

Lamellar Keratoplasty With Lyophilized Tissue for Treatment of Corneal Scarring

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ABSTRACT

BACKGROUND: A pilot study was carried out in Pakistan to assess the feasibility of the use of lathed freeze-dried corneal tissue in the treatment of corneal scarring.

METHOD: Six eyes underwent lamellar keratoplasty and were followed up for 18 months.

RESULTS: Visual improvement was obtained in every eye. In one eye, the procedure was complicated by delayed epithelialization of the graft, but in the remaining five patients, the grafts epithelialized rapidly.

CONCLUSIONS: The use of freeze-dried donor tissue simplifies storage and distribution of corneas and may offer the best hope of treatment in developing countries for patients with corneal scarring. (*Refract Corneal Surg* 1993;9:140-142.)

Bilateral corneal scarring, which is relatively uncommon in the developed world, is a major cause of blindness in developing countries. It is especially prevalent in children either following xerophthalmia or keratitis associated with measles.^{1,2} Kagame and Schwab have put a new perspective on the morbidity from corneal disease by calculating the "sighted person years" lost from corneal scarring.³ Using this method of calculation, the problem is highlighted, as corneal blindness is often seen in younger patients who may have a greater life expectancy than the typical patient with cataracts. The treatment of cor-

neal disease is, however, much more problematic than that of cataract. Schwab has argued that penetrating keratoplasty has no place in developing countries and that resources are better channeled into prevention.⁴ The arguments are certainly potent, but lamellar keratoplasty has been neglected as a middle road which deserves further exploration.

The majority of patients with corneal blindness in "developed" countries are treated by penetrating keratoplasty because the visual results are better than with lamellar keratoplasty.⁵ The success of full thickness grafts is dependent on the ready availability of fresh corneal donor tissue and also, postoperatively, on the prevention of graft rejection, achieved by careful long-term medical treatment and follow up. For these reasons, it is not considered that the treatment model of penetrating grafting is relevant in a developing country as the appropriate medical infrastructure is usually not available.

Lamellar corneal grafting has been carried out for many years but is a technically demanding surgical procedure, also it is reliant on the availability of donor corneal tissue. For these reasons, its use in developing countries has not been widespread, although successful results have been achieved.⁶

Recent work on preservation of human corneal tissue for partial thickness grafting has shown that freeze-drying the corneal tissue reduces its immunogenicity so avoiding all problems with graft rejection even in the most adverse circumstances, thus removing the need for long-term treatment or follow up.⁷ Lyophilization of corneal tissue also extends its preservation time to 3 months, facilitates distribution, and makes the availability of corneal tissue in developing countries more feasible.

The use of lyophilized tissue for lamellar keratoplasty would thus seem to overcome many of the objections to the implementation of keratoplasty in a developing country, so we set out to determine whether this tissue could be used effectively in a pilot study in Pakistan.

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Corneal lenticles for this study were donated through the Keratec Eye Bank.

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Table
Summary of Patient Population

Patient No.	Sex	Age (Yr)	Follow-Up (Mo)	Preoperative Visual Acuity	Postoperative Acuity (Meters)	Reason for Corneal Scarring	Comment
1	M	25	18	counts fingers at 30 cm	6/36	trauma/infection	now has cataract and acuity of 6/60
2	M	45	18	perception of light with good projection	6/60	trachoma	other eye phthisical
3	F	50	18	hand movement at 30 cm	6/60	measles	other eye blind from glaucoma/corneal scarring
4	M	30	18	6/60	6/6	trachoma	bilateral corneal scarring
5	M	35	9	counts fingers at 30 cm	6/60	trauma/infection	slight interface hematoma from deep vessels
6	M	37	18	6/60	6/36	herpes simplex	persistent epithelial defect postoperatively

