A Tooth for an Eye- Osteo Odonto Keratoprosthesis: A Case Report

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Abstract
Osteo-Odonto-Keratoprosthesis (OOKP) is a preferred technique of vision restoration surgery in eyes with end stage ocular surface disorders such as Steven-Johnson syndrome, ocular circatricial pemphigoid and dry keratinized eyes following severe chemical burns. The conventional corneal transplant surgery has much poorer prognosis in these disorders due to intense vascularisation of cornea. OOKP uses an acrylic optical cylinder which replaces the diseased cornea and gives excellent image resolution and quality. Although the possibility of immune mediated rejections is less than conventional grafts, the technique is associated with inherent complications such as resorption of bone lamina which can lead to extrusion of the graft and retroprosthetic membrane formation. This makes the technique not only surgically difficult but also demands long term follow-up of the patient. In spite of this being a tedious procedure, it definitely has promising visual outcomes.

Keywords: Keratoprosthesis; alveolar bone; PMMA optic; vascularisation.

Introduction

Osteo-Odonto-Keratoprosthesis (OOKP) is a vision restoring surgical technique where the patient's opaque cornea is replaced with artificial optical device. This optical device is made up of a PMMA (polymethylmethacrylate) cylinder which acts as an artificial cornea. Thus, the device is called keratoprosthesis (kerato means cornea and prosthesis means artificial device). This PMMA cylinder is embedded in a base made from patient's own tooth which is then sutured to the cornea to restore the vision. The procedure is done in patients with end stage corneal disease where conventional corneal graft has a poor prognosis. The conventional surgery includes the use of a full thickness corneal button excised from a cadaver eye (allograft), which replaces the diseased cornea of partial or total opacity. When it is associated with intense vascularisation, it prevents the taking up of the donor graft and leads to graft rejection. Thus, these patients are eligible for keratoprosthesis. A vast number of designs and materials of keratoprostheses have been developed and implanted in the patients. The technique with the best results and long term follow-up is the osteo-odonto-keratoprosthesis (OOKP) invented by Strampelli and modified over the years by Prof. G Falcinelli.[1] This technique demands the involvement of both dental and ophthalmic surgeons to complete the procedure. Thus, it is necessary for both the surgeons to understand the finer details of the procedure and its possible complications which can be avoided with adequate precautions during the surgery and timely follow-up of the patients.

Case report

A 56-year-old man reported to an eye hospital for restoration of vision. A detailed history to determine the primary diagnosis and previous surgical interventions was recorded. A brisk perception of light and normal B-scan was an essential pre-requisite. Intraocular pressure was usually assessed by digital tonometry. Oral assessment included assessment of oral and dental hygiene and state of buccal mucosa. An orthopantomography (OPG), X-ray and spiral CT scan of canines was carried out for selection of a suitable tooth with the assistance of an oro-maxillofacial surgeon.

Surgical technique

Stage 1 involves ocular surface reconstruction and fashioning of an osteo-odonto lamina and its optical cylinder (Figure 1). A large circular piece of buccal mucosa is harvested from the cheek. The graft is trimmed off excess fat and soaked in cefuroxime solution. A lateral canthotomy is performed, followed by division of symblephara and superficial keratectomy. The buccal mucous membrane graft is sutured to the sclera bounded by the insertion of the four rectus muscles to create a new ocular surface (Figure 2).

Harvesting the tooth

The ideal tooth with the best surrounding bone is usually the canine tooth. Other single-rooted teeth can be used in the absence of a canine. The assessment of suitability of the tooth can be done by clinical examination but depends mainly on radiological assessment. The mainstay views are orthopantomograms (OPG) and intra-oral periapical radiographs (IOPAs). The choice of upper or lower canine depends on the proximity of the maxillary sinus in the upper and the proximity of the mental foramen in the lower. The lower canine harvesting is straightforward but the buccal plate is occasionally a little thin and the lingual muco-periosteum is more difficult to preserve. The upper canine occasionally gives too much bone palatally and there is a risk of violation of the antrum.

