Review Article :

ROAD TO ARTIFICIAL CORNEA- *"KERATOPROSTHESIS"*

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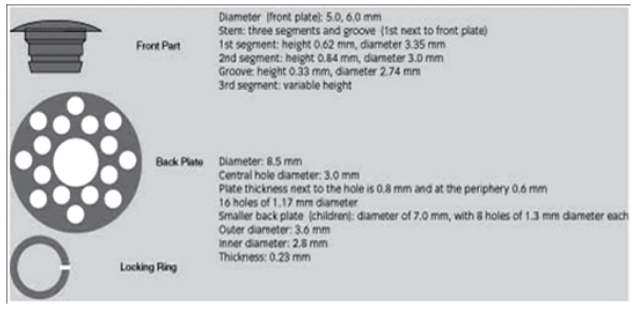
INTRODUCTION

Keratoprosthesis (Kpro) implantation is performed to restore vision in patients with severe corneal blindness who are at too high risk of graft failure after conventional corneal transplantation. Penetrating keratoplasty remains the oldest, most common, and most successful form of solid tissue transplantation and enjoys a success rate of more than 90% in the treatment of corneal disorders such as keratoconus, traumatic corneal scars, dystrophy, and degeneration[1]. The failure rate, however, is very high in patients with ocular surface disorders such as immunologically mediated cicatrizing conjunctivitis, loss of limbal cells from chemical or thermal burns, severe keratoconjunctivitis sicca, or after multiple transplant rejections and in pediatric patients. In such cases, Kpro could be an alternative and should be considered for the achievement of visual rehabilitation.

EVOLUTION

Pellier de Quengsy was the first to replace an opaque cornea with a glass plate in France around 200 years ago[2].In1853,Nussbaum implanted a collar-stud glass device in a rabbit eye which consisted of two plates sandwitching the cornea connected by a optical cylinder[3].In 1859,Heusser was possibly first to implant a keratoprosthesis(K-Pro) in human eye[4]..In early 1950,Herbert and Stone used plastic as corneal replacement in rabbit and found lamellar implants to be better tolerated than full thickness ones. The implants implanted by them were extruded within 2 weeks[5]. Bock and Maumenée,followed by Knowles, studied the fluid kinetics within the corneal tissues and examined the effect of implanting a plastic disc on the nutrition of the anterior corneal layers. They showed a barrier effect from these implants, which led to anterior corneal dehydration and thinning. The results were similar for implants made from poly glycerylmethacrylate[6-9].This research led to the concept of an ideal KPro.This artificial implant would restore corneal clarity,integrate with host tissues and withstand a hostile ocular surface environment while leading to a minimum of complications.

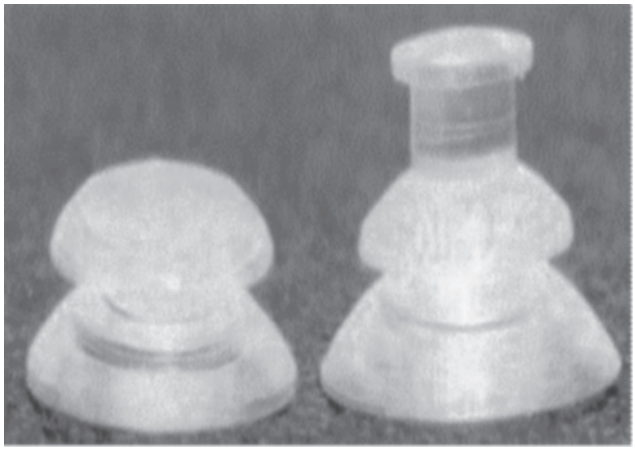
CURRENT KERATOPROSTHESIS DEVICE IN USE BOSTON KERATOPROTHESIS



Design and dimensions of Boston KPro

Surgery begins with the assembly of the device. A donor corneal button (usual size 8.5–9.0 mm) is prepared and a central 3 mm hole is trephined. The front plate is fixed to the adhesive surface supplied with the device. The donor button is then placed over the stem of the front plate and the back plate is slide into place on top of this without screwing or turning. A titanium locking ring is then pushed onto the remaining exposed stem until an audible 'snap' is heard.

