Penetrating Keratoplasty

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The first corneal transplant, also referred to as a "penetrating keratoplasty," was performed in 1824—nearly 160 years ago—by Reisinger, who attempted various tissue substitutions including glass, xenografts, and homografts. Because initial attempts at tissue substitution met with limited success, corneal transplants were rare until 30 years ago; now, with donor corneal tissue available, corneal transplants have become the most commonly performed type of transplant surgery.[1] According to The Eye Bank Of America (EBA), the governing body that regulates standards for eye institutions across the country, more than 45,000 corneal transplants were performed in the US last year alone.[2] Other factors contributing to this dramatic increase in the number of corneal transplant procedures performed include development of the surgical microscope and microsurgical instruments, and improved suture materials and preoperative and postoperative care.

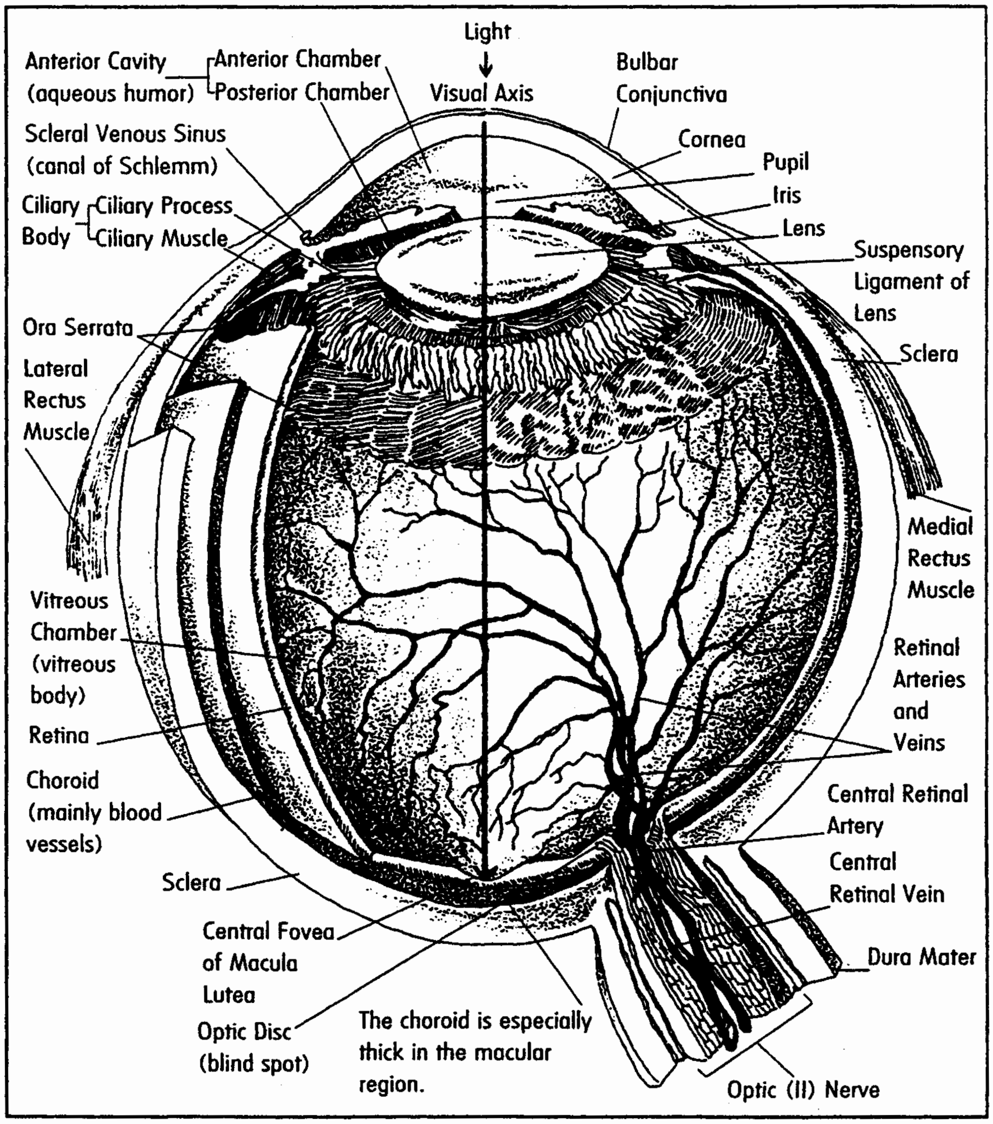

Figure 1. *Anatomy of the eyeball.*

Anatomy of the Eyeball

The eyeball wall has three layers: the fibrous tunic, vascular tunic, and retina or nervous tunic (Figure 1). The fibrous tunic consists of the cornea, which makes vision possible by focusing light, and the sclera—or "white" of the eye. The rigidity of the sclera, which covers the entire eyeball except the cornea, protects the eyeball. The middle layer of the eyeball, known as the vascular tunic, consists of the vascular choroid coat, the ciliary body, which is the thickest portion of the vascular tunic, and the iris, or colored portion of the eyeball. The pupil rests in the center of the iris. The visual pathway begins in the inner layer of the eyeball, known as the retina, which consists mostly of epithelial cells that contain melanin. Melanin in the retina prevents glare that could distort vision.[1]

