Chapter 14
Keratoprosthesis

James V. Aquavella

Abstract The concept of a clear device imbedded in the cornea to restore vision was first expressed in the eighteenth century. The modern era began in the 1950s with the work of WM Stone conducted in Boston's Howe Laboratory. The team of Devoe, Castroviejo, and Cardona labored in the mid-twentieth century demonstrating the potential utility of the technique in severely damaged eyes. The current success is attributed to the design changes instituted by Claes Dohlman working at Harvard. The concepts of a fenestrated back plate, the protection of the surface with a bandage contact lens and the use of prophylactic antibiotics, were instrumental. Others contributed multiple changes in operative technique.

For a half-century, keratoprosthesis was perceived by cornea surgeons as an infrequently performed procedure associated with high rate of complication and only indicated in bilateral cases of irreversible cornea blindness. Success was considered as the ability to provide sufficient vision to enable self-care for a year or two. Developments were slow to come by in view of the small number of cases perceived to be candidates for the procedure. The close relationship between a biocompatible material, the specific design of the device, and the surgical technique necessary for successful implantation continues to this day. In the early days of the twenty-first century, the developments in device design, surgical technique, and postoperative management combined to transform the procedure in a very significant positive manner. While the acceptance of the technique has been slow, over the past decade, thousands of procedures utilizing the Boston type 1 device have been performed worldwide.

Keywords Keratoprosthesis • Boston type 1 • KPro • Graft failure • Ocular surface • Glaucoma • Cornea transplant • Aqueous shunt • Pars plana vitrectomy • Retroprosthetic membrane

Indications

While the primary indication continues to be cases in which penetrating keratoplasty is either contraindicated, or unadvisable, such as repeated graft failure, more and

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more surgeons are turning to the procedure as an alternative to cornea transplantation as a result of the rapid visual rehabilitation associated with the procedure. Cases with normal ocular surface and good lid motion are preferred, and cases with autoimmune disease should only be contemplated by very experienced KPro surgeons, since they are always complex. These autoimmune cases as well as the infant population require a significant infrastructure and a very experienced team of subspecialists, not only the single cornea surgeon (Figs. 14.1 and 14.2).

Essential Steps

1. Preoperative evaluation of the potential for useful acuity, intraocular pressure status, and control of glaucoma, demonstration of an anatomically attached retina, axial length determination (essential to obtaining an appropriately powered

