Descemet's Endothelial Keratoplasty (PDEK). Early evidence to support the existence of a distinct pre-Descemet's layer of tissue was presented by Dua et al² in 2007 and followed by a detailed paper wherein evidence is presented to further support the presence of the distinct PDL. In PDEK procedure, this layer is included with the endothelium-DM complex thereby providing additional support to the graft. Presence of this layer with its characteristics of relative rigidity and toughness allows easy intraoperative handling and insertion of the tissue as it does not tend to scroll as much as the DM alone. The most popular in 'DM barring' techniques is the big bubble (BB) method where the BB forms a cleavage plane, leaving the DM bare for the dissection in lamellar keratoplasties. This entails the creation of Type 2 BB where the bubble forms between the PDL and the DM. In PDEK procedure, Type 1 BB² is formed which typically lies between the PDL and the residual corneal stroma; thereby creating a dome of PDL-DM-Endothelial complex above the air bubble.

SURGICAL TECHNIQUE:

DONOR GRAFT PREPARATION-

A corneo-scleral disc with an approximately 2 mm scleral rim is dissected from the whole globe or obtained from an eye bank. A 30-gauge needle attached to a syringe is inserted from the limbus into the mid peripheral stroma (Fig 1 Top left, Top middle). Air is slowly injected into the donor stroma till a type 1 big bubble is formed which is a well-circumscribed, central dome shaped elevation measuring 7 to 8.5 mm in diameter (Fig.1 Top right, Bottom left). It always starts in the center and enlarges centrifugally retaining a circular configuration. Trephination of the donor graft is done along the margin of the big bubble (Fig 1Bottom middle). The bubble wall is penetrated at the extreme periphery and trypan blue is injected into the bubble to stain the graft, which is then cut all around the trephine mark with a pair of corneo-scleral scissors (Fig.1Bottom right) and is covered with the tissue culture medium. The graft is loaded in to an injector when ready for insertion.

RECIPIENT BED PREPARATION-

After administering peribulbar anesthesia; the recipient corneal epithelium is debrided (if grossly edematous) (Fig 2 Top left) for better visualization. A trephine mark is made on the recipient cornea respective to the diameter of DM to be scored on the endothelial side (Fig 2 Top middle). A 2.8 mm tunnel incision is made at 10 o'clock hours near the limbus. The anterior chamber (AC) is formed and maintained with saline injection or infusion. The margin of DM to be removed is scored initially from the endothelial side with a reverse Sinsky hook (Fig 2 Top right). Once an adequate edge is lifted, a non-toothed forceps is used to gently grab the DM at its very edge and the graft is separated from the underlying stroma in a capsulorhexis-like circumferential manner. The peeled DM is then removed from the eye.

DONOR LENTICULE IMPLANTATION-

Donor lenticule (endothelium-DM-pre Descemet's layer) roll is inserted in the custom made injector (Fig 2 Bottom left) and slowly pushed up the lumen of the nozzle. The injector is improvised from an intraocular lens implant injector by removing the sponge tire and spring and re-attaching the sponge tire, to prevent any back suction and inadvertent damage to the donor graft. Using the injector, the graft roll is injected in a controlled fashion into the AC. The donor graft is oriented endothelial side down and positioned on to the recipient posterior stroma by careful, indirect manipulation of the tissue with air and fluid (Fig 2 Bottom middle). Once the lenticule is unrolled, an air bubble is injected underneath the donor graft lenticule to lift it towards the recipient posterior stroma. The AC is completely filled with air for the next 30 minutes followed by an air-liquid exchange to pressurize the eye (Fig 2 Bottom right). Eye speculum is finally removed and AC is examined for air position. The patient is advised to lie in a strictly supine position for next 3 hours.