Images form on the retina when light rays are refracted by the cornea and lens. The cornea's curved shape and transparent structure enable it to focus light. Additionally, the avascular nature of the cornea makes survival impossible for the antibodies that cause transplant rejection. The rejection rate for corneal transplants is therefore typically less than 5 %—

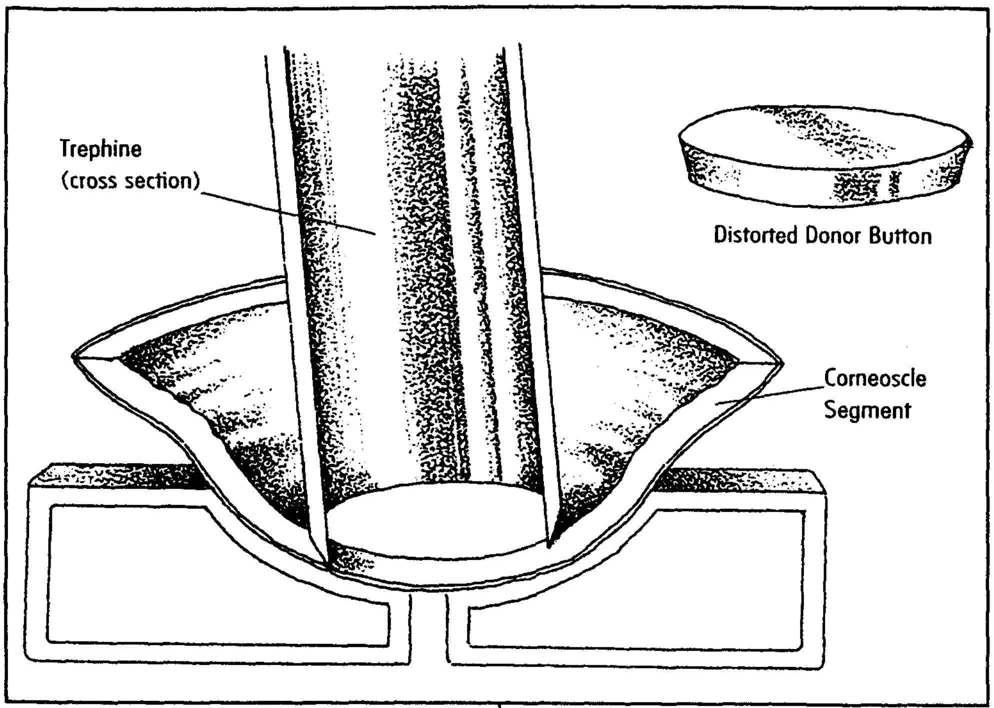

Figure 2. *Cross section of a trephine blade.*

making corneal transplants the most successful type of transplant surgery.[2]

Indications for Corneal Transplant Surgery

Corneal transplant surgery involves replacing diseased or injured corneal tissue with full-thickness donor corneal tissue. The four primary indications for performing a corneal transplant include the following:

- **Optical**—restore sight to the patient
- **Tectonic**—replace corneal tissue lost through trauma or disease
- **Therapeutic**—treat refractory corneal disease
- **Cosmetic**—replace cornea to improve patient's appearance without hope of restoring vision

Donor Tissue Procurement Protocol

According to the EBA, a set protocol must be followed to procure donor corneal tissue; however, the rules and regulations governing corneal procurement vary from state to state. The following description of procurement procedure therefore represents only a general overview.

When possible, the procurement team reviews the donor's current medical records and conducts an in-depth interview with the next of kin. This information-gathering process protects the recipient because informed decisions can be made regarding donor acceptability. Donors are excluded if the cause of death is unknown, if they had Creutzfeldt-Jacob disease, or if they have undergone radial keratotomy or laser photoablation surgery. To reduce the possibility of transmitting the HIV virus, the procurement team also eliminates donors who had a history of intravenous drug use. For the same reason, men who have had sexual encounters with men within the preceding 5 years and/or were inmates of correctional institutions are not considered acceptable donors. Persons who had hemophilia or related blood-clotting disorders for which they received human-derived clotting factor concentrates also may not donate corneal tissue. However, people who have undergone cataract and intraocular lens insertion may donate corneal tissue if a specular microscopy screening indicates that the cornea meets EBA endothelial standards.