MATERIALS AND METHODS

Donor Lenticules

Corneas were retrieved from donors up to 48 hours postmortem. The donor lenticules were prepared at the Keratec Eye Bank (London, England). All corneas were placed in an organ culture system at 34°C and maintained in this state for periods up to 6 weeks. During this time, the donor's serology was assessed for evidence of infection with HIV and HBsAg, and the organ culture system screened for microbiological contamination. Corneas with negative serological and microbiological results, but with poor endothelial cell count, were deemed unsuitable for use in penetrating keratoplasty, and were prepared for use in lamellar keratoplasty. The corneoscleral segments were removed from the culture system and the corneal epithelium, endothelium, and Descemet's membrane were stripped using micro-sponges. A central corneal button of 8-millimeter diameter was punched by trephine. The corneal button was soaked in a sucrose solution and prepared for dry state lathing by desiccation for 24 hours on a polymethylmethacrylate (PMMA) base.⁸ The tissue was then lathed from the endothelial side with a diamond tool at 5000 rpm to form a plano-powered lenticule with a uniform thickness equal to 100% of the central thickness of the unlathed corneas. The lathed lenticules were then rehydrated, washed in an antibiotic solution, and freeze-dried. The lyophilized tissue was preserved under vacuum at ambient temperature for periods up to 3 months.

Patient Selection

Patients attending the ophthalmic clinic at Lahore General Hospital, who had significantly reduced visual acuity due to central corneal scarring, were selected. Those with severely disorganized

anterior segments or with doubtful endothelial function were not entered into the trial.

Surgical Technique

All the surgery was carried out by M.T., except for the operation on patient no. 4, which was performed by J.S.S. Local anesthesia with retrobulbar and facial nerve block was employed in every case. An 8-millimeter trephine blade was used to mark the area of corneal tissue to be resected and a shallow trephination into the stroma was made. This incision was deepened with a razor fragment and a lamellar resection of the diseased corneal stromal tissue carried out. The lyophilized lenticules were rehydrated for a few minutes in a saline solution and sutured in place on the recipient cornea with continuous 10-0 nylon suture. Routine postoperative management consisted of oral antibiotics for 3 days and a topical antibiotics/corticosteroid combination.

CASE REPORTS

The results of the series are summarized in the Table. Follow up was available for up to 18 months in all but patient 1 who was last seen at 9 months postoperatively.

Case 1. This case is documented in the Figure. Visual acuity preoperatively was counting fingers at 30 cm and had improved to 6/36 after a few days.

Case 2. This man of about 45 years had only one eye. This eye had a dense corneal scar, trichiasis, marked conjunctival scarring due to trachoma, and there was a history of recurrent infection and ulceration. His other eye had perforated some time before and was phthisical. Preoperative acuity was perception of light with accurate projection, and postoperatively the acuity improved to 6/60. The resection of diseased stromal tissue was incomplete, but despite

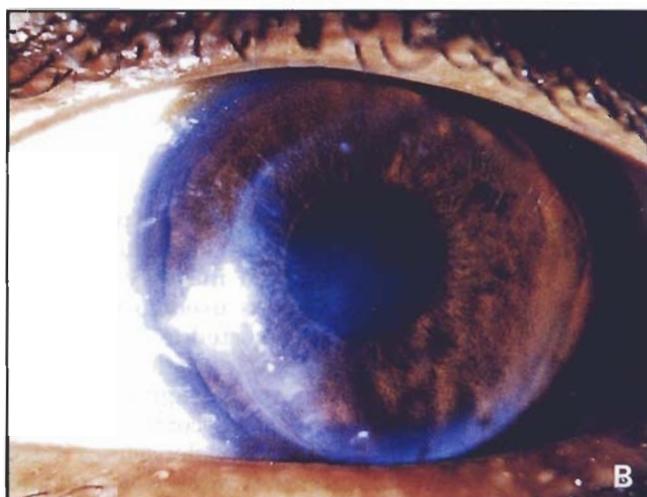
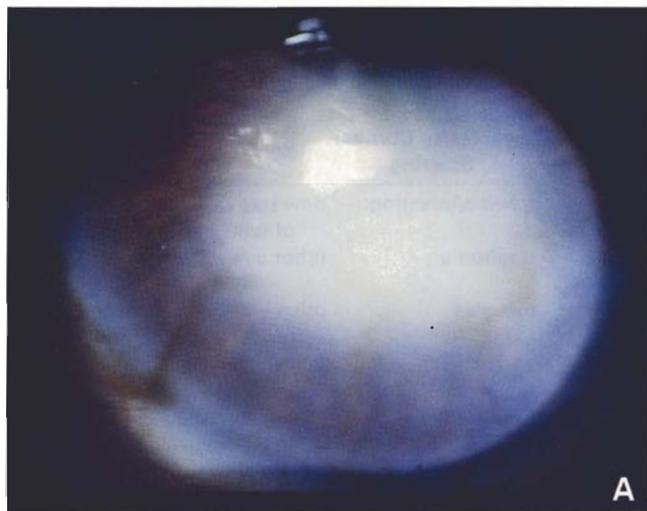


