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Osteo-Odonto-Kerato-Prosthesis - A Review

Dr. Balamurugan .R MDS

Chennai- 600071, India

Abstract: ***Osteo-Odonto-Keratoprosthesis is a multidisciplinary approach to restore vision for the patients with corneal blindness. The window of the soul is our eye and the window of the eye is cornea. This involves removing a canine tooth from the patient, shaping and drilling to allow implantation of an artificial plastic corneal device and finally implanting back into the eye few months later. This transplantation procedure has an autologous dental root-bone lamina complex and buccal mucosal graft to secure the optical cylinder which acts as a ray of vision for corneal blindness. This paper on review intends to present with indications, contraindications, and patient assessment and the surgical procedure, complications, and future scope of OOKP.***

Keywords: corneal blindness, tooth for eye, optical cylinder

1. Introduction

Osteo odonto keratoprosthesis (osteo- bone, odonto- tooth, kerato- cornea, prosthesis- artificial device) is a surgical procedure to replace damaged cornea in patients for whom corneal transplant becomes failure[1]. WHO reported that 4.9 million are blind due to corneal pathology. Corneal transplant has served as a successful curative for most of the blindness. Inspite of various advances in human corneal transplantation technique, the prognosis of keratoplasty was poor in patients with compromised ocular surfaces such as dry eyes, chemical burns, Steven Johnson syndrome, cicatricial pemphigoid[2,3]. In such cases keratoprosthesis plays an acceptable alternative mode of management to provide visual rehabilitation of such patients[4]. After long interval ookp itself has finally gained an recognition by the corneal surgeons and was considered to be the most reliable treatment option for patients presenting with opaque cornea[5]

2. Rationale of OOKP

The rationale for this operation is the use of non-immunogenic tissues, particularly in patients with a vascularized cornea, who are prone to quickly reject any foreign corneal allograft. Strampelli decided to use a thin lamina of the recipient's tooth root and surrounding alveolar bone, in which a cylindrical acrylic lens is fixed by means of dental mastic. Following this operative stage, the diseased cornea is trephinized, the conjunctiva mobilized and the osteo dental acrylic lamina (ODAL) is inserted in the bulbar sclera and covered with a rounded strip of the patient's buccal mucosa provided with a central aperture. The existence of extracellular matrix fibers possessing the features of incomplete or immature elastic/elastin fibers was first described in the periodontal membrane by Fullmer and Lillie. These oxytalan fibers have since been shown to correspond to the earliest identifiable stage of elastogenesis. Along with the intermediate elaunin fiber, they constitute the three members of the normal elastic fiber family. In certain tissue sites, such as the periodontal membrane/ligament and the suspensory ligament of the ocular lens, oxytalan fiber do not undergo maturation. The normal adult cornea does not exhibit any member of the elastic fiber family, but they are demonstrated during wound repair[7].

Patient Selection (TABLE I)[5,9,10,11]

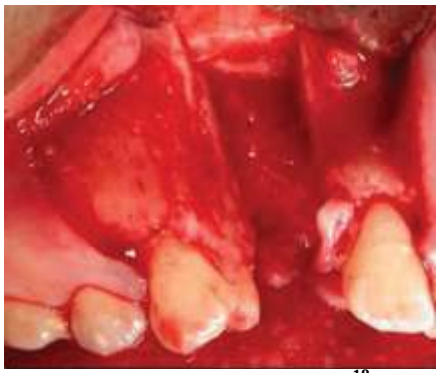
Indications	*Contraindications*
• Bilateral corneal blindness • Steven Johnson syndrome • Ocular cicatricial pemphigoid • Chemical burns • Trachoma • Multiple corneal graft failure	• Patient managing with their level of vision • Children under 17years • Phthisis • Irrepairable retinal damage • Eyes that have no perception of light

Patient Assessment (TABLE II)[5,8,9,10,11,12,16]

Pre- Operative	*Oral*	*Psychological*
• Multidisciplinary approach. • Detailed case history. • Etiology for loss of vision.	• Buccal mucosal graft donor site. • Appropriate tooth dentine/ bone. • Oral mucosal lesions. • Compromised tissue quality due to smoking and betel nut chewing. • Teeth selected should be free from periapical diseases.	• Multiple procedures. • Loss of eye- significant risk. • Life long follow up. • Unreasonable expectations of outcome and cosmesis.

3. Surgical Technique

Stage - 1: OOKP surgery is usually carried out in two stages second surgical procedure is carried out at the time interval of two to four months of time. During 1st stage a canine tooth is extracted with the entire root and a portion of the jawbone and wound site is covered.