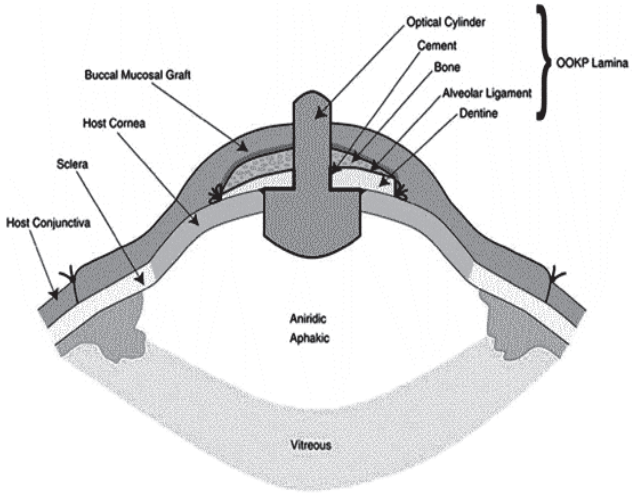
The recipient cornea is then trephined as for conventional PKP (trephine diameter 0.5 mm less than donor trephine size). If



simultaneous cataract extraction is performed, it is advisable to leave the posterior capsule of lens intact if possible, otherwise an anterior vitrectomy should be performed. The donor graft with the KPro is then sutured in place with interrupted 10–0 nylon, using the same technique as a standard PKP. Surgery usually concludes with the intracameral injection of 0.4 mg dexamethasone and the application of a soft contact lens

THE OSTEO-ODONTO - KERATOPROSTHESIS (OOKP)

The OOKP was first described by Strampelli in 1963[10]. It uses the patient's own tooth root and surrounding alveolar bone to support a centrally cemented optical cylinder. This lamina is implanted onto an eye that has undergone corneal trephination, total iridodialysis, cryo-extraction of the lens and anterior vitrectomy, under cover of a full-thickness buccal mucous membrane graft .Other biological materials used for supporting a synthetic optical cylinder have been cartilage and tibial bone,when no tooth from the patient or suitable allograft is available. The main theory behind all these devices was to have a biological skirt which could easily be integrated into the surrounding tissues and derive its own blood supply with subsequent longer survival, and hence a lower extrusion rate. The main strength of the OOKP lies in the fact that it can withstand a very hostile ocular surface environment in patients with corneal blindness and a severely dry eye.



ALPHACOR

The AlphaCor was developed from the Chirila KPro at the Lions Eye Institute in Western Australia, first being implanted in human eyes in 1998 and receiving FDA approval in 2003.[11] It is manufactured from a single biocompatible polymer, poly(2-hydroxyethyl methacrylate) or pHEMA. The Alpha- Cor is formed of two zones, a clear central optical core and an opaque spongy skirt, made by polymerizing the pHEMA under conditions of differing water content. The skirt is polymerized first using a higher concentration of water, 45%, and the core is then polymerized by reducing the water concentration to 35%.[12] The two parts are joined permanently by an interpenetrating polymer network across the junctional zone. The underlying principle behind the design of the AlphaCor was the ability of the outer skirt to be colonized by invading keratocytes resulting in integration of the device with the surrounding tissues. The central zone was designed to remain optically clear, although various states of epithelialization can occur.

PINTUCCI BIOINTEGRABLE KERATOPROSTHESIS

In 1979, Pintucci made use of the biointegrable properties of Dacron, which was successfully used previously in angioplasty and

cardioprosthesis, to develop a supporting skirt for a PMMA optic.[13] The device, together with its assembled dimensions, can be seen in Figure. Implantation of the Pintucci device is very similar to that of the OOKP and involves a two-stage procedure.

EMERGING DEVICES

The supraDescemetic Synthetic Cornea (sDSC) is one of these devices, developed by Parel, Lacombe and Alfonso in 1990. It involves implantation of a synthetic, biocompatible prosthesis directly onto bare Descemet's membrane after deep lamellar dissection, theoretically reducing some of the disastrous complications associated with penetrating KPros such as epithelial downgrowth, fistula formation and endophthalmitis. Stoiber *et al.* reviewed the results of using supraDescemetic KPros in normal and vascularised rabbit corneas and had favourable success rates[14]. Recent advances in tissue engineering have now made it possible to produce natural corneal substitutes from recombinant human collagen. Results of *in vivo* animal studies show good integration, with regeneration of corneal cells, including nerves and tear film production. Researchers reported no difference between type I and III collagen-based substitutes with both being nerve-friendly. These substitutes, following further clinical testing, show promise in helping to alleviate the shortage of corneal material and as emergency patch grafts.[15-16]

CONCLUSION

In the last few decades, great advances have been made in the field of KPro surgery, but still, there is little understanding of many of the underlying biological mechanisms surrounding integration, melting and resorption. A multitude of devices have been described and invented but few remain in clinical use. It is hoped that artificial corneal substitutes will soon be available to relieve the world shortage of donated corneal materials, allowing visual rehabilitation of corneal blindness worldwide.

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