One Donor Cornea for 3 Recipients

A New Concept for Corneal Transplantation Surgery

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Objective: To describe the use of a single donor corneal tissue in 3 patients with corneal pathologic conditions.

Methods: A donor corneal tissue was divided into 3 parts using a microkeratome and a trephine. The anterior lamellar disc was transplanted into a patient with macular corneal dystrophy using the automated lamellar therapeutic keratoplasty technique. The posterior lamellar disc was transplanted into a patient with pseudophakic bullous keratopathy using the Descemet stripping automated endothelial keratoplasty technique. The peripheral corneoscleral rim was used for limbal stem cell transplantation in a child with limbal stem cell deficiency.

Results: All surgical procedures were performed successfully. At 3 months, the best-corrected visual acuities achieved following automated lamellar therapeutic keratoplasty, Descemet stripping automated endothelial keratoplasty, and limbal stem cell transplantation were 20/60, 20/40, and 20/200, respectively.

Conclusion: The advent of customized component corneal transplantation techniques may allow the use of 1 donor cornea to treat multiple patients.

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Corneal transplantation surgery has come a long way since Eduard Zirm performed the first corneal graft in 1905 as reported by Moffatt et al.1 During the last century, there were ongoing efforts to improve the technique and the results of this surgery. Recent emphasis is on performing customized component corneal transplantations that allow the selective excision of diseased corneal tissue and its replacement by healthy donor corneal tissue. These surgical treatments are mostly lamellar corneal transplantation techniques and include procedures such as the Descemet stripping automated endothelial keratoplasty (DSAEK) technique, deep anterior lamellar keratoplasty, and automated lamellar therapeutic keratoplasty (ALTK). Techniques for endokeratoplasty such as DSAEK involve replacement of the diseased endothelium with healthy donor endothelium. The surgical outcomes in DSAEK have shown that the technique provides significant advantages over penetrating keratoplasty, including more rapid healing, predictable refractive outcomes, and better retention of corneal strength and integrity.2,3 Likewise, customized component corneal surgery such as ALTK has become popular in the treatment of corneal pathologic conditions limited to the corneal stroma using microkeratomes to cleanly excise the corneal tissue. Lamellar corneal transplantations performed using automated microkeratomes provide enhanced optical quality, and the interface between the host and donor tissue is free from opacification and vessel growth.3,5

The other significant advantage of these techniques is that they have opened up the possibility of using 1 donor cornea to treat multiple patients. In this study, we present our experience with this new concept in treating 3 patients with a single donor corneal tissue.

Methods

Donor Cornea

A good-quality donor cornea that was retrieved from a 44-year-old donor who had died of cardiac arrest (with an enucleation time of 1 hour 15 minutes after death) was stored in McCarey-Kaufman medium. The donor blood sample tested negative for human immunodeficiency virus, hepatitis B surface antigen, hepatitis B core antigen, and syphilis antigen. The death-to-use time was 2 hours 30 minutes. A microkeratome (Moria, Antony, France) and a trephine (Madhu Instruments, Dehli, India) were used to divide the tissue into the following 3 parts: (1) the anterior lamellar disc, consisting of partial-thickness corneal stromal tissue; (2) the posterior lamellar disc, consisting of corneal stroma and endothelium; and (3) the peripheral corneoscleral rim, which harbors the limbal stem cells.
A corneoscleral rim with 4 mm of sclera and an intact epithelium were mounted in the microkeratome’s artificial anterior chamber. The chamber was pressurized using balanced salt solution (Alcon, Fort Worth, Tex) hung from an adjustable pole at a height of 1.9 m. The height of the microkeratome guide plate was adjusted to provide an anterior lamellar graft of 9.0-mm diameter as confirmed using the applanation lenses, and a 350-µm microkeratome head was used to harvest a lamellar donor button over a closed chamber. The remaining posterior lamellar tissue was carefully removed from the artificial chamber and was transferred to a Teflon block with the endothelial side facing up. An 8-mm trephine was used to punch the posterior lamellar donor lenticule. From the remaining corneoscleral rim, 2 limbal stem cell lenticules (6 × 2 mm each) were harvested. After splitting the donor corneal tissue into 3 parts, 3 surgical procedures were performed in 3 patients.

**REPORT OF CASES**

**CASE 1: ALTK**

A 40-year-old man with macular corneal dystrophy that seemed to involve only the anterior two thirds of corneal stroma was selected for ALTK. His preoperative best-corrected visual acuity was 20/200 OU. Peribulbar anesthesia was used for the surgery. After excising the anterior 350 µm of the host corneal tissue using a microkeratome and a trephine, the anterior lamellar disc of the donor cornea was transplanted using sixteen 10-0 interrupted nylon sutures. The postoperative treatment included a combination of 1% prednisolone acetate eyedrops every 4 hours, 0.5% moxifloxacin hydrochloride eyedrops 3 times daily, and preservative-free tear substitutes every 4 hours.

