

# Four in one: Four recipients with a single donor tissue - A novel concept for eye transplantation surgery post-COVID-19

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A donor corneo-scleral button was dissected into four parts using a simple manual technique. The anterior corneal lamellae was stripped from the Descemet's Membrane (DM) and Deep Anterior Lamellar Keratoplasty (DALK) was performed in a patient with advanced keratoconus after removing the recipient's stroma using the big bubble technique. Descemet's Membrane Endothelial Keratoplasty (DMEK) was done with the stripped donor DM in a patient with Fuch's endothelial dystrophy (FECD). The cadaveric limbal stem cells from the tissue were used for simple limbal epithelial transplantation (SLET) in a Steven-Johnson Syndrome (SJS) with localized limbal stem deficiency and symblepharon. The sclera was used to revise a leaking hypotonus bleb in an advanced single-eyed glaucoma patient. No intraoperative or postoperative complications were observed. At 1 year, all the 4 cases retained healthy transplanted tissues with good visual outcomes. Shortage of donor eyes is a global problem and with the present COVID-19 scenario the situation is bound to worsen. The advent of customized component corneal transplantation using simple cost-effective techniques will be the future trend in the years to come.

**Key words:** Component corneal surgery, corneal blindness, multiple recipients, single donor

Corneal transplantation surgery has come a long way since Eduard Zirm performed the first corneal graft in 1905 as reported by Moffatt *et al.*<sup>[1]</sup> During the last century, there have been various efforts to improve the techniques and results of corneal transplants. Recent emphasis is on performing customized component corneal transplantation that allows the selective excision of diseased corneal tissue and its replacement by a healthy donor corneal tissue.<sup>[2]</sup> Apart from having a better prognosis, the other significant advantage of these techniques is that they may allow the use of one donor cornea to treat multiple patients.

In the past, surgeons have tried to use the same donor corneal button for 2 or 3 cases.<sup>[3,4]</sup> All these techniques involved sophisticated expensive machines to perform the lamellar cuts in the cornea.<sup>[2]</sup> In this study, we present our simple manual surgical techniques in treating 4 patients using a single donor tissue. Currently, during this COVID-19 pandemic, when the entire organ donation has been paralyzed in India, our technique will be relevant for corneal surgeons to effectively utilize the tissue in future.

## Surgical Technique

A good-quality donor cornea was retrieved from a 50-year-old donor who had died of cardiac arrest (with an enucleation time of 2 h 45 min after death). The donor blood sample tested negative for human immunodeficiency virus (HIV), Hepatitis B surface antigen (HbSAg) and syphilis antigen. In the current

situation, COVID-19 antibody test has to be additionally performed for all the donors. A corneoscleral rim with 4 mm of sclera was dissected from the donor eyeball in a lamellar flow hood, under sterile conditions and was stored in Cornisol medium (AuroLab, India). The remaining sclera was preserved in McCarey and Kaufman medium. The separated tissues were stored at 4° Celsius. The next day in the operation theatre, the tissue was placed over the Teflon block with endothelial side up and the Descemet's membrane (DM) was stripped by a single pull technique. "L" shaped stamp mark was made over the stromal side of the DM after staining it with the ink of a sterile marker pen. The stamped DM was transferred into another pre-stripped low grade corneal tissue with the endothelial side facing up. The good quality donor cornea, now devoid of the DM was punched 8.70 mm with a vacuum punch and used for Deep Anterior Lamellar Keratoplasty (DALK) in a keratoconus patient. The stripped DM was injected into a patient with Fuch's Endothelial dystrophy (FECD) for Descemet's Membrane Endothelial Keratoplasty (DMEK) after punching with a 7.75 mm trephine and was attached with air. From the remaining corneoscleral rim, a limbal stem cell lenticule (7 mm × 2 mm) was harvested for symblepharon release and Simple Limbal Epithelial Transplantation (SLET) in a Stevens Johnson Syndrome (SJS) patient. The preserved sclera was dissected partial thickness (7 × 4 mm, <100 microns) and was used for revising a thin bleb. The tissue preparation

