

## Outcomes of corneal transplantation using donor corneas retrieved from patients with chronic kidney disease

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**Purpose:** To report the outcomes of corneal transplantation utilizing corneas retrieved from donors with chronic kidney disease (CKD). **Methods:** Outcomes of corneal transplantation (optical PK and EK) performed from Jan 2018 to Dec 2018 utilizing donor corneas retrieved from CKD patients was performed retrospectively. **Results:** Of the total of 233 donor corneas retrieved from CKD, 135 (57.9%) were utilized for transplantation after the routine screening protocol of the eye bank. Mean age of the donors was  $56.2 \pm 13.5$  years. The mean endothelial cell density on specular microscopy of the donor corneas used for optical PK was  $2685.7 \pm 377.6$  cells/mm<sup>2</sup> (range, 2028–3448 cells/mm<sup>2</sup>) and for EK was  $2731.7 \pm 189.1$  cells/mm<sup>2</sup> (range, 2380–3194 cells/mm<sup>2</sup>). The overall primary graft failure rate was 5.1%. All grafts except 1, cleared in the PK group. In the EK group (6 DMEK and 16 DSAEK), 1 patient had a complete graft detachment and another 1 had a primary graft failure after DMEK. **Conclusion:** The donor corneas retrieved from chronic kidney disease patients are safe and suitable for optical keratoplasty provided they meet the criteria for transplantation.

**Key words:** Chronic kidney disease, corneal endothelium, keratoplasty, specular microscopy

Chronic kidney disease (CKD) is a spectrum of disease associated with gradual decline of renal functions.<sup>[1,2]</sup> The condition is classified into stages 1 to 5, where stage 5 is a stage of end-stage renal disease that is managed by renal replacement therapy such as hemodialysis or kidney transplantation. Patients with CKD can develop various ophthalmic complications such as cataracts, band-shaped keratopathy, calcification of conjunctiva, renal retinopathy, and retinal detachment.<sup>[3,4]</sup> The most reasonable explanation for these changes is the breakdown of homeostasis of body fluids. As aqueous humor is extracellular fluid, it is presumed that the metabolic abnormalities in the aqueous humor can affect the health of corneal endothelium and lead to endothelial alterations. Many studies have reported the endothelial abnormalities in patients with CKD.<sup>[5-7]</sup> These changes were reportedly more prominent in those patients undergoing hemodialysis and elevated blood urea levels.

The contraindications for donor corneal transplantation on the grounds of the donor's medical history are exhaustive. Despite reports of endothelial changes in CKD patients, corneas retrieved from these donors have been used for transplantation if the donor corneal parameters fulfilled the requirements for corneal transplantation. The screening of donor corneas using specular microscopy gives an assessment of morphological and quantitative parameters of endothelium. The functionality of corneal endothelium from a transplanted cornea can be only assessed with the recovery of graft clarity after transplantation.

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Received: 10-Aug-2019

Revision: 23-Oct-2019

Accepted: 02-Jan-2020

Published: 25-May-2020

Access this article online

Website:

www.ijo.in

DOI:

10.4103/ijo.IJO\_1465\_19

Quick Response Code:



There are no studies on the outcomes of corneal transplantation from CKD donors.

Hence, the purpose of this study is to evaluate the outcomes of corneal transplantation using donor corneas retrieved from CKD patients that were deemed suitable for transplantation after routine donor cornea evaluation.

### Methods

This is a retrospective observational study conducted at a tertiary eye care center. All the donor corneas retrieved by the eye bank affiliated to the institute from January 2018 to December 2018 were screened and those with CKD being the cause of death were analyzed. Those donors where diabetes mellitus was the underlying cause of CKD were excluded. Primary graft failure was defined as persistent graft edema at 2 months after keratoplasty.

### Donor cornea selection criteria at the Eye Bank

The general criteria for selecting corneas for keratoplasty is endothelial cell density above 2000 cells/mm<sup>2</sup> for optical penetrating keratoplasty (PK) and 2200 cells/mm<sup>2</sup> for endothelial keratoplasty (EK) that includes both Descemet's stripping automated endothelial keratoplasty (DSAEK) and Descemet's membrane endothelial keratoplasty (DMEK). Those corneas with endothelial cell density ranging

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**Cite this article as:** Sravani NG, Mohamed A, Nandyala S, Chaurasia S. Outcomes of corneal transplantation using donor corneas retrieved from patients with chronic kidney disease. Indian J Ophthalmol 2020;68:1054-6.

between 1500 and 2000 cells/mm<sup>2</sup> are often selected for use in anterior lamellar keratoplasty or therapeutic penetrating keratoplasty where eradication of infection is the primary goal of surgery.

