

The tooth in eye, osteo-odonto-keratoprosthesis – A review

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ABSTRACT

The major cause of vision loss worldwide is by diseases affecting the cornea followed by cataract in overall importance. The recent advance in this keratoprosthesis is using the person's own tooth and alveolar bone for the prosthetic material so as to reduce the risk and, hence, came the name "osteo-odonto-keratoprosthesis" (OOKP). Strampelli, in 1963, was one among many pioneers who were involved in developing new keratoprosthesis. The procedure of OOKP is by two steps with an interval of 3–4 months. Studies show that this method is getting established in very smaller range. Hence, this review aims to emphasize the usefulness of OOKP in corneal diseases.

KEY WORDS: Corneal diseases, Osteo-odonto-keratoprosthesis, Polymethyl methacrylate, Tooth in eye

INTRODUCTION

The cornea is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. Transparency, avascularity, and immunologic privilege make the corneal anatomy more special.

The major cause of vision loss worldwide is by diseases affecting the cornea followed by cataract in overall importance. Corneal scarring caused by wide variety of infectious and inflammatory eye diseases leads ultimately to functional blindness.^[1] Various refractive eye surgery techniques, i.e., orthokeratology are methods using specialized contact lenses to transiently reshape the cornea so as to improve the refractive state of the eye or reduce the need for eyeglasses and contact lenses. Keratoprosthesis implantation is a procedure performed to remove a person's cornea and replacing it with artificial cornea.

The recent advance in this keratoprosthesis is using the person's own tooth and alveolar bone for the prosthetic material so as to reduce the risk and, hence, came the name "osteo-odonto-keratoprosthesis" (OOKP). Studies show that this method is getting established in very smaller range. Hence, this review

aims to emphasize the usefulness of OOKP in corneal diseases.

HISTORY OF OOKP

Pellier de Quesgysy, a French ophthalmologist first proposed implanting a glass plate into cornea about more than 200 years for replacing damaged and opaque cornea with an artificial implant or keratoprosthesis and in early 1855, Nussbaum placed the first artificial corneal implant made of quartz crystal in a human eye. Later on, different scientists came with different keratoprosthesis and techniques where almost all the early implants extruded, but the interest in keratoprosthesis leads to the need of introducing keratoplasty.

Elshnig in Prague (1914), Filatov (1924), and Tudor-Thomas from the United Kingdom (1936) were the leading pioneers in keratoprosthesis. Penetrating keratoplasty went stronger with Stocker in the 1950s when the introduction of steroids, fine needles, and sutures was accompanied.

Strampelli, in 1963, was one among many pioneers who were involved in developing new keratoprosthesis. He suggested replacing of acrylic implants by the use of patients own tooth and bone as an autograft picture frame. Initially, the technique did not gain much popularity. It was Dr. Gian Carlo Falcinelli, in 1980,

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who refined the technique and gained fame and so the technique was named as Rome-Vienna protocol.^[2-5]

HOW OOKP SURGERY IS PERFORMED?

The procedure of OOKP is by two steps with an interval of 3–4 months. The preparation procedure is the first step where the patient's canine tooth is extracted *in toto*. The tooth is sliced down to the root and dentin so that a thin sheet is formed. Next, a hole of 3–4 mm is drilled in the sliced tooth. A cylindrical lens is inserted into the hole and then the prosthesis combination of tooth slice and lens is inserted into the cheek of the same side of the desired eye. Finally, an oral mucosa graft from the patient's cheek is inserted on top of the damaged cornea.

The second stage after 3–4 months interval, the tooth-lens combination is removed from the cheek, and it is placed to the desired site and lifted up slightly so that the damaged cornea can be removed, and the graft gets an implantation hole for the lens. The tooth-eye is placed underneath the graft and begins the recovery phase.

INDICATIONS

The main indication for OOKP is bilateral corneal diseases. These corneal lesions occurred in conditions such as ocular cicatricial pemphigoid, Stevens-Johnson syndrome, trachoma or trachomatous chronic conjunctivitis, multiple corneal graft failure, congenital trigeminal nerve hypoplasia, linear immunoglobulin A disease and nutritional deficiency, severe end stage of dry eyes, chemical burns, multiple vascular corneal surgery failures, and corneal trauma. Boston Type 1 keratoprosthesis is preferred over OOKP in cases of wet corneal lesions and unilateral corneal blindness.^[6,7]