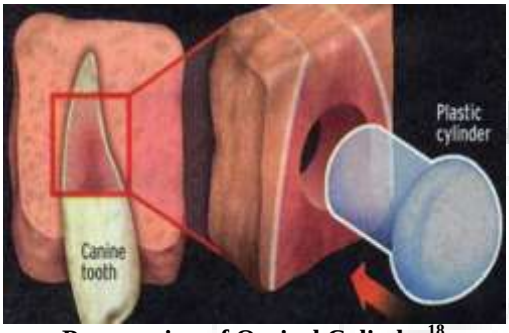


After Removal of Canine[18]

The coronal half of the tooth is sectioned and the remaining root, along with the bone and tissue are shaped into a cube that is referred to as osteo-odonto alveolar lamina. A hole is prepared in the centre of OOAL to fit a small clear plastic optical cylinder that is sealed with the help of dental cement. This optical cylinder becomes a media to receive the light ray that is focused on the retina. The dental lamina is inserted through a slit below the lower eyelid of non-operating eye. Superficial keratectomy is then performed and replacing it with a full thickness buccal mucosal graft. Once harvested, the fat from the graft is removed and the graft is sutured to the sclera thus creating a new ocular surface[5,11,16]

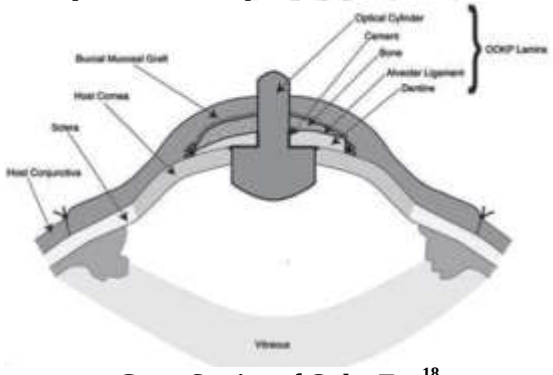
Step 1a: The mucous membrane graft harvesting is done first.

Step 1b: Only after the graft is very well established, OOKP lamina is prepared.



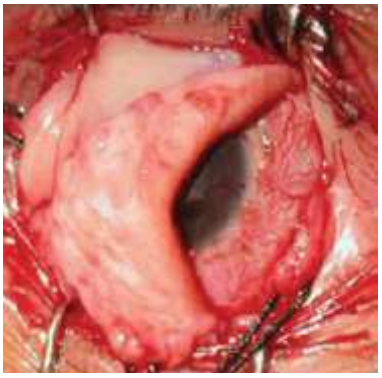
Preparation of Optical Cylinder[18]

Stage - 2: Stage 2 starts with the retrieval and inspection of buried lamina for adequate size. The surgeons now proceed, to prepare the eye for receiving the implant. The buccal mucosal graft is lifted and corneal trephination (5mm in diameter) is created for the central opening in the eye. Iridodialysis and lens extraction is followed by vitrectomy to create the space for new implant.

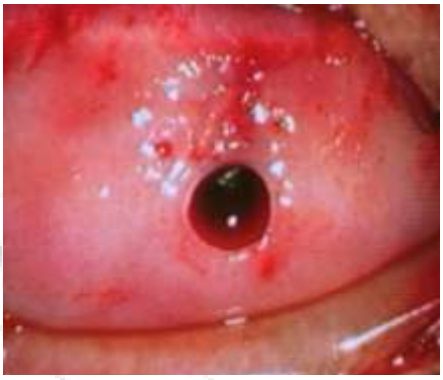


Cross Section of Ookp Eye[18]

The kerato prosthesis is placed into the opening, which serves as a strong biological skirt for securing the prosthesis in position by sutures. Finally the buccal mucosal graft is sutured over the implant and trephined in the centre to allow the anterior aspect of the optical cylinder to protrude. This will allow the light to enter the optical cylinder and then the buccal graft is sutured back onto the sclera. The patient should be able to see within two-three weeks time.