#### Inclusion criteria

- All the donor corneas retrieved from CKD patients that were labeled suitable and utilized for corneal transplantation (either PK or EK) at our institute, after eye bank screening protocol.

#### Exclusion criteria

- Donor corneas which did not meet the suitability criteria for transplantation
- Donor corneas which were suitable for transplantation, but were utilized at other hospitals for transplantation were excluded due to lack of access to post-keratoplasty medical records of those patients
- Donor corneas that were utilized for anterior lamellar keratoplasty and therapeutic penetrating keratoplasty
- Donor corneas where the underlying cause of CKD was diabetes mellitus.

The software Origin 7.0 (OriginLab Corporation, Northampton, MA, USA) was used to perform the statistical analysis. Normality of the continuous data was evaluated using the Shapiro–Wilk test. Mean ( $\pm$  standard deviation) and median (along with inter-quartile range [IQR]) were used to describe the parametric and nonparametric data, respectively.

## Results

A total of 233 donor corneas were retrieved from CKD from January 2018 to December 2018, of which 135 (57.9%) were utilized for transplantation after the routine screening protocol of our eye bank. The remaining 98 donor corneas could not be used for the following reasons: seropositive donors ( $n = 13$ ), intraoperative reasons for non-utilization ( $n = 4$ ), donor tissue earmarked for therapeutic keratoplasty (endothelial cell density <2000 cells/mm<sup>2</sup>) but not used ( $n = 51$ ), and poor tissue quality for any kind of transplant ( $n = 30$ ).

Of the 135 corneas, 61 donor corneas were utilized at the institute. The surgeries were performed by faculty and senior cornea fellows with adequate experience in performing keratoplasty. Of these 61 corneas, 40 were utilized for optical PK ( $n = 18$ ) and EK ( $n = 22$ ). Of the 22 EK, 6 were DMEK and 16 were DSAEK. The remaining 21 donor corneas were used for anterior lamellar keratoplasty ( $n = 5$ ), therapeutic keratoplasty ( $n = 12$ ), and keratoprosthesis or patch graft ( $n = 4$ ) and, hence, were excluded from outcome analysis. Table 1 summarizes the baseline parameters and outcomes of the PK and EK group.

#### Donor characteristics

The mean age of the donors was  $56.2 \pm 13.5$  years (range, 21–75 years). The donor tissues were stored in McCarey-Kaufmann tissue preservation media until they were utilized. Of the 40 eyes from where the donor corneas were retrieved, 38 were phakic and 2 were pseudo-phakic. The mean endothelial cell density, % coefficient of variation, and hexagonality % on specular microscopy of the donor corneas for PK was  $2685.7 \pm 377.6$  cells/mm<sup>2</sup> (range, 2028–3448 cells/mm<sup>2</sup>),  $32.7 \pm 4.8$  (range, 25–40), and  $57.2 \pm 5.9$  (range, 48–67), respectively, and for EK  $2731.7 \pm 189.1$  cells/mm<sup>2</sup> (range, 2380–3194 cells/mm<sup>2</sup>),  $35.5 \pm 4.7$  (range, 26–46), and  $55.5 \pm 7.5$  (range, 49–77), respectively. The mean pachymetry in PK group was  $530.6 \pm 7.8$   $\mu$ m (range, 511–539  $\mu$ m) and in EK group was  $530.9 \pm 10$   $\mu$ m (range, 514–550  $\mu$ m).

#### Recipient characteristics

The median age of recipients that had PK was 47.5 years (IQR, 35–61 years) and for those that had EK was 64 years (IQR, 56–68 years). The indications for PK were corneal scar (10 patients), failed prior PK (5 patients), disorganized anterior segment with anterior staphyloma ( $n = 1$ ), anterior segment dysgenesis ( $n = 1$ ), and primary congenital glaucoma ( $n = 1$ ). Of 18 patients that had PK, 11 had an additional procedure at the keratoplasty (amniotic membrane grafting in 2 patients, tarsorrhaphy in 3 patients, cataract surgery in 3 patients, anterior segment reconstruction 2 eyes, and anterior vitrectomy in 1 eye). The indications for EK were pseudophakic

