Artificial Cornea - The Boston Keratoprosthesis

(Information provided by Dr. Claes Dohlman, inventor of the Boston Keratoprosthesis, and edited by Dr. Dimitri Azar and Dr. Jose de la Cruz, with permission.)

The Boston Keratoprosthesis is an “artificial cornea” that can be used in severe corneal opacity. Many people with corneal disease can be helped by regular corneal transplantation involving tissue transplanted from human donors. This is the most common treatment for severe corneal opacity; however, in some cases such transplantation is hopeless, or nearly so.

The Boston Keratoprothesis can be used when standard corneal transplant would be unlikely to succeed. Thus keratoprosthesis implantation is a procedure designed to help patients whose conditions are the most difficult to treat.

Boston Keratoprosthesis Development

The Boston Keratoprosthesis has been under development since the 1960s and has gradually been perfected. It received FDA clearance in 1992. It is the most commonly used keratoprosthesis in the United States. (Dr Claes Dohlman, Massachusetts Eye and Ear Infirmary)

The keratoprosthesis is made of clear plastic with excellent tissue tolerance and optical properties. It consists of two parts but when fully assembled, it has the shape of a collar button. (See picture above.) The device is inserted into a corneal graft, which is then sutured into the patient’s cloudy cornea. If the natural lens is in place, it is also removed. Finally, your physician may recommend that a soft contact lens may be applied to the surface.

With the recent success of the Boston keratoprosthesis newest design, surgeons in Boston, Chicago and other major centers are expanding the applicability of this technology to help patients who suffer from repeated rejections/failure of standard corneal transplants.

Boston Keratoprosthesis Surgery

Generally, indications that a patient is suitable for the Boston Keratoprothesis include:

- Two failed grafts, with poor prognosis for further grafting,

- Vision less than 20/400 in the affected eye
- No end-stage glaucoma or retinal detachment.

Prior to surgery, a detailed history will be taken which helps to assess the corneal condition and determine if the patient is a good candidate for the surgery.

The one-step surgery is simpler than the procedure used in other keratoprosthesis models. Although general anesthesia is recommended, the recent trend is for performing the surgery under local anesthesia with intravenous sedation. The device is incorporated into a corneal graft which is then sutured into the patient's cornea like a standard graft (See photo above.) Visual improvement is usually already seen the following day or week(s).

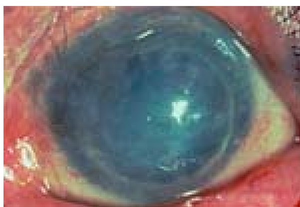
Postoperative Care

Because of possible complications that can result, patients with keratoprosthesis require relatively frequent ophthalmologic examination. The patient should be seen the day following surgery, as well as during the first and second weeks after surgery. It is customary to return every month for a check-up during the first year. After this time, examination by the surgeon every three months is also recommended.

For long-term postoperative safety it is recommended that the patient wear a therapeutic soft contact lens (continuous wear) and use prophylactic antibiotic drops once or twice daily. A life-long regimen of daily drops of antibiotics is prescribed to prevent infection. In addition, medications to control inflammation and/or glaucoma are often used.

Stability and Safety

The Boston Keratoprosthesis is known for long-term (many years) stability and safety. Its optical system can provide excellent vision if the rest of the eye is undamaged.


Corneal graft failure (in non-autoimmune diseases) is the main indication for this procedure. **(Dr Claes Dohlman, Massachusetts Eye and Ear Infirmary)**

The Boston Keratoprosthesis consists of two plastic parts that clamp a corneal graft. The graft is then sutured into the patient's cornea like a standard graft. **(Dr Claes Dohlman, Massachusetts Eye and Ear Infirmary)**

Patient Evaluation

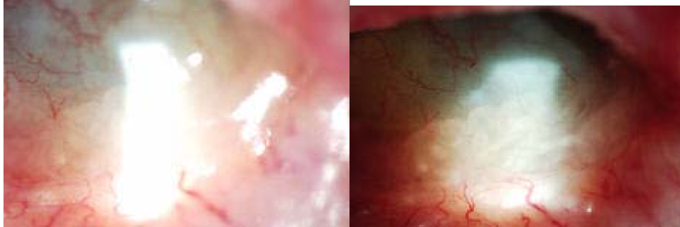
Patient evaluation often includes the following components. In some patients it may not be necessary to perform all the following tests; in others, additional tests may be needed.

