

# Keratoprosthesis

## Indications

Many corneal diseases can be effectively treated by corneal transplantation, so the use of keratoprostheses is largely restricted to patients whose eye condition is such that corneal transplantation offers little hope of success. These include patients who have had multiple previous penetrating grafts with graft failure from rejection, leading to an eye highly sensitised to donor antigens with an extreme risk of rejection of further grafts.

The other major indications for keratoprosthesis surgery are eyes where there is extensive damage to the ocular surface membranes (conjunctiva), as a result of chemical injury or disease such as cicatricial pemphigoid, trachoma etc. In these situations a conventional graft is likely to fail due to the instability of the corneal epithelium in the absence of a healthy tear film and normal eyelid function.

## Early types of keratoprosthesis surgery

A keratoprosthesis is an 'artificial cornea', but until recently designs of keratoprosthesis bore little similarity to the physical form of the natural cornea. All the early designs used polymethylmethacrylate (PMMA) as the material for the optical part of the device, and this was mounted in a plate-shaped supporting ring which stabilised the optic in the visual axis ('nut and bolt' design). Because of poor biocompatibility, the early keratoprostheses had a high incidence of failure – particularly from infection and extrusion. In an attempt to overcome these problems, the osteo-odonto-keratoprosthesis used a tooth derived from the prospective recipient as a platform to mount the optical cylinder, whilst the surrounding periosteum of the tooth acted as a bio-compatible anchor to stabilise the device on the surface of the eye. Modern day practitioners using this device, such as Professor Falcinelli in Rome, have managed to achieve an excellent success rate, but this operation remains a complex, costly procedure and requires a preliminary operation to harvest the tooth and part of the adjacent jaw bone. The optical device is mounted into the tooth, and then the prepared prosthesis is buried in the eyelid for a couple of months to stabilise the device and ensure that it is free from infection. A second operation is then conducted to implant the mounted prosthesis in the eye, the whole implant being covered by a mucous membrane graft, again derived from the patient's mouth.

Such 'nut and bolt' keratoprostheses have a long optical cylinder (the 'bolt') which protrudes both into the eye and externally. Optically it performs poorly, giving only a restricted field of vision to the patient.

## **The Legeais Keratoprosthesis**

Over the past few years impressive advances in keratoprosthesis design have been made by Professor Legeais in Paris. His keratoprosthesis uses a synthetic polymer optic similar to a contact lens, which has a flexible woven PTFE polymer 'skirt' (haptic) intimately bonded to its edge. The microporous skirt allows invasion of the patient's tissue into the material and achieves an improved level of biocompatibility between the synthetic 'cornea' and the eye. Since the optical part of the Legeais keratoprosthesis is thin and shaped like the natural cornea, this prosthesis design offers a much wider field of vision than was possible with the older style 'nut and bolt' prosthesis.

Although the Legeais keratoprosthesis is a significant advance on previous generations of keratoprosthesis, it remains some way from being a true synthetic corneal substitute that could be used as an alternative to human corneal tissue for routine conventional corneal grafting.

### **Surgical Technique**

The implantation of the Legeais keratoprosthesis is carried out as a single procedure. Firstly the patient's cornea is cleared of overlying fibrous or vascular tissue and a circular cut is made of partial thickness through the corneal stroma. The surrounding cornea is then split to create a pocket to receive the outer 'skirt' of the prosthesis. Before its insertion, the prosthesis is bathed in a sample of the patient's blood, coating the polymer with a layer of protein that enhances the invasion of fibrous tissue into the 'skirt' in the post-operative period. The central part of the patient's diseased cornea is then cut away and the 'bioactivated' prosthesis sutured in place. Finally a thin mucous membrane graft harvested from the patient's mouth is sutured over the prosthesis to give a better external surface to the eye. After a month or two the central area of the mucous membrane graft overlying the optical part of the prosthesis is removed restoring the visual pathway. If there is subsequent overgrowth of the mucous membrane leading to closure of the visual aperture, occasionally the procedure to open the mucous membrane needs to be repeated.

### **Complications**

The major risk with keratoprosthesis surgery is infection in the eye – endophthalmitis. This may arise at the time of surgery, or later due to erosion of the mucous membrane, or through spread of infection through the blood stream. Patients are given systemic antibiotics at the time of surgery, and should take prophylactic antibiotics if they are undergoing any further surgery such as tooth extraction.

The quality of vision achieved following keratoprosthesis surgery is obviously dependent on the normal functioning of the retina etc. – a fact not easy to establish preoperatively in patients with extensively damaged anterior segments. The incidence of retro-prosthetic membranes is lower with the Legeais keratoprosthesis than with the earlier designs, and in addition, estimation of intraocular pressure is possible through the synthetic cornea, making management of any associated glaucoma more practicable.