PDEK entails the inclusion of the PDL in the donor graft; thereby providing the benefits of Descemet's membrane endothelial keratoplasty (DMEK) like speedy visual recovery and overcoming the disadvantages posed by DMEK. PDEK takes ultra thin- Descemet's stripping endothelial keratoplasty (UT-DSEK) to a "thinner level" whilst retaining its advantages but not requiring sophisticated instrumentation and keratome. The spectral domain optical coherence tomography (SD-OCT) in vivo analysis of PDEK grafts showed mean graft thickness after 1 month to be 28 ± 5.6 microns which is larger than the conventional DMEK graft and lesser than the ultrathin Descemet's stripping automated endothelial keratoplasty (DSAEK) graft. In PDEK, the additional layer thickness with endothelium-DM complex is lesser than the overall thickness of the DSEK or ultrathin DSAEK graft. This is compatible with a faster visual recovery. A comparison of the preoperative and postoperative clinical slit lamp pictures of the eye along with OCT images show a clear graft on the first postoperative day (Fig 3). Some aspects of the different endothelial keratoplasty techniques are demonstrated in Table 1. Long term studies evaluating different parameters such as endothelial cell loss over time, interface, detachment rates and final visual acuity including higher order aberrations and contrast sensitivity are required to establish a place for PDEK in corneal transplantation surgery.

REFERENCES:

1. Terry MA. Endothelial Keratoplasty: Why Aren't We All Doing Descemet's Membrane Endothelial Keratoplasty?. *Cornea*. 2012; 31 (5) 469:471.
2. Dua HS, Faraj LA, Said DG, Gray T, Lowe J. Human Corneal Anatomy Redefined: A Novel Pre-Descemet's Layer (Dua's Layer). *Ophthalmology*. 2013 Sep;120(9):1778-85.

LEGENDS FOR FIGURES:

Figure 1: Pre-Descemet's endothelial keratoplasty (PDEK) donor graft preparation.

Top left: A 30G needle inserted at the limbus on the endothelial side

Top middle: Needle advanced into the stroma

Top right: Intrastromal air injection

Bottom left: Central dome shaped Type-1 big bubble formed

Bottom middle: Trephination of endothelial graft performed

Bottom right: Endothelial-Descemet's membrane (DM) complex with pre-Descemet's layer stained with trypan blue and cut with corneo-scleral scissors