- History
- Visual acuity, also with hard contact lens when necessary. Accuracy of light projection
- Intraocular pressure (pneumontonometry, palpation)
- Evaluation of blink and tear mechanism
- Signs of chronic inflammation
- Phakic, pseudophakic or aphakic
- Optic nerve cupping, macula
- Ultrsound B-scan, A-scan, Ultrasound Biomicroscopy
- External photo

Patient Selection

In the past, physicians avoided patients with pemphigoid, Stevens-Johnson syndrome, uveitis, Sjogren's syndrome, etc, and used a different approach involving a more complex surgical procedure. In patients where the tear production is adequate and the inflammation is limited to the ocular surface, some of these patients can now be treated with the Boston keratoprosthesis. However, more frequent follow up may be needed and the complication rate may be higher in these patients.

Stevens-Johnson Syndrome


Vascularized cornea, with moderate tear production

Other considerations include:

- Blink and tear mechanisms should be reasonably intact and vision should not be better than 20/400,
- Opposite eye often has reduced vision,
- Retinal detachment or extreme optic nerve cupping must be excluded,
- Intact nasal light projection is important to be able to exclude end-stage glaucoma,
- Consider shunt if a patient has advanced glaucoma (before or after Keratoprothesis—rarely simultaneously).

If the eye is pseudophakic, plan to keep the intraocular lens in place to prevent vitreous prolapse (can be sucked into a glaucoma shunt tube).

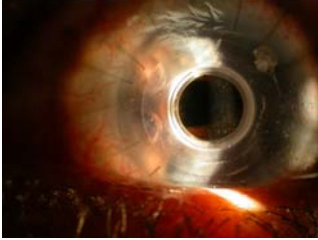
The more involved care of children and individuals who easily cannot be followed frequently and regularly should be anticipated and the potential unknown long-term side effects should be discussed in detail with the parents and/or caretakers.

Keratoprosthesis surgery may have the best results in patients with previous graft failures and no other ocular problems.

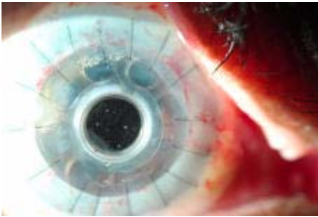
Keratoprosthesis Surgery

- Standard preoperative medical assessment
- General anesthesia is frequently used
- Antibiotics IV recommended at the time of surgery, e.g., cefazolin 1.0 g., if no allergy.
- The surgery time is usually about an hour and a half.

Postoperative Photos of patients treated the Illinois Eye and Ear Infirmary, Chicago.



Keratoprosthesis after two failed transplants. Initial transplants after perforating bacterial infection, second transplant rejected. Vision prior to keratoprosthesis, CF(count fingers). Five days after keratoprosthesis vision is 20/50. **(Illinois Eye and Ear Infirmary)**



Keratoprsothesis after two failed transplants. Initial transplants done after chemical burn injury. Vision prior to keratoprosthesis was HM (hand motion). Vision after keratoprosthesis 20/60. **(Illinois Eye and Ear Infirmary)**

Postoperative Care

The patient should be seen the following day, after one week, two weeks, one month and every month for the first half year, and then every two to three months. Modify the schedule, if problems.

Postoperative medication might be fluoroquinolone and vancomycin drops (14mg/ml) once or twice daily (note: must be compounded). Prednisolone acetate 1% as needed. If pressure problems appear, steroids may be eliminated but the antibiotics should be used for life, on a daily basis. Impress upon the patient the importance of compliance.

Soft contact lens should be worn around the clock on a long-term basis. The lens is very protective of the corneal tissue hydration. If lost, it should be replaced. Request assistance from your contact lens department.

Complications

The problems of melt and extrusion that were common previously have now been virtually eliminated. (See graph.)

Inflammmation can be an issue for eyes that have undergone many surgical procedures. In addition to topical steroids, occasional peribulbar injections of 40 mg. of triamcinolone may be necessary.

Any retroprosthesis membrane can be opened with a YAG laser as long as no blood vessels have entered. Conclude with 40 mg. triamcinolone peribulbarly. Vascularized membranes are rare but may require surgery by a vitreo-retinal surgeon.

A sudden vitritis can form rarely with drastic reduction of vision. If there is no accompanying redness or pain, the vitritis is most likely sterile and can be treated with peribulbar triamcinolone and prophylactic antibiotics only. They always clear up.