The harvest of the osteo-odontal lamina involves the sectioning of bone on either sides and apical to the chosen tooth and removing the tooth and its surrounding alveolar bone, together with the associated mucoperiosteum (Figure 3). The incision is made to the bone and mucoperiosteum elevated from the adjacent teeth. The bone cuts are made between the teeth and below the chosen tooth with a fine saw. The resulting alveolar defect is covered as best as possible with adjacent mucosa but the exposed bone reepithelialises very rapidly.

The crown of the harvested tooth is used as a handle; whilst the attached tooth root and the surrounding bone is worked

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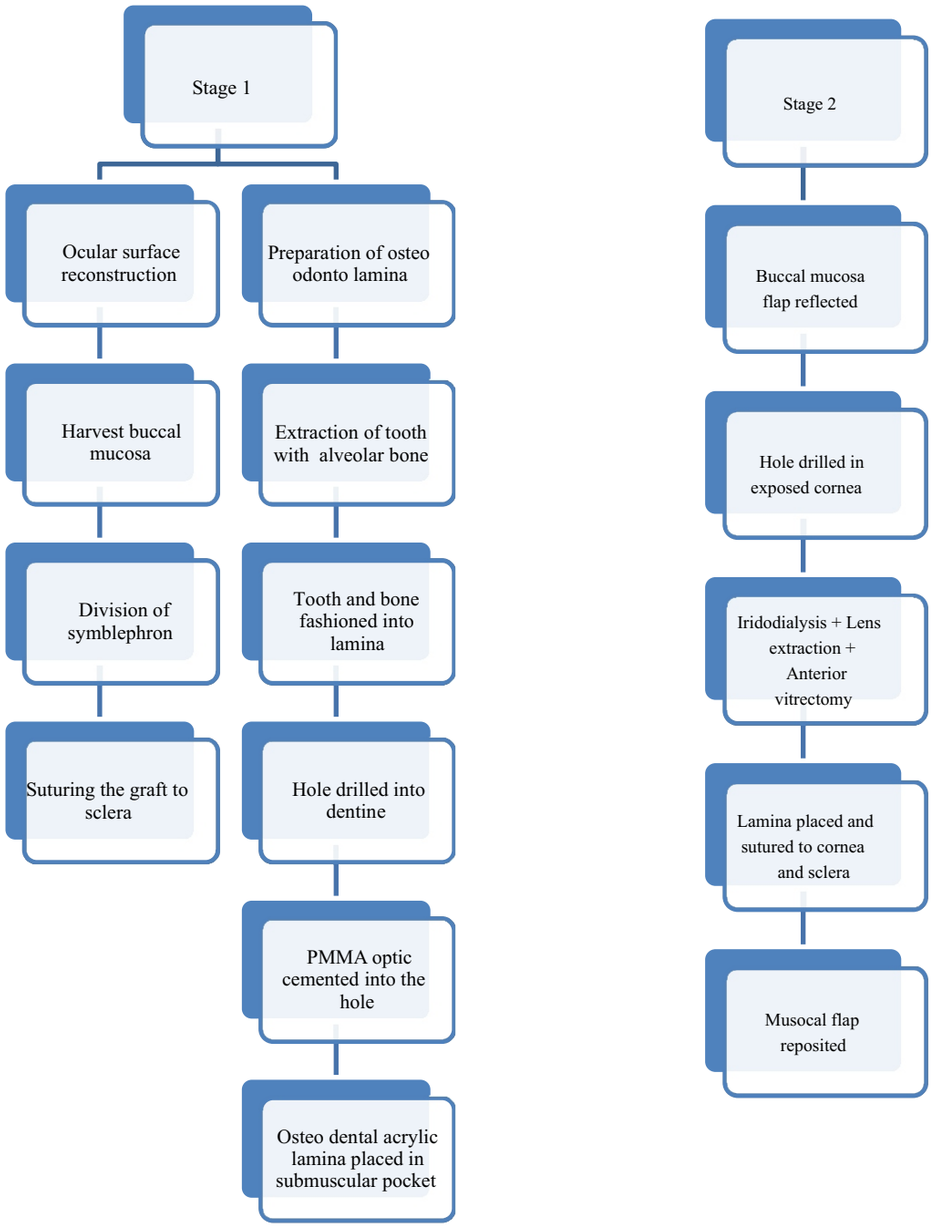