Figure: (A) Patient 1 preoperatively. Dense central scarring. (B) Patient 1 postoperatively. Good clearing of the central cornea.

this, the patient was delighted with his visual improvement and was able to resume his job as a dishwasher, and is now able to go out shopping on his own.

Case 3. This patient had bilateral corneal scarring from measles in childhood and one eye was blind from glaucoma. The operated eye improved following the lamellar keratoplasty from hand movements at 30 cm preoperatively to 6/60 postoperatively.

Case 4. This patient had visual improvement from 6/60 to 6/6 following graft surgery. With this visual improvement, he was able to carry out the paperwork and accounts of his own business instead of having to hire assistants.

Case 5. This patient had scarring from old corneal ulceration, probably posttraumatic. There were deep vessels running into the scar near Descemet's membrane, and these caused slight bleeding into the

interface beneath the graft. By 9 months postoperatively, the blood had absorbed, leaving a yellow discoloration to the cornea.

Case 6. This patient had healed herpetic keratitis with a preoperative acuity of 6/60. Following lamellar graft surgery, he had persistent problems with reepithelialization despite being treated with acyclovir ointment both with and without corticosteroids, and with a pad. The graft epithelium finally stabilized with a bandage contact lens.

Recent animal studies have shown that lyophilized grafts do not provoke rejection in recipients even if the recipient is presensitized and has a vascularized cornea.⁷ All our patients had some degree of corneal vascularization, but no rejection phenomena were seen during the 18-month follow-up period. If, however, these patients had undergone penetrating keratoplasty, although the short-term visual results might have been encouraging, it is likely that the long-term results would have been poor due to progressive numbers of grafts failing from rejection.

Although for some developing countries the cost of carrying out lamellar grafting with donated lyophilized tissue may be too great, in other locations the medical infrastructure may be developed to a point where this is a realistic option. By carrying out successful graft operations, with time, community support could be engendered which would enable the development of local eye banks to help serve the local population.

Further work is required to refine the surgical technique, to clarify patient selection criteria, and optimize postoperative management. It is likely that this technique will offer a real way forward in helping the many people blind from corneal disease in developing countries.

REFERENCES

1. Sandford-Smith JH, Whittle HC. Corneal ulceration following measles in Nigerian children. *Br J Ophthalmol.* 1979;63:720-724.
2. Foster A, Johnson GJ. Magnitude and causes of blindness in the developing world. *Int Ophthalmol.* 1990;14:135-140.
3. Kagame K, Schwab L. Childhood blindness: dateline Africa. *Ophthalmic Surg.* 1989;20:128-131.
4. Schwab L. Penetrating keratoplasty is an inappropriate procedure for underserved populations in developing countries. *Refract Corneal Surg.* 1991;7:443-445.
5. Richards JM, Paton D, Gasset AR. A comparison of penetrating keratoplasty and lamellar keratoplasty in the surgical management of keratoconus. *Am J Ophthalmol.* 1978;86:807-811.
6. Blumenthal M. Corneal keratoplasty in Tanzania. *Am J Ophthalmol.* 1968;65:726-729.
7. Frantz JM, Gebhardt BM, Reidy JJ, McDonald MB. Immunogenicity of epikeratophakia tissue lenses containing living donor keratocytes. *Refract Corneal Surg.* 1991;7:141-145.
8. Rostron CK, Sandford-Smith JH, Morton DB. Experimental epikeratophakia using tissue lathed at room temperature. *Br J Ophthalmol.* 1988;72:354-360.