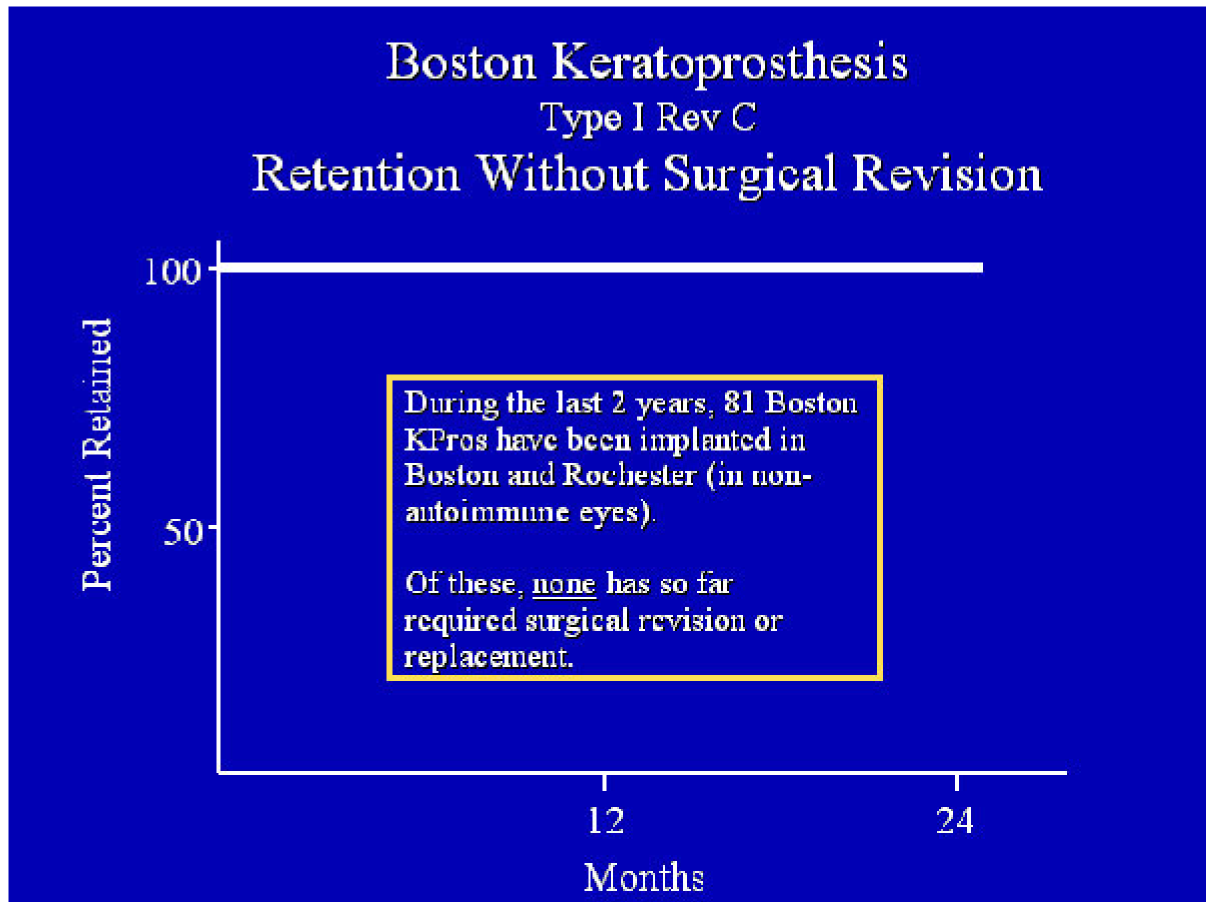
Bacterial endophthalmitis is fortunately very rare in the graft failure group as long as the prophylactic antibiotics regimen is adhered to. No endophthalmitis has occurred as long as vancomycin has been given.

Glaucoma is common in patients needing the Boston Keratoprothesiis and may get worse postoperatively. Standard drops are usually effective since they readily diffuse into the eye. Systemic carbonic anhydrase inhibitors have the expected effect. Finally, a glaucoma shunt may have to be resorted to in the severe cases.

Results of the Boston Keratoprothesis

The Boston Keratoprosthesis has excellent long-term stability and safety. It is also known for having excellent optics.

The following graph was generated by Dr. Dohlman the inventor of the Boston Keratoprosthesis. It illustrates the retention rate of patients who receive the Boston Keratoprosthesis.



Autoimmune diseases (Pemphigoid, Stevens Johnson Syndrome, severe connective tissue diseases) require a somewhat different approach. (Dr Claes Dohlman, Massachusetts Eye and Ear Infirmary)

Keratoprosthesis still carries a somewhat greater burden post-operatively than standard keratoplasty. Successful outcome requires patient compliance, more frequent follow-up and more demands on physician time. However, in cases where further keratoplasty appears futile, keratoprosthesis can be most rewarding.

Contact Us

The device is manufactured under the auspices of Massachusetts Eye and Ear Infirmary, a hospital affiliated with Harvard Medical School. For further information, please consult

the University of Illinois Eye and Ear Infirmary, Drs. Dimitri Azar and Jose de la Cruz, at 312 996-2020 or 312-996-6590 or please consult the closest ophthalmologist with special expertise in corneal diseases, or contact Dr Claes Dohlman at 617-573-3240

Click here to view **Boston Keratoprothesis bibliography.**