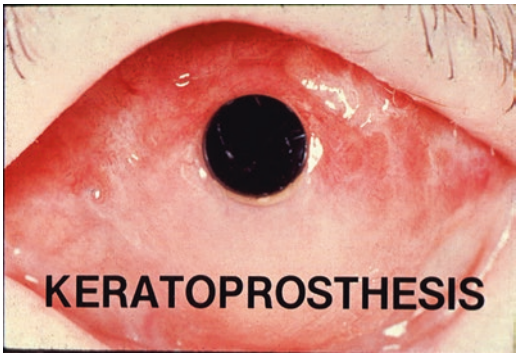

Fig. 14.1 Keratoprosthesis

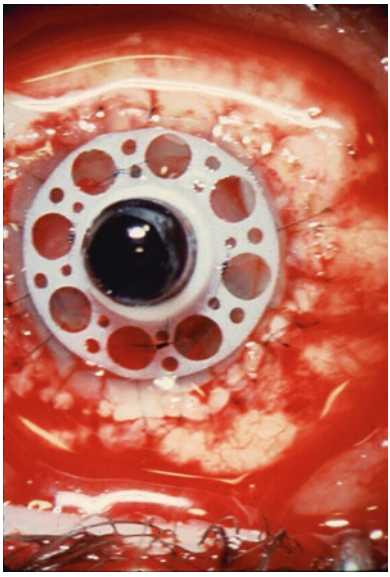

Fig. 14.2 Design changes instituted by Claes Dolman

device), and cataract/intraocular lens status. These components are essential to the routine work up necessary to evaluate potential candidates. Once the determination has been made, an appropriate aphakic or pseudophakic device along with necessary donor tissue must be on hand.
2. Either general anesthesia or retrobulbar injection with sedation is appropriate depending on the specifics of the cases and the desire of the primary surgeon.
3. Standard preparation, draping, and speculum insertion will also depend on the nature of the case. Vitreoretinal surgeons and anterior segment surgeons have differing requirements.
4. Placement of a Flieringa ring for stability is the preferred first step (Fig. 14.3).
5. Creation of 360° conjunctival dissection is performed if indicated.
6. Creation of a central 3 mm trephine opening in the donor tissue can be facilitated by a variety of specialized devices. This is followed by a concentric peripheral cut of appropriate diameter (8–10 mm). The placement of these trephinations must be carefully controlled to enable proper positioning of the keratoprosthesis as well as the subsequent placement of the sutures (Figs. 14.4, 14.5, and 14.6).
7. Assembly of device and placement in balanced salt solution. In order to minimize the "open-sky" time, the device should be ready for speedy implantation (Fig. 14.7).

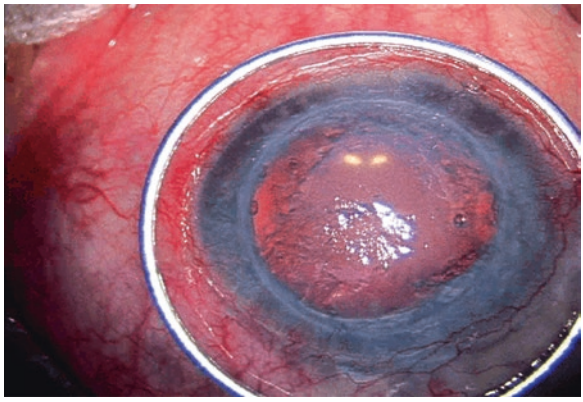

Fig. 14.3 Placement of a Flieringa ring

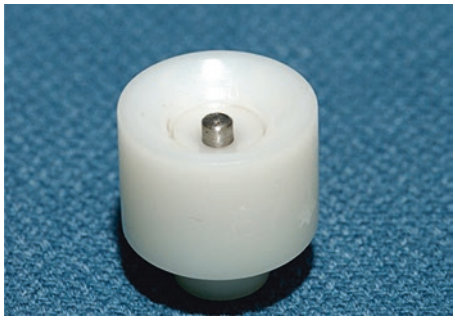

Fig. 14.4 Trephination

Fig. 14.5 Trephination

Fig. 14.6 Trephination

8. Nonpenetrating trephine outline in host cornea is then placed. It should allow for 0.5 mm oversized donor tissue (Fig. 14.8).
9. Cautery in wound to avoid hemorrhage into anterior chamber is wise as blood will require several days to absorb, delaying the process of visual restoration.
10. Guarded entrance into anterior chamber can be made with a diamond blade.
11. The use of a cyclodialysis spatula is useful prior to cutting the pathological tissue, in order to protect the underlying iris tissue and to lyse synechia. In many cases anterior and posterior iris adhesions will need to be severed.
12. Excision of pathological cornea tissue can then be completed.
13. A 360° assurance of open angle and space to accommodate the back plate of prosthesis must be obtained.
14. Viscoelastic is instilled into the angle and over the vitreous face as necessary.
15. Sphincterotomy may be performed if the pupil is miotic and fixed or eccentric.