**CASE 2: DSAEK**

The posterior lamellar disc with healthy corneal endothelium was transplanted into a 60-year-old man who had pseudophakic bullous keratopathy following complicated cataract surgery using the standard technique of DSAEK. His preoperative best-corrected visual acuity was 20/400 in the eye to be operated on. The surgical technique consisted of stripping the Descemet membrane and endothelium from the recipient’s central cornea and transplanting an 8.0-mm disc of donor endothelium and posterior stroma through a 5.0-mm scleral tunnel incision. Three 10-0 monofilament sutures were used to close the scleral incision. After surgery, the patient was given a combination therapy of 1% prednisolone acetate eyedrops every 4 hours, 0.5% moxifloxacin hydrochloride eyedrops 3 times daily, and preservative-free tear substitutes every 4 hours.

**CASE 3: CADAVERIC LIMBAL STEM CELL TRANSPLANTATION**

The 2 partial-thickness corneal limbal stem cell lenticules harvested from the peripheral corneoscleral rim of the donor cornea were transplanted into the right eye of a 5-year-old boy who had total limbal stem cell deficiency in 1 eye due to alkali burns. His preoperative visual acuity was counting fingers close to the face. All the scarred conjunctival tissue encroaching on the damaged cornea was excised using a crescent knife, and the 2 donor limbal stem cell lenticules were transplanted onto the recipient’s limbal stem cell bed using 10-0 monofilament sutures. The postoperative treatment included a combination of 1% prednisolone acetate eyedrops every 4 hours, 0.5% moxifloxacin hydrochloride eyedrops 3 times daily, 2% cyclosporine eyedrops 4 times daily, and preservative-free tear substitutes every 4 hours. A bandage contact lens was put into the operated eye.

**RESULTS**

All the surgical procedures were performed on the same day and were successful in all 3 cases. At the last follow-up (3 months), the 9.0-mm anterior lamellar graft, transplanted into a man with macular corneal dystrophy, was well apposed with the recipient cornea. All sutures were normal, and the anterior chamber was formed. There was mild interface haze, which cleared within 2 weeks. The time until epithelialization followed ALTK was 4 days, and his best-corrected visual acuity after surgery was 20/60 (Figure 1).

Following DSAEK into the patient with pseudophakic bullous keratopathy, the graft was well centered (Figure 2). No intraoperative problems were encountered. There was a minimal amount of edema in the graft and host cornea during the postoperative period. The central part of the graft cleared within 2 weeks, and a best-corrected visual acuity of 20/40 was achieved at the 3-month follow-up.

In the child with limbal stem cell transplantation, the corneal epithelium regenerated in 1 week. The limbal stem cell lenticules were well positioned after surgery (Figure 3). The patient showed symptomatic improvement. There was a mild amount of inflammation. After placement of the bandage contact lens in the operated-on eye, the patient was discharged on a regimen of 2% cyclosporine eyedrops 4 times daily. At the 3-month follow-up, the ocular surface was stable, and the best-corrected visual acuity was 20/200. The patient was scheduled for optical penetrating keratoplasty.
Blindness and visual impairment due to corneal diseases are a significant public health problem in the developing world. The prevention of causes that lead to corneal blindness would be the preferred approach for this problem in the long term. However, until prevention strategies become effective and make a significant difference, corneal transplantation is a viable option for visual rehabilitation of those who are blind as a result of corneal diseases.

In developing countries such as India, there is a marked shortage of good-quality corneal tissue. In the setting of an annual requirement of 300,000 corneas, only 15,000 are available. Of these, almost half are unsuitable for transplantation. The need for donor corneas per year in India is at least 20 times the current procurement. To circumvent this problem, less invasive alternatives to keratoplasty are resorted to such as optical iridectomy in patients with partial corneal opacification. However, extensive corneal disease requires corneal transplantation, and novel approaches for the optimal use of available donor tissues are desirable. This has become possible as we have moved from the era of overkill therapeutics, in which conventional penetrating or lamellar keratoplasty was performed, to a more focused approach of customized component replacement surgery of the cornea, in which the diseased part of the cornea is selectively exchanged with the healthy component of the donor cornea. The advent of automated microkeratome and other new surgical techniques such as ALTK and DSAEK has allowed such selective replacement of diseased corneal tissue. Peripheral healthy donor corneal tissue can also be carefully salvaged and used as small patch grafts. Such surgical techniques provide an opportunity to make use of a single donor cornea in more than 1 patient. Our strategy of using a single donor corneal tissue for multiple patients opens up the possibility of optimal use of available donor corneal tissue and will reduce the backlog of patients with corneal blindness in countries in which there is a dearth of good-quality donor corneal tissue. With more corneal surgeons converting to techniques of customized component corneal transplantation in the form of anterior and posterior lamellar disc corneal transplantation, the use of a single donor cornea in more than 1 patient may become standard surgical practice.

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