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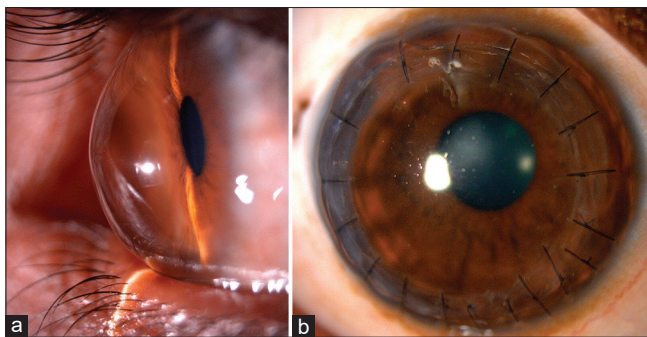
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and transplantation were performed by a single surgeon. All the patients read and signed an informed consent document prior to surgery.

**Case 1**

Seventeen year old male with advanced keratoconus with anterior stromal, scarring sparing the DM was selected for manual DALK [Fig. 1a]. His preoperative best spectacle corrected visual acuity(BSCVA) in the left eye was 5/60. The surgery was performed under general anaesthesia. After marking the cornea with a 8.70 mm trephine, partial trephination with a 350 micron guarded knife was performed. A 27 gauge DALK cannula was used to create a type 1 big bubble to separate the stroma from the DM. After complete removal of the recipient's stroma, the pre-DM stripped donor button was transplanted using eighteen interrupted 10-0 nylon sutures.



**Figure 1:** Deep anterior lamellar keratoplasty (a) Advanced Keratoconus (b) Postoperative period – 1 year

**Case 2**

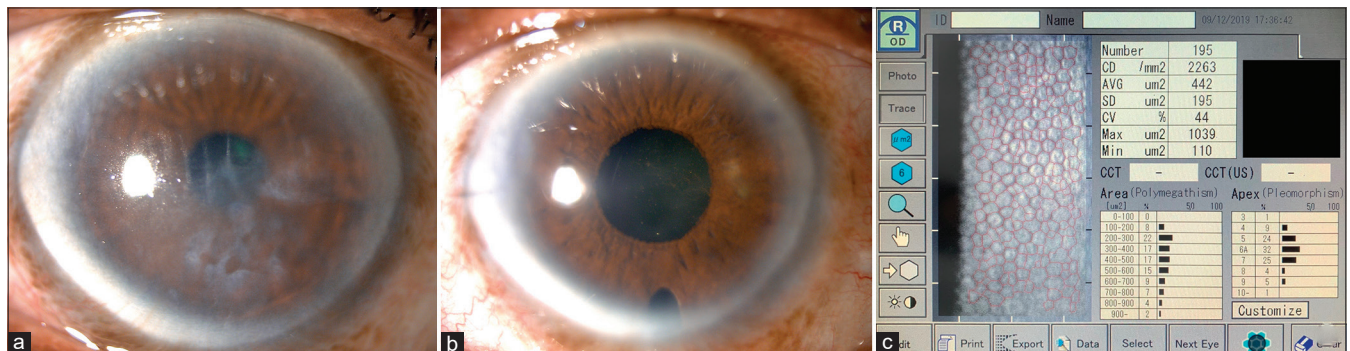
The pre-stripped DM tissue was used for DMEK in a 55-year-old female, a known case of FECD [Fig. 2a]. Preoperative BSCVA was 6/36. Phacoemulsification with intraocular lens implantation was done through a 3 mm corneal tunnel. The healthy donor DM placed over the low grade tissue was punched with a 7.75 mm vacuum trephine and the scroll was injected through the same corneal incision and 1 suture was applied with a 10-0 nylon suture. The DM was unfolded in the anterior chamber and fixed with a complete air fill.