**Table 1: Baseline parameters and outcomes after PK and EK**

Parameters	PK ( $n=18$ )	EK ( $n=22$ ; 16 DSAEK and 6 DMEK)
Age of donor (years), mean $\pm$ SD (range)	50.4 $\pm$ 15 (21-75)	60.8 $\pm$ 10.9 (38-73)
Endothelial cell density (cells/mm <sup>2</sup> ), mean $\pm$ SD (range)	2685.7 $\pm$ 377.6 (2028-3448)	2731.7 $\pm$ 189.1 (2380-3194)
Coefficient of variation (%), mean $\pm$ SD (range)	32.7 $\pm$ 4.8 (25-40)	35.5 $\pm$ 4.7 (26-46)
Hexagonality index (%), mean $\pm$ SD (range)	57.2 $\pm$ 5.9 (48-67)	55.5 $\pm$ 7.5 (49-77)
Pachymetry ( $\mu$ m), mean $\pm$ SD (range)	530.6 $\pm$ 7.8 (511-539)	530.9 $\pm$ 10 (514-550)
Age of recipient (years), median (inter-quartile range)	47.5 (35-61)	64 (56-68)
Outcomes of keratoplasty		
a. Primary graft failure	1	#1
b. Early post-keratoplasty infection	0	0
c. Secondary graft failure	3	2
Rejection	3	1
Delayed Microbial keratitis	0	1
d. Median visual acuity (logMAR)		
At 3 months	1.05	0.39
At 6 months	1.30	0.39

#One eye had a complete graft detachment after DMEK, underwent DSAEK subsequently and is excluded here

corneal edema (8 patients), Fuchs endothelial corneal dystrophy (4 patients), failed PK (3 patients), iridocorneal endothelial syndrome (1 patient), and other causes of corneal edema (6 patients). Seven patients had additional surgery at the time of EK (cataract surgery in 4 patients, intraocular lens repositioning in 1 patient, secondary IOL in 1 patient, anterior vitrectomy in 1 patient).

### Outcomes of keratoplasty

All grafts except 1, cleared at 1 month in the PK group. The indication for surgery in the patient who had primary graft failure was disorganized anterior segment with anterior staphyloma. Three patients developed secondary graft failure following an episode of rejection at 3 months in 2 patients and at 1 year in 1 patient.

In the EK group (6 DMEK and 16 DSAEK), 1 patient had a complete graft detachment and another one had a primary graft failure after DMEK. In the case of primary graft failure after DMEK, there was a difficult unfolding documented in the operative notes. Two patients had a secondary graft failure following an episode of rejection at 6 months in 1 patient and microbial keratitis at 3 months in the other patient. This patient who had rejection had DSAEK under previous therapeutic penetrating keratoplasty. None of the patients had any acute infective episode following keratoplasty.

The median visual acuity in the PK group at 3 months was logMAR 1.05 ( $n = 11$ ) and logMAR 1.30 at 6 months ( $n = 8$ ). The median visual acuity in EK group was logMAR 0.39 at 3 and 6 months ( $n = 17$ ).

### Discussion

In most centers of the world, the donor cornea demand far exceeds the supply of corneas. The donor corneas obtained from patients with a history of chronic medical conditions are harvested and, if deemed suitable after a routine evaluation at the eye bank, are utilized for transplantation. There are many reports of endothelial affliction in patients with CKD. Although there are no reports of clinical corneal edema in patients with CKD, most studies have observed morphological abnormalities in the corneal endothelium of these patients. Ohuguro *et al.* reported an increased polymegathism and pleomorphism despite a normal endothelial cell density in patients with chronic renal failure.<sup>[6]</sup> Other authors have found that the endothelial alterations are more marked in those patients who had hemodialysis.<sup>[7]</sup>

During routine donor cornea evaluation in the eye bank, we have observed some instances where both the corneas procured from CKD patients had low to borderline endothelial cell density. However, corneas procured from donors suffering from CKD more often meet the parameters needed for optical keratoplasty and, hence, were considered for use in optical keratoplasty. The purpose of this study was to evaluate the clinical outcomes of optical keratoplasty using donor corneas harvested from patients with CKD.

Of the total of 233 corneas procured from donors with CKD, 102 (43.7%) corneas did not meet the criteria for transplantation for optical keratoplasty. Among those that fulfilled the criteria for utilization for optical keratoplasty (PK and EK) on the basis of endothelial evaluation, except for two, all grafts (95%) cleared after keratoplasty. In the two eyes which had a primary graft failure (2/39, 5.1%; 1 after PK and another after DMEK), the preoperative factors and intraoperative/iatrogenic factors could not be ruled out as contributing factors for primary graft failure.

We could not evaluate an association of donor endothelial health with the stage of CKD and hemodialysis as the data were collected retrospectively and there were inherent limitations in obtaining a clear history on the exact management of CKD patients with hemodialysis from the donor documents maintained at the eye bank. The other limitations of the study are limited follow-up duration after keratoplasty and lack of postoperative endothelial cell density in most of the patients, which would have been useful in correlating the endothelial cell loss after keratoplasty with these donors.

### Conclusion

In conclusion, even though literature suggests a reduction in endothelial health parameters in CKD patients, the donor corneas from these patients can be utilized for optical penetrating and endothelial keratoplasty provided they meet the evaluation criteria.

### Acknowledgements

The authors acknowledge the eye bank staff for providing donor data for the clinical study.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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