Ideally, donor corneas are procured within 12 hours of the time of death. At the time of procurement, the cornea is usually removed in situ because performing an enucleation—removing the entire eyeball without rupturing it—and then performing a corneal procurement later, at the eye bank, exposes the cornea to unnecessary trauma. Immediately after procurement, the cornea is tested for the HIV virus, hepatitis B and C, syphilis, and HTLV 1 (feline leukemia—a retrovirus). The cornea is also grossly tested for clarity, epithelial defects, foreign objects, and contamination. A test of scleral color indicates if the donor was jaundiced.

Following procurement and testing, the cornea is placed in the transfer medium, commonly "optisol." This medium keeps the cornea safe for 5 to 10 days so it may be transferred to the facility where the transplant will take place; however, ideal circumstances dictate that the cornea be transferred as soon as possible.

The Operating Room Setup, Instrumentation, and Transplant Procedure

Corneal transplants are usually performed on an outpatient basis with the surgical suite set up to accommodate the affected eye. The recipient is given a retrobulbar (behind the eyeball) block by either the surgeon or anesthesiologist. General anesthesia can, of course, be used instead. While no evidence suggests that either general or local anesthesia is preferable, each has advantages: Local anesthesia allows for increased mobilization postoperatively, while general anaesthesia reduces the risk of chamber shallowing and improper suture placement caused by patient movement during the surgical procedure.

After the retrobulbar block has been administered, the surgical team ensures that the patient is in a safe and comfortable supine position. The patient is then prepped and draped to provide a sterile field and simultaneously allow for adequate ventilation and access for monitoring. The drapes should be sufficiently loose on the patient so that

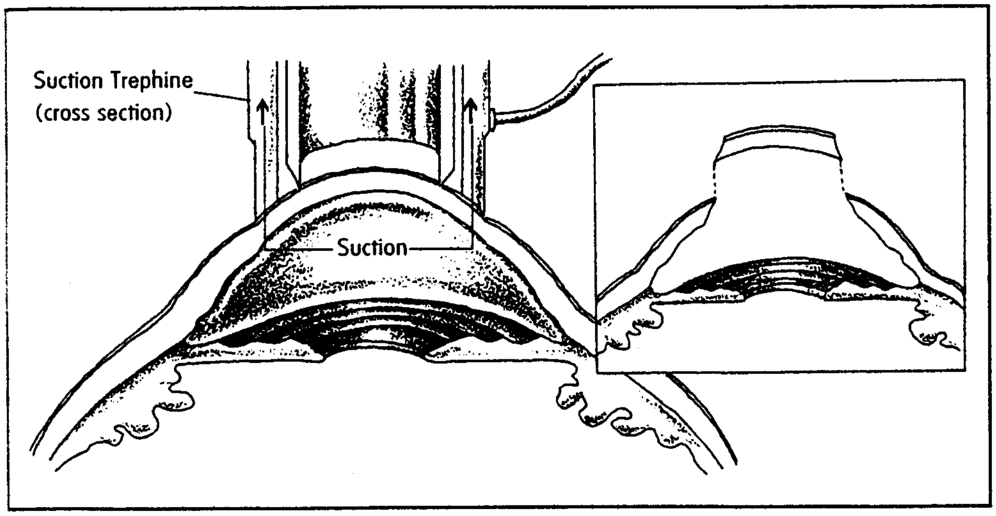

***Figure 3.** While some surgeons prefer suction trephine blades, the simpler manual blades offer surgeons more control.*