**Case 3**

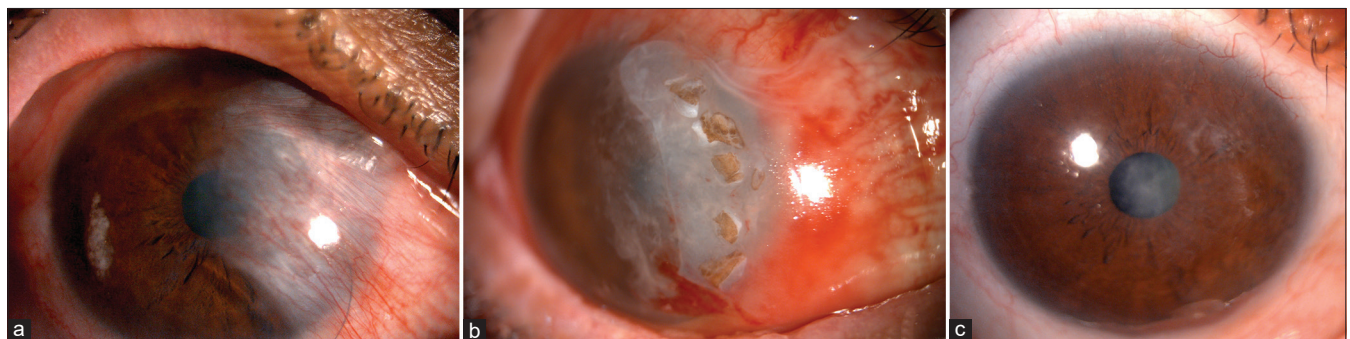
A partial-thickness limbal stem cell lenticule (7 mm × 2 mm) harvested from the same donor cornea was placed along with an amniotic membrane graft (AMG) after symblepharon release into the right eye of a 45-year-female who had developed SJS about 2 years back [Fig. 3a]. Her preoperative visual acuity was 6/36. All the fibrotic conjunctival tissue adherent to the underlying sclera was removed with tenotomy scissors and those encroaching on the cornea was excised using a crescent knife. The bare sclera and the corneal portion was covered with an AMG and the donor limbal stem cell lenticules were cut into 4-5 small pieces and placed over the AMG and fixed with glue. A bandage contact lens was put over the operated eye [Fig. 3b].

**Case 4**

The stored sclera was used for a patch graft for a 72-year-old patient with a thin leaking bleb with IOP of 5 mmHg [Fig. 4a]. He had underwent trabeculectomy in 2011. The bleb had gradually thinned over the years and started leaking for the past 1 month. Since it was the only seeing eye with a relatively good vision of 6/9, the donor sclera was partially dissected (less



**Figure 2:** Descemet's membrane endothelial keratoplasty (a) Fuch's endothelial dystrophy (b) Postoperative period – 1 year (c) Specular count – 1 year

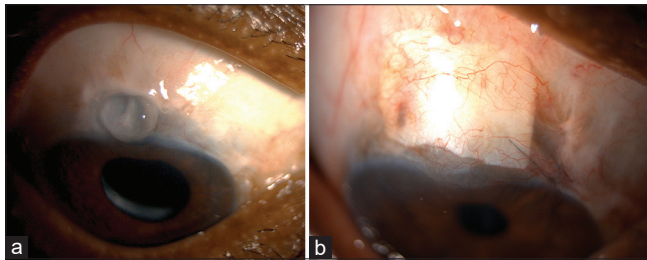


**Figure 3:** Simple limbal epithelial transplantation (a) Steven-Johnson Syndrome with symblepharon (b) Immediate postoperative period (c) Postoperative period – 1 year

**Table 1: Single donor eye- Summary of component surgery**

Donor component used	Name of surgery	Indication	Preop BSCVA	Post op BSCVA (1 year)
Epithelium - BM- anterior and posterior stromal lamellae	DALK	Keratoconus	5/60	6/9
DM and endothelium	DMEK	FECD	6/36	6/6
Cadaveric limbal stem cells	SLET	SJS with partial LSCD	6/36	6/9
Sclera	Scleral patch graft	Post trab -thin leaking bleb	6/9	6/9