Figure 1: Stages of the surgical technique

into a lamina with dentine on one side and bone on the other. Periosteum is conserved and wherever possible glued back with fibrinogen adhesive. A hole is drilled through the dentine to accommodate a PMMA optical cylinder, which is cemented in place (Figure 4). The resultant osteo-dental acrylic lamina (ODAL) is placed into a sub-muscular pocket under orbicularis oculi, usually in the lower lid of the fellow eye, in order to acquire a soft tissue covering.

Stage 2 starts with retrieval of the osteo-dental acrylic lamina (ODAL) from its sub-muscular pocket (Figure 1). It is carried out 2 to 4 months after Stage I for the soft tissue to invest into the bone pores of the lamina. The interval also allows the lamina to recover from thermal damage and any infection. After the lamina is retrieved from its sub-muscular pocket, the soft tissue is excised (Figure 5) and a template is made of the lamina in order to plan placement of prosthesis. The buccal mucosal graft is reflected to allow access to the cornea. The centre of the cornea is marked, and a small hole is drilled, the diameter of which corresponds to that of the posterior part of the optical cylinder. Relieving incisions are made and total iridodialysis, lens extraction and anterior vitrectomy are performed. This is necessary otherwise the iris tissue gets plastered on the posterior surface of the optical cylinder. The posterior part of the lamina is inserted through the central corneal hole and the lamina is sutured onto the cornea and sclera (Figure 6). The

Figure 2: Mucous Membrane Graft sutured to sclera

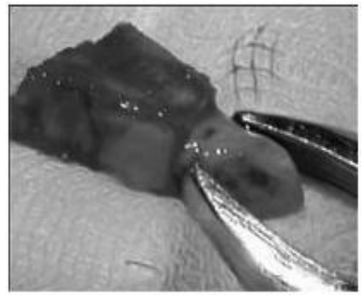

Figure 3: Extracted tooth with alveolar bone

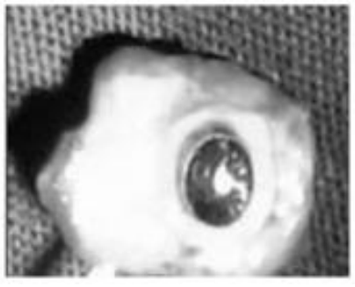

Figure 4: Optical cylinder cemented to the dentine

Figure 5: Excision of soft tissue from the lamina (ODAL) after removal from submuscular pouch

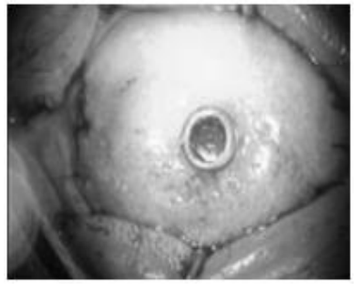

Figure 6: Implantation of ODAL

eye is re-inflated with filtered air. The mucosal flap is replaced after making a hole to allow the protrusion of the anterior part of the optical cylinder.[2]

Discussion

OOKP is a surgical technique where the patient's own tooth is used to form a biological frame to support an acrylic optic cylinder. This surgery restores the sight of patients with end-stage ocular surface disease where conventional grafts fail because of intense vascularisation and subsequent graft rejection or dessication. In diseases with severe ocular surface inflammation and dry eyes, this technique has been found to be more successful than other purely synthetic prostheses. OOKP provides a stable and superior long term visual rehabilitation in these patients.

Indications and contraindications

The procedure is indicated in bilateral cases of Cicatricial corneal diseases such as Stevens Johnson syndrome and Ocular cicatricial pemphigoid where there is high chance of rejection of a penetrating graft due to highly vascular cornea. It is also done in patients with severe grade chemical or thermal injury to the cornea which leads to total corneal opacity, keratinisation of cornea, conjunctival ischemia and dry eye. Other indications include repeated failed penetrating keratoplasties where there is little corneal tissue left for subsequent graft. The conventional graft is more likely to fail when it is larger in size (a large diameter graft will be nearer to the corneo-sclera junction and the blood vessels, thus at risk of immune mediated reaction). In patients with aniridia there is congenital limbal (corneo sclera junction) stem cell deficiency along with the absence of iris tissue. Limbal stem cells are multipotent cells which help in epithelialisation of the grafted cornea after the transplant. Loss of these cells will lead to rejection in cadaver grafts but not in artificial prosthesis. Thus, OOKP is indicated for vision restoration in such patients.