Buccal Mucosal Graft



Protrusion of Optical

Cylinder from the Graft

Immediate post operative symptom relief including corticosteroids and antibiotic prophylaxis. Follow up is life ophthalmologist. One month after surgery, a cosmetic prosthesis covering the external ocular surface can be given. Main outcome measures to be considered are visual acuity, field of vision, anatomical integrity and stability and complications related or unrelated to the OOKP technique[13,14,15,16,17,18]

Complications [12,16,18]

Ocular	*Oral*	*Systemic*
Glaucoma	Mucosal membrane thinning	Related to local and general anesthesia
Retroprosthetic membrane	Mucosal membrane necrosis	Immunosuppression due to steroid administration
Vitritis	Extrusion of prosthesis	
Expulsion of cylinder	Oroantral fistula	
Endophthalmitis	Damage to parotid duct	
Retinal detachment	Damage to adjacent teeth Mandibular fracture	

4. Discussion

The osteo-odonto-keratoprosthesis (OOKP), although described over 40 years ago, keratoprosthesis by Strampelli which remains as a choice of treatment for end stage of corneal blindness not amenable to penetrating keratoplasty. OOKP offers advantage by permanent fixation of an acrylic lens, insertion of the mucosal epithelium onto the alveolar dental ligament, long-term retention of the prosthesis due to

its complete biological compatibility as far as other pathological conditions do not occur[1].

OOKP surgery has been performed with minor modifications to the technique for visual rehabilitation of certain patients with severe ocular surface disease such as dry keratinized eye resulting from steven Johnson syndrome, ocular cicatricial pemphigoid, trachoma and chemical injuries[2,3]These patients may have a high incidence of glaucoma even before keratoprosthesis implantation. In a series of 111 patients (none with keratoprosthesis) with ocular cicatricial pemphigoid, 29 patients (26%) were found to have glaucoma, mostly in the advanced stage[4].

The functional results seen in the patients who have undergone OOKP surgery confirmed the overall statistical trends observed for the anatomical outcome because best-corrected visual acuity found in general, is acceptably good and stable over the years. The innovation introduced to the original OOKP procedure may make the present surgical approaches less prone to fatal complications (endothalmitis and prosthesis extrusion) and more likely to achieve better functional outcome when compared with either the original technique or other proposed approaches. We recognize that this procedure routinely requires the extraction of at least 1 of the patient's teeth which has disadvantage of scarifying a strong and healthy tooth along with considerable amount of healthy bone. However, the findings of numerous studies provide evidence of a long term stability of prosthesis with a level of visual rehabilitation that is currently unattainable with other keratoprosthesis techniques[6].

In reviewing the efficacy of OOKP procedures the success of surgery is found to be dedicated to the material used for implants by most of theauthors[6]. The superiority of OOKP (biointegrated and biocompatible Kpro) approaches has been proved and supported by various clinical and histological studies as reported by G. Falcinelli, et al[6] in 2005. Efficacy of these implants is mainly due to its uniqueness of the living material, that composes the keratoprosthesis i.e. the tooth along with the alveolar bone with its ligament and small periosteum which are all covered by the autologous oral mucous membrane, that provides a long term support to the optical component of Kpro with the lowest risk of infection and extrusion. Indeed, in various clinical studies post operative complications are less frequently reported with OOKP than as compared with other biologically compatible or biointegrated haptic implants[6].

Complications at various stages of surgery were noticed[12,16,18]. Oral complications from Stage 1 surgery include damage to adjacent roots, oronasal or oroantral perforation, mental nerve injury, fracture of the palatal or lingual alveolar bone from the harvested tooth, mandible fracture, damage to the parotid duct orifice with possible stricture, and scar band formation. Ocular complications during Stage 2 surgery may be risk of vitreous haemorrhage, choroidal and retinal detachment. Post-operatively vision may be limited by a pre-existing condition such as glaucoma or macular disease. There can be resorption of the lamina, fistula formation. The extrusion of the optical cylinder as reported in literature according to Falcinelli et al[6]18 years after surgery, the probability of retaining an intact OOKP was 85%. A significant risk of 19% has been estimated by Liu et al[5,10,18].

Current research is being done for creating synthetic analogues to substitute the dental lamina and as well as accurately measuring intraocular pressures (to diagnose glaucoma) in post transplant patients. The incidence of complications is reduced with accurate surgery and meticulous follow-up. The complications are also associated with local and general anesthesia[16].Numerous synthetic keratoprosthesis devices have been developed as total replacements of the cornea for the treatment of corneal blindness[3,18]an autologous osteodental lamina is always used, an allograft is considered in edentulous patient.

5. Conclusion

The standards for modified OOKP according to Strampelli and Fallicinelli, the Rome-Vienna protocol have been followed in various centres all over the world. OOKP still has many barriers as it is technique sensitive and needs an surgical expertise, yet provides hope for restoring vision in corneal blindness patients. Tooth as an eye implant should inspire the future professionals in providing best care for the patient.

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