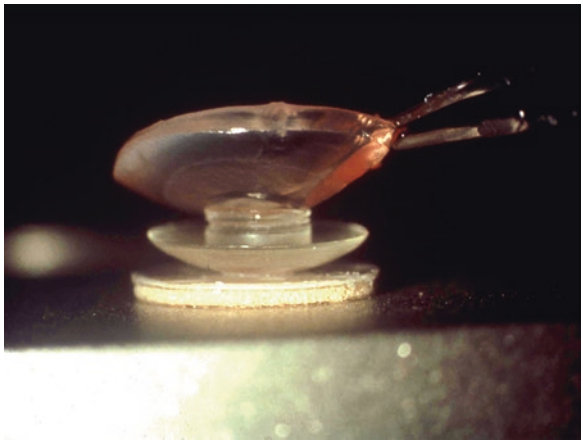

Fig. 14.7 Minimize the "open-sky" time

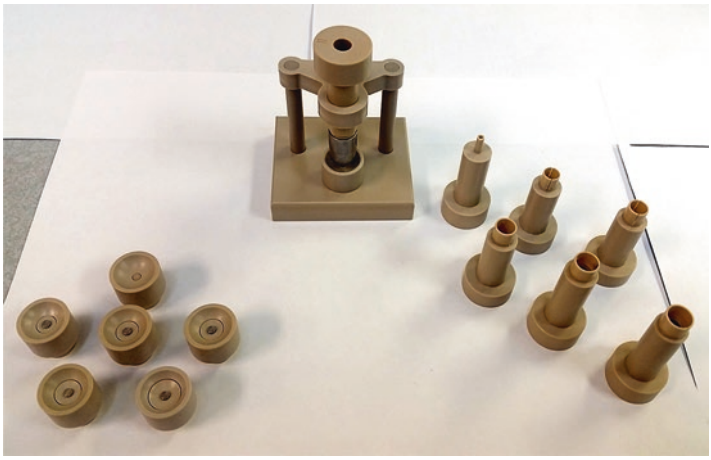

Fig. 14.8 Nonpenetrating trephine outline in host cornea

16. Peripheral iridectomy or a full sector iridectomy is necessary in all cases.
17. Cataract or natural lens extraction or removal of a preexisting IOL is preferred by most surgeons in order to create a single-chamber eye. An aphakic prosthesis device is then mandatory.
18. Limited anterior vitrectomy, if necessary, may be performed at this point.
19. Placement of the assembled device and suturing with 12–16 (9-0 or 10-0) nylon sutures (Fig. 14.9).
20. Trimming suture ends and rotation into recipient cornea.
21. If Ahmed shunt is to be placed, placement of shunt.
22. Consider a pars plana vitrectomy performed by a vitreoretinal surgeon (our preference) in all cases. This enables 360° inspection of the retina and any repairs which may be indicated.

23. Removal of Flieringa ring.
24. Consider advancement of conjunctival flap to the border of the optical cylinder. It may be wise to remove all viable epithelial cells with absolute alcohol and betadine solution prior to closing the conjunctiva in such fashion as to prevent subsequent exposure.
25. Placement of hydrophilic bandage lens (Kontour 16 mm diameter is supplied with the device) (Fig. 14.10).
26. Monocular dressing with antibiotic solution (not ointment).

Complications

- Vitreous loss
- Hemorrhage into anterior chamber
- Vitreous hemorrhage
- Retinal detachment
- Poor centration of optic due to malpositioned trephination
- Glaucoma, often rapidly progressive when associated with KPro, must be treated aggressively to prevent vision loss. Aqueous shunts either pre-prosthesis, concurrent with prosthesis surgery, or at any time if pressure elevation is noted. Intraocular pressure can be monitored with tactile tension if the surgeon is experienced. Scleral depression with a muscle hook during slit lamp examination is often employed. Good visualization of the optic nerve by ophthalmoscopy or in conjunction with OCT measurements is advocated on a periodic basis.
- Endophthalmitis
- Difficulty in maintaining contact lens (lens is essential in early postoperative period; if ocular surface is healthy and the lids functional, the bandage lens may be eliminated after several months if patient is comfortable)
- Retroprosthetic membrane (may be lysed with YAG laser with reduced energy)
- Sterile vitritis (must be differentiated from endophthalmitis and may require topical and peribulbar steroids)
- Cystoid macular edema (usually responds to steroids, but may become chronic)

Template Operative Dictation

Preoperative diagnosis: Cornea opacity (*OD/OS*) secondary to (*describe pathology*) in an (*aphakic/phakic eye*)

Procedure: (1) Keratoprosthesis, (2) cornea transplant utilizing eye bank tissue, (3) cataract/IOL extraction, (4) Ahmed shunt, (5) automated pars plana vitrectomy

Postoperative diagnosis: *Same*

Indication: This is a ____-year-old (*male/female*) who presented to our clinic with a corneal opacity secondary to (*describe pathology*) where a penetrating keratoplasty was either (*contraindicated/unadvisable*). In attempts to continue preserving

