Clearing the fog on corneal transplants

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The authors discuss the delicate topic of corneal transplants and the surrounding ethical issues.

Although corneal transplantation has been around for more than 150 years, performed in humans for the last 100 years, and generally effective for the last 50 years, this specialised treatment remains little-known amongst lay people, medical students and even many doctors. Who gets corneal transplants and why? Where do the corneas come from? How does it even work? In this article we aim to shed some light on this fascinating topic.

What is the cornea?
The cornea is the window that lies in front of the iris and pupil. Its transparency is essential for allowing light to enter the eye. It is curved in shape, like a contact lens, and so helps bring light entering the eye into focus, doing two-thirds of the eyes overall refraction. It also acts as a tough shield to help keep the contents of the eye safe. In short, the cornea is really important for good vision!

When things go wrong
When the cornea becomes diseased it can become cloudy or distorted, leading to loss of vision. The cornea is also prone to damage from infections such as bacteria and viruses, especially so in contact lens wearers. The cold sore virus (Herpes simplex) can be devastating for the eye, as can measles in the unimmunised. Extensive damage to the cornea can cause a hole, known as a perforation, which must be glued as a temporary measure to stop the fluid content of the eye leaking out (Figure 1A). When a patient’s condition is advanced or all other treatments have failed, the last resort is a corneal transplant.

There are many techniques for transplanting corneas. The cornea is actually made up of several layers, and seeing which layer has the problem helps doctors decide which technique to recommend to their patients. Some techniques involve transplanting a full-thickness donor cornea with all its layers intact, but the latest advances now allow doctors to transplant only those layers that are required.1 After the donor cornea is transplanted into the recipient’s eye it is carefully sutured into place using a nylon thread which is thinner than human hair (Figure 1B). The unusual structure of the cornea means healing is a slow process. The sutures can only be taken out after 12-18 months (Figure 1C). Given the
cornea’s lack of blood vessels (an immune privileged site), systemic immunosuppression is not usually required to prevent rejection. Instead, steroid eye drops can be used to effectively manage the cornea post-transplant. In the event of donor cornea rejection, the patient may experience pain, redness or loss of vision and must be seen urgently by a specialist.\(^2\)

The commonest cause of receiving a transplant in the UK is failure of the innermost layer (the endothelium), which leads to a cloudy cornea.\(^3\) This is often treated by replacing only the innermost layer. The second commonest cause is a condition called keratoconus, where the middle layer (the stroma) is weak and the whole cornea becomes distorted in shape. This can be treated by either replacing the full thickness of the cornea or just the middle and outermost layers. The third commonest cause of receiving a transplant is a re-graft operation, where a previous transplant has unfortunately failed and needs to be replaced.

**Corneal Donation**

Corneas for transplant come from people who have passed away and either expressed a wish before death for their eyes to be donated, or whose next of kin consented to donation after their death. Corneas can be donated up to 72 hours after death.\(^4\)

Eye banks, now found in many specialist eye hospitals around the world, act as the gateway for donor tissue to be used either in transplant or in

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**Figure 1 | Images of Corneal Transplant.** (A) A perforated cornea with glue applied. (B) A corneal graft with sutures in place. (C) The border of the graft is visible along with tiny suture holes in the cornea. (D) A cornea in tissue culture; the surrounding rim of sclera can be seen around the transparent corneal tissue. Photographs C and D courtesy of Medical Illustration department, and photographs A and B courtesy of Mr Alex Shortt, Consultant Ophthalmologist at Moorfields Eye Hospital NHSFT.
medical research. Contrary to the name, eye banks do not store whole eyes for any length of time but only the relevant tissue for transplant. They employ donation co-ordinators who work on hospital wards and whose job it is to approach the families of patients who have passed away, sensitively inform them about the donation process and find out if their loved one had expressed any wishes before they died. If the next of kin consents, a member of the eye bank staff checks the donor’s medical history to be sure that they had no conditions which would prevent them from donating (Table 1). If all is well, the eyes are then retrieved for donation. Following the procedure, donor’s appearance is reconstructed which can involve the use of prostheses.