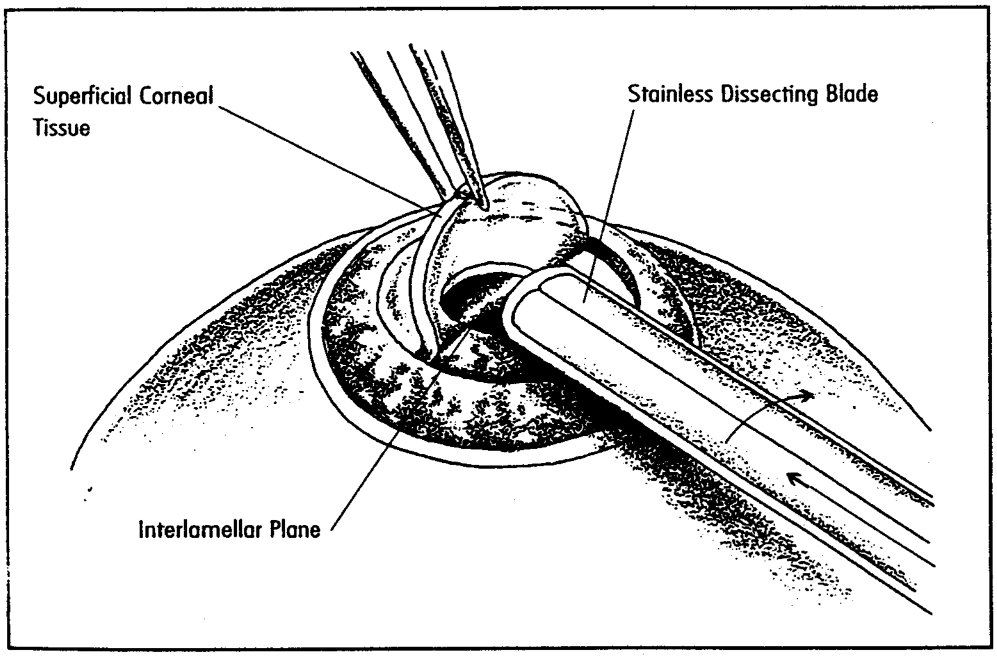

***Figure 4.** Removal of recipient's cornea.*

the surgeon and assistant may move without causing the drapes to pull on the eye, thus transmitting pressure to the orbit, which would increase intraocular pressure.

After prepping and draping, the anterior aspect of the eye is exposed with the aid of a speculum. Generally, this is accomplished with a bladed speculum; however, in some cases, a simple wire speculum is the instrument of choice. Once the speculum is in place, 4-0 silk fixation sutures are placed on two or all four rectus muscles—the four short muscles of the eye—to fixate and immobilize the globe.

The recipient bed is then prepared for the transplant using trephine blades that range in size from 6.0 mm to 9.5 mm. The selected blade should be large enough to surround the affected tissue, but not so large that it encroaches on the limbus. At least two blades in each size should be available in case one is damaged or dropped. Simple, disposable, open-bladed blades are preferable for incising the recipient bed because the surgeon is able to directly sight down the barrel of the blade, which offers more control over the procedure than using an automated or suction trephine blade (Figures 2 and 3).

To prepare for the corneal transplant, the trephine blade is placed on the recipient bed and gently rotated with slight pressure until the proper depth is reached. The incision must extend approximately three-quarters of the way through the cornea. Simultaneously, the anterior chamber is entered with the aid of a sharp, disposable blade. The host button—the recipient's cornea—is then removed using a fine forceps and corneal scissors (Figure 4). This cornea is placed in a sterile field, usually a medicine glass filled with Balanced Salt Solution (BSS) and must be saved until the surgery is completed. (In cases where the donor cornea is damaged during surgery, the patient's cornea must be replaced in the eyeball.)

The donor cornea is then placed onto the surgical field and prepared by "punching out" the size button (Figure 5, p. 16) with another trephine blade, which must measure .25-mm to .5-mm larger than the blade used to prepare the recipient bed. To punch out the size button, a procedure that resembles using a cookie cutter, the donor cornea is placed on a nylon cutting block, and the blade is placed against the endothelial side of the graft. (The advantages of preparing the graft from the endothelial side rather than the epithelial side include reducing the risk of endothelial damage and enabling the surgeon to make a cleaner incision.) Pressure is applied until a distinct "snap" is heard. Viscoelastic is then placed over the recipient's anterior lens capsule and iris surface, and the donor cornea is superimposed on top of the viscoelastic. This procedure helps to prevent forward movement of the iris-lens diaphragm and trauma to the new corneal endothelium.

The donor cornea is sutured into place with either a running or interrupted stitch, using 10-0 Ethilon suture material. A combination of these two types of stitches may be used also. The suture type