Rare indications include case with severe corneal opacity resulting from complicated ocular surgical procedures su-

ch as vitrectomy with silicone oil injection and cataract extraction with vitreous touch to corneal endothelium. In these procedures corneal endothelium is decreased in number and unable to maintain the transparency of cornea.

The only absolute contraindications to the procedure are absent light perception and an edentulous patient. Posterior segment of the eye (retina and optic pathway) should be normal before carrying out the surgery. Thus, irreparable retinal detachment or other posterior segment pathologies such as macular degenerations are contraindications for this procedure.[3]

Complications

Oral complications of OOKP surgery may include excessive scarring of the buccal mucosa, exposure of roots of the adjacent teeth, damage to maxillary sinus and parotid duct which may occur while extracting the tooth and the alveolar bone.

Ocular complications during Stage I surgery include the risk of globe perforation, post-operative lamina and mucous membrane infection, and laminal resorption.[4] During Stage II surgery there may be a risk of vitreous hemorrhage, choroidal or retinal detachment.

Late postoperatively, there may be diminution of vision due to retroprosthetic membrane formation and subsequent rise in intraocular pressure. This may lead to glaucomatous optic nerve damage and irreversible visual loss.[5] There can be resorption of the bone lamina leading to extrusion of the optical cylinder.[6]

Though an extremely demanding and time consuming procedure, the rewards can be extremely satisfying if the adequate precautions are observed by both the dental and ophthalmic surgeons. Although the technique was described some 40 years ago, subsequent improvements in the methodology have been made over the last decade. Studies have been done to assess the success of the procedure, and visual status many years after surgery has been found to be normal.[7] The vision in these patients is likely to decrease over a longer period of time due to antecedent complications such as glaucomatous optic nerve damage, laminal resorption and retroprosthetic membrane formation. Thus, more studies are needed to assess the long term visual outcome in these patients and the development of possible late post-operative complications.

References

1. Hille K, Grabner G, Liu C, Colliardo P, Falcinelli G, Taloni M, et al. Standards for modified osteoodontokeratoprosthesis (OOKP) surgery according to Strampelli and Falcinelli: the Rome-Vienna Protocol. Cornea 2005;24:895-908.
2. Liu C, Sciscio A, Smith G, Pagliarini S, Herold J. Indications and technique of modern osteo-odonto-keratoprosthesis (O OKP) surgery. Eye News 1998;5:17-22.
3. Falcinelli G, Falsini B, Taloni M, Colliardo P, Falcinelli G. Modified osteo-odontokeratoprosthesis for treatment of corneal blindness: long-term anatomical and functional outcomes in 181 cases. Arch Ophthalmol 2005;123:1319-29.
4. Stoiber J, Forstner R, Csaky D, Ruckhofer J, Grabner G. Evaluation of bone reduction in osteo-odontokeratoprosthesis (OOKP) by 3-dimensional computed tomography. Cornea 2003;22:126-30.
5. Falcinelli GC, Falsini B, Taloni M, Piccardi M, Falcinelli G. Detection of glaucomatous damage in patients with osteoodontokeratoprosthesis. Br J Ophthalmol 1995;79:129 -34.
6. Stoiber J, Csaky D, Schedle A, Ruckhofer J, Grabner G. Histopathologic findings in ex-planted osteoodontokeratoprosthesis. Cornea 2002;21:400-4.
7. Liu C, Okera S, Tandon R, Herold J, Hull C, Thorp S.. Visual rehabilitation in end-stage inflammatory ocular surface disease with the osteoodonto-keratoprosthesis: results from the UK. Br J Ophthalmol 2008;92:1211-17

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