BM: Bowman's membrane DM: Descemet's membrane, DALK: Deep anterior lamellar keratoplasty, DMEK: Descemet membrane endothelial keratoplasty, SLET: Simple Limbal epithelial transplantation. SJS: Stevens-Johnson Syndrome, LSCD: Limbal Stem Cell Deficiency, FECD: Fuchs' endothelial corneal dystrophy



**Figure 4: Scleral patch graft (a) Thin fragile bleb (b) Postoperative period – 1 year**

than 100 microns) and placed over the sclerotomy opening and sutured at the periphery with 10-0 nylon sutures. Conjunctival autograft was taken from the other eye, to close the conjunctival defect.

## Results

Component surgery from a single donor is summarized [Table 1]. The anterior lamellar graft was attached well to the host DM in the DALK patient and no interface haze or debris was seen and the BSCVA slowly improved to 6/9 over a year [Fig. 1b]. In DMEK, the cornea cleared well with stromal scarring gradually fading away and the BSCVA improved to 6/6 [Fig. 2b]. Specular count at 1 year was 2263 cells/mm<sup>2</sup> [Fig. 2c]. In the patient with SJS, the limbal stem cell lenticules placed over the AMG took up well and the ocular surface remained stable at 1 year with BSCVA improving to 6/9 [Fig. 3c]. In the bleb leak patient, the scleral patch graft was well apposed with the conjunctival autograft and no leak was noted. At 1 year follow up, his vision was stable with normal IOP. The visual fields were normal with no progression of glaucoma [Fig. 4b].

## Discussion

Full-thickness penetrating keratoplasty has always been the gold standard in the management of corneal lesions irrespective of the layer of corneal involvement. In recent times, there is a shift towards disease-specific corneal layer replacement rather than replacing the entire cornea which has led to an evolution in the concept of customized component corneal surgery.<sup>[2]</sup>

In 2004 Shimmura first conceptualized this new idea of component corneal surgery.<sup>[5]</sup> Later in 2007, Vajpayee *et al.* successfully used one donor cornea for anterior lamellar, posterior lamellar and the limbal stem transplantation procedures in 3 different patients.<sup>[3]</sup> The advantages of this procedure is that it decreases the risk of graft rejection and avoidance of complications associated with open-sky

procedures but the depth of the lamellar cut is sometimes variable and there is a chance of interface irregularity resulting in suboptimal visual outcomes unable to match PK visual quality.<sup>[6]</sup> To perform the component corneal surgery they used automated microkeratomes, which are very expensive and are not widely available with all corneal surgeons in India. For endothelial transplantation we preferred DMEK over DSAEK as it provides faster visual rehabilitation and a perfect anatomical replacement of the endothelial cells with no additional stroma. We in this study performed a simple cost effective manual technique which entails the complete utilization of one donor cornea for multiple recipients.

The eye banks should be able to segregate the patients list into cluster segments so that when a donor's eye is recovered, the component corneal surgery patients are synchronously coordinated and the tissue is utilized immediately without delay to all the multiple recipients. Also care is taken in the process of documentation of the donor and the multiple recipients details in the eye bank records when the same eye is utilized for various surgeries. In our eye bank, we segregated the waiting list according to the diagnosis. After assessing the quality of the donor tissue, the first patient in each waiting list was called for surgery the next day. The fellow donor cornea was usually used for regular full-thickness keratoplasties. If the corneal surgeons feel the tissue separation is a difficult process the eye banks can take up the initiatives to split the donor corneal tissue and distribute the pre-cut tissue to a large number of surgeons.<sup>[4]</sup>

## Conclusion

In conclusion, without using any sophisticated microkeratomes our simple manual surgical technique provides an opportunity to make use of a single donor eye in at least four patients, thus putting the available corneal and scleral tissue to maximum use. In developing countries, such simple evolution of manual techniques for customized corneal surgery will help surgeons to reduce the load of preventable blindness. The current COVID-19 situation is bound to increase the corneal blindness worldwide and learning techniques allowing multiple utilization of a single tissue is critical.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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