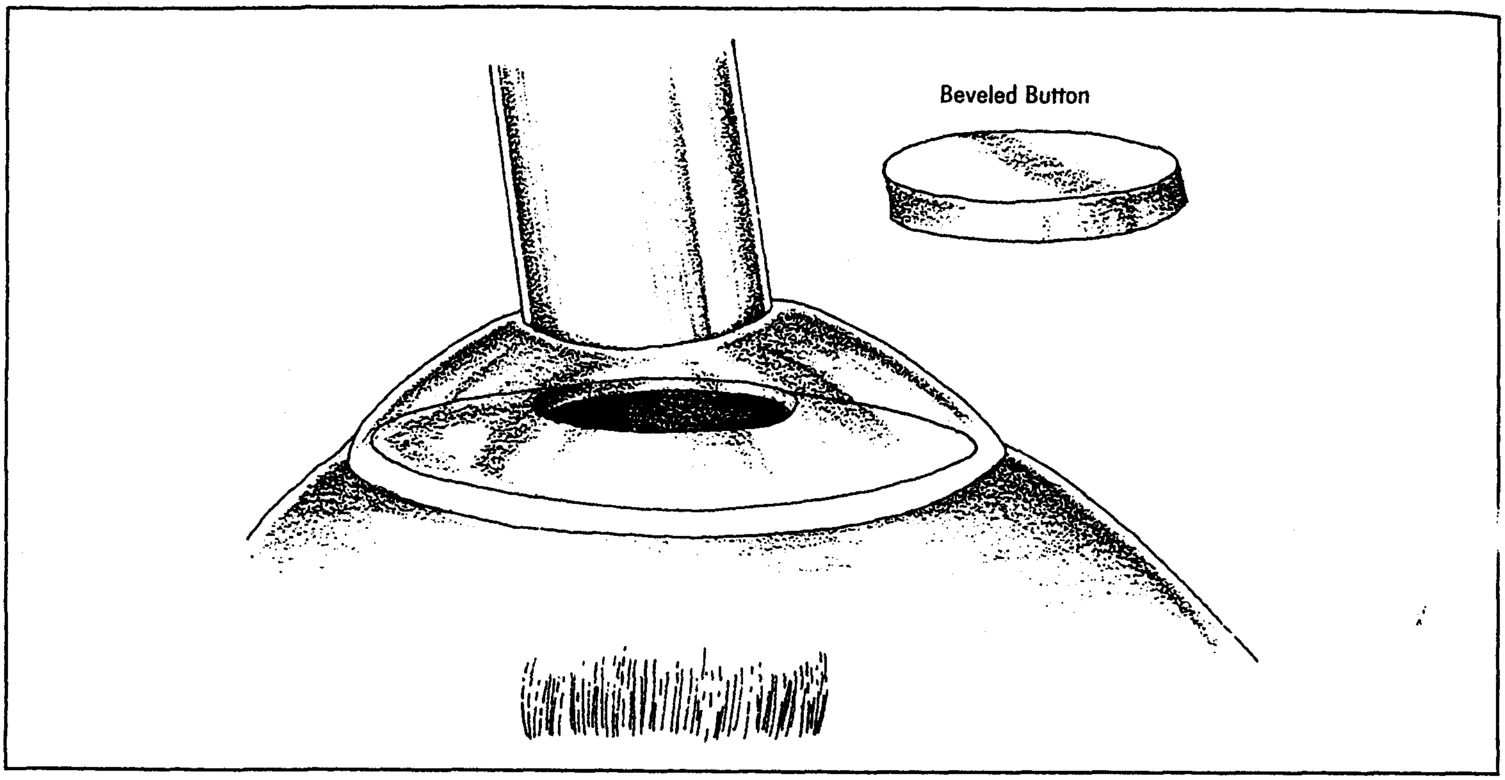

Figure 5. *Removal of the donor cornea size botton.*

selected is not nearly as critical as placement of the first four sutures on the graft. The first suture must be placed at twelve o'clock and the second suture at six o'clock. Following placement of the second suture, the graft should be aligned so that it is distributed equally on both sides of the sutures. The three- and nine-o'clock sutures are then placed. Suture tension should be checked carefully: If the sutures are too tight, postoperative epithelial problems may develop, which could lead to greater difficulty in correcting the patient's vision. If the sutures are too loose, the donor graft could become displaced.

Once the sutures are in place and the ends are trimmed with a sharp blade, the knots are rotated until they are covered by epithelium. BSS is then injected into the anterior chamber with a 27-gauge cannula to enable the surgeon to check the wound margins for fluid leaks. This is accomplished using Pilling Weck cell sponges to apply gentle pressure to the globe. Leaks can be remedied by placing an interrupted suture. Sutures are usually removed in the surgeon's office approximately 4 to 6 months postoperatively. However, some surgeons prefer waiting up to a year to remove the sutures, and others never remove them.

Commonly prescribed medications following corneal transplants include dexamethasone and other subconjunctival antibiotics. Subconjunctival soluble corticosteroids are also used even though their benefit has not been determined fully. If, during the procedure, the procured cornea cannot be implanted, the patient's original cornea is reimplanted, and the patient can be brought back to surgery for an implant at a later date. Δ

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