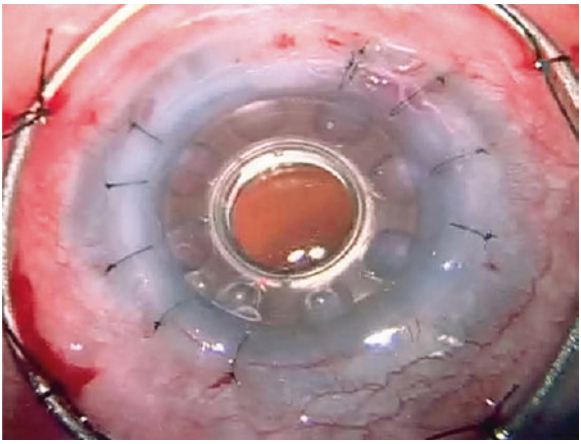

Fig. 14.9 Placement of the assembled device

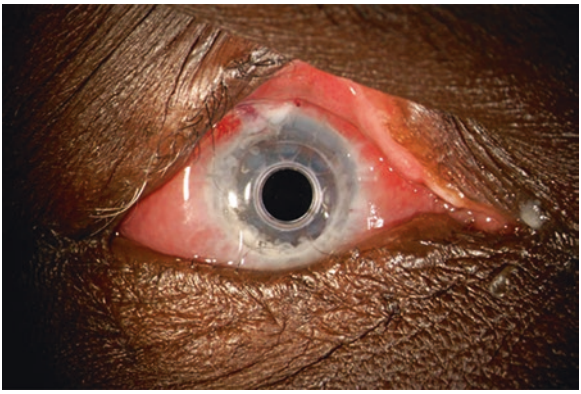

Fig. 14.10 Placement of hydrophilic bandage lens

vision, surgical options were discussed. After a detailed review of risks and benefits, the patient elected to undergo the procedure.

Description of the procedure: After general anesthesia was obtained, the eye was prepped and draped in standard fashion. A proper time-out was performed, and a speculum was placed between the lids of the (*right/left*) eye where the cornea pathology was examined under the high power of the operating microscope. A Flieringa ring was attached with _#_ interrupted *black silk* sutures. It was decided to remove an (*8.25*, *8.5, 8.75*) diameter pathological cornea button. An appropriate trephine was selected and a nonpenetrating outline was performed, vessels were coagulated.

Attention was turned to the assembly table where the keratoprosthesis was assembled. A 3 mm central opening was fashioned in the eye bank cornea followed by a ___ diameter concentric peripheral trephination (0.5 mm larger than the removed cornea). The cornea was placed over the optic of the prosthesis, the posterior plate was attached, and the assembled unit was placed in balanced salt solution.

Penetration into the anterior chamber was made with a blade through the deepened nonpenetrating outline, and the pathological button was carefully removed with sharp dissection from the underlying iris. A peripheral iridectomy was performed followed by dissection of the anterior lens capsule and delivery of the lens nucleus (*or removal of the IOL*). Cortical material was removed with irrigation/aspiration. A cyclodialysis spatula was passed through the angle to insure 360° patency and adequate space for the posterior plate of the prosthesis. Viscoelastic material was injected into the angle space, and the assembled prosthesis was inserted into the trephine opening and sutured with _#_ *10-0 nylon* interrupted sutures.

[Choose]

If shunt was placed*—The superior temporal conjunctiva was dissected to enable placement of the Ahmed shunt which was sutured 8 mm posterior to the limbus with _#_ 7-0 sutures. The distal tube was inserted into the anterior chamber via a stab incision made __ mm posterior to the limbus, its position ascertained by direct visualization through the optic. The tube was covered with a half-moon donor tissue and sutured. The conjunctiva flap was sutured to the limbus.*

If pars plana vitrectomy was performed*—The remainder of the procedure was performed by the vitreo/retina surgeon. Prior to the removal of the Flieringa ring and placement of a 16 mm Kontour contact lens.*

The conjunctival flap was advanced to the border of the optical cylinder, and all viable epithelial cells were removed prior to closing. A hydrophilic bandage lens was placed (Kontour 16 mm diameter that was supplied with the device). A monocular patch was applied, and the patient returned to recovery in good condition.