FIGURE # 1

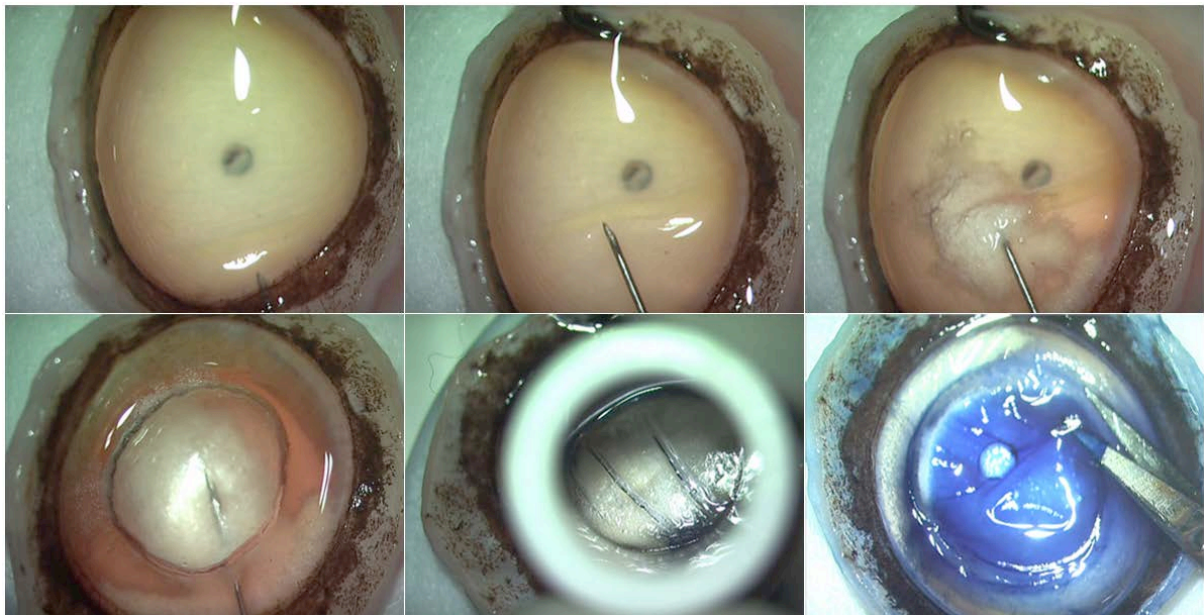


Figure 2: Recipient bed preparation and Graft insertion.

Top left: Preoperative image of the eye with endothelial decompensation. Epithelium debridement being done.

Top middle: Trephine marking done on cornea.

Top right: DM scored and stripped with reverse Sinsky hook.

Bottom left: Graft lenticule is loaded into an injector

Bottom middle: Intraoperative manipulation of the graft for proper positioning.

Bottom right: Air injected underneath the donor graft lenticule to lift it towards the recipient posterior stroma. Anterior chamber filled with air.

FIGURE #2

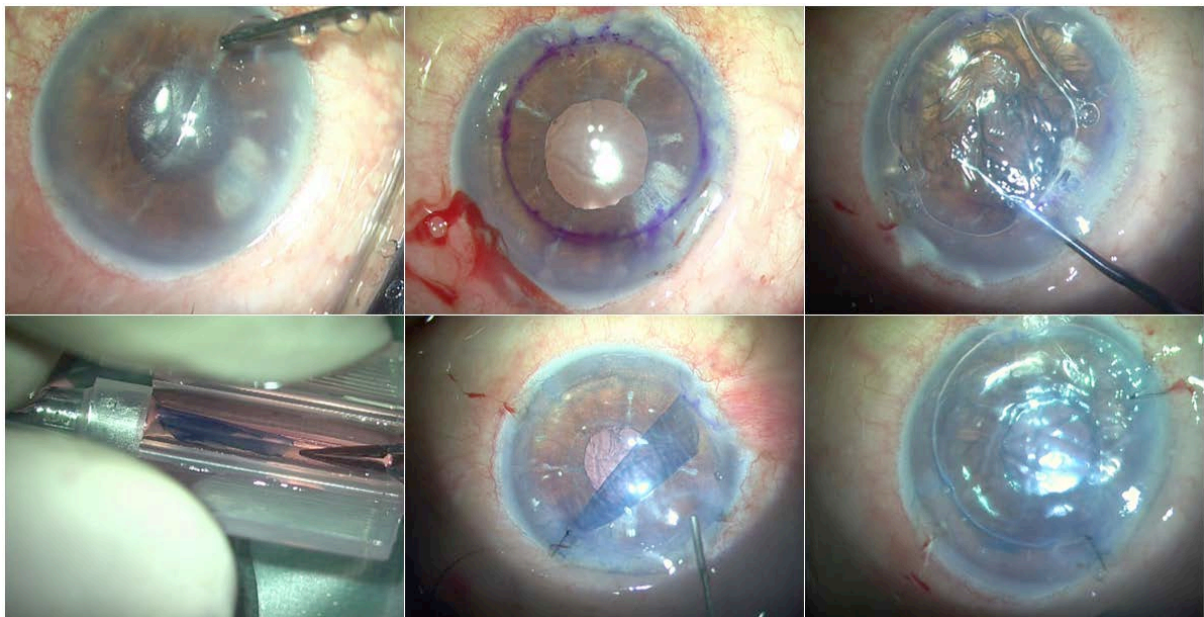


Figure 3: Preoperative, postoperative and Optical coherence tomography (OCT) picture (day one) of a PDEK case.

FIGURE # 3