After retrieval of the donor eyes, the corneas are removed in a clean room at the eye bank, along with a small surrounding rim of sclera. Both the cornea and sclera can be used, the latter for glaucoma operations. In fact, one donor eye can be used to help up to eight different recipients. The rest of the eye is used for medical research. The cornea is then examined under the microscope to check that it is of appropriate quality for transplant, principally determined by the number of cells in the endothelium layer – which is important to ensure that it will stay transparent and not become cloudy after transplant. If the endothelial cell count is high enough, the cornea is prepared for theatres, and with modern methods can be kept for up to four weeks before transplant (Figure 1D). Corneas not found to be of appropriate quality for transplant can still be used for research.

**Transplantation: the views surrounding donation**

Transplantation has, since its debut in 1823, raised many ethical issues and rates of organ donation are still substantially lower than needed. With 7134 patients on the active transplant list in the UK (October 2013), the chronic shortage is something the Department of Health is currently trying to recover through its support of NHS Blood and Transplant (NHSBT). NHSBT is a Special Health Authority in the NHS responsible for optimising the supply of blood, organs, and tissues. In England and the United States of America, an ‘opt-in’ system is operated for donor registration, meaning individuals choose to sign-up to organ donation whilst they are alive. In the US, whilst 90% of people support organ donation, only 30% are actually on the register and in England, families can still negate a donor’s wish. Equally, in the current system, if someone has not signed up to the register whilst alive, a person in a ‘qualifying relationship’, as specified by the Human Tissue Act 2004 (Scotland 2006), can decide to give consent on their behalf, after their death. An ‘opt-out’ system is currently being trialled in Wales where you are presumed to want to donate unless you specifically opt out.

An audit carried out by NHSBT looking at reasons families didn’t consent between April 2012 and March 2013, showed that for 186 potential donors the family did not feel able to consent due to being unsure of what their relative would have wanted. A staggering 105 families also overruled their loved ones’ expressed wish to be a donor at death. Given the emotional turmoil surrounding death, it would be interesting to conduct sensitive research into whether these families’ decisions would have differed after the bereavement period. Some support the concept of a national ‘opt-out’ system where you are given the opportunity (which cannot then be overturned by family members) to withdraw otherwise presumed.

Table 1 | Key reasons for a donor being unsuitable for corneal donation

- Death of unknown cause
- Infections: HIV, viral hepatitis, syphilis, TB
- Men who have sex with men
- Illicit use of intravenous drugs
- Commercial sex work
- Alzheimer’s disease, Parkinson’s disease, multiple sclerosis
- Cancer of the blood

Table 1 | Key reasons for a donor being unsuitable for corneal transplant. Table adapted from Kanski and Bowling, Clinical Ophthalmology: A Systematic Approach (Elsevier Saunders, 2011).
consent for donation at, for example, polling stations; driving tests; passport applications and GP registration.

Corneal transplantation raises even more issues. Data from the United States of America and Australia shows that even of the people who do decide to donate organs, 30% refuse corneal donation. A key issue surrounding corneal donation is the way people perceive eyes to play a key role in human interaction, whereas other organs, hidden deep beneath layers of skin, are more easily perceived in a ‘biologic’ way. When describing a friend or loved one, it may not be their beating heart or robust liver you reminisce fondly over, but their kind and twinkly eyes. For some, when a loved one has just passed away the thought of the eyes, in particular, being taken is often too much to bear. It is therefore easy to understand why many families and individuals opt for the eyes to be left out of the organ retrieval.

Conclusion
We hope that our discussion of the cornea, the transplant process and some of the ethical issues surrounding it has provided some insight to guide you through this little-known topic. It may even have prompted thought on personal organ donation. In summary corneal transplant relies on the understanding and generosity of all members of the public and we hope that this article goes some way to addressing this.

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