CONTRAINDICATIONS

Patient who is well adjusted to their visual handicap, age restriction is limited till 17 years, in cases where potential for visual gaining is poor, in patients with previous iris lesions, edentulous patients, patients with a history of graft rejections, patients with previous history of glaucoma, patients who are more concerned with esthetics, and patient with adverse oral habits such as smoking and paan chewing are strictly contraindicated for OOKP.^[8] Patient should be educated about the procedure, follow-up, and complications. The post-surgery expectations should be given with a lesser hope because the outcome after surgery is not esthetic and remains unnatural, i.e., the patient should not be given confidence about the esthetic outcome of the surgery. Patients with a history

of tobacco or betel nut usage may have poor tissue quality and vascularization issues are more common in them.^[7,9]

SURGICAL PROCEDURE

Pre-operative Patient Assessment

A team of ophthalmologist, oral surgeon, and radiologist together performs a multidisciplinary approach. History taking has a major role and ruling out the etiology also has its own importance in treatment planning. The patient should be assessed psychologically to evaluate their interest toward the surgery, whether they have understood the follow-up procedures and the unexpected outcome postsurgically if applicable.^[10,11]

Oral Assessment

Evaluation of both the buccal mucosal donor site and appropriate tooth selection is mandatory for oral assessment.

Since patients advised with OOKP are more affected by mucocutaneous diseases, their oral cavity may also be affected. Betel nut chewing will compromise tissue quality while smoking will affect graft revascularization. Hence, habit cessation is must for patients who are undergoing OOKP. Examination of buccal mucosa should be done thoroughly to rule out any oral lesions such as lichen planus or oral submucous fibrosis. The teeth selected for the prosthesis should have adequate bone support and be vital.^[12-14] The teeth should not be root canal treated or with any periapical and periodontal lesions. Periapical radiographs and panoramic radiograph should be made to assess the height and other features of the tooth. Usually, maxillary canine is preferred considering the length of the root. Other single-rooted teeth can also be selected if they have the required anatomy and in cases of missing canines. Lower canines can also be selected. It depends on the maxillary sinus and mental foramen levels to select the teeth. In lower canine harvesting, buccal plate is occasionally thin and the lingual mucoperiosteum is difficult to preserve and in case of upper canine, there is a risk of antrum perforation.^[11,15]

Ophthalmic Assessment

Patients are thoroughly assessed for the etiology of vision loss through detailed history and extensive examination of the eye.

Stage 1 Surgery

In the 1st stage of OOKP surgery, the selected single-rooted tooth (usually, maxillary canine is preferred considering the length of the root) is harvested and prepared as a tooth-bone lamina. The tooth is removed along with the surrounding jaw bone and is then separated by cutting across the bone. While the crown

of the harvested tooth is used as a handle, the attached tooth root and surrounding bone are sliced into a lamina with dentine on one side and bone on the other side, also pulp is removed. A fibrinogen adhesive is used to hold the periosteum. A hole is drilled through the dentine to accommodate polymethyl methacrylate optical cylinder, which is cemented in place. The crown portion of the tooth is cut before the cementation of the optical cylinder. The resultant tooth-bone lamina is placed under orbicularis oculi usually in the lower lid of the fellow eye to acquire a soft tissue graft for a period of 2–4 months. A buccal mucous membrane graft is used to cover the ocular surface. It will be vascularized by the time of Stage 2 surgery and will subsequently provide the blood supply to the bone part of the tooth-bone lamina.^[11,16]

Stage 2 Surgery

After 2–4 months of Stage 1 surgery, review is done and the keratoprosthesis which is placed out is retrieved. After inspection of the fibrovascular capsule, reflection of the buccal mucosal graft is done. Excess tissue is removed from the bone surface. Corneal trephination is done to form a central opening in the eye to remove the iris lens and the anterior vitreous. Incision is made to remove the iris completely. Posterior of the lamina is placed through the central hole. The lamina is sutured onto the cornea and sclera. Air is injected in and the keratoprosthesis implant is centered.^[17] Intravenous mannitol is administered to reduce the intraocular pressure. After marking the center of the cornea, 3 mm trephination will be carried out over the center of the graft to clear the visual axis and to allow the transmission of light for clear vision. Replacement of the mucosal flap is done after preparing a hole in the anterior part of the cylinder. Patient is kept in a supine position for 5–6 days till the intravitreal air is completely resorbed. Cosmetic prosthesis is later placed over the external ocular surface following a month after the surgery.^[3,8]

Post-operative Care

Post-operative period immediately following the surgery requires pain relief. Prednisolone 20 mg and lansoprazole 30 mg for 5 days and oral antibiotics for a week are given. Chlorhexidine and nystatin mouthwashes are given to the patient. The optic region is kept clean and the buccal mucosa is monitored. Skin sutures are removed after a 5 days.^[18,19] Lifelong follow-up and at weekly intervals for a month followed by monthly for 3 months and then by every 2 months for 6 months and later every 4 months are advised and followed.^[17] Stability of the prosthesis and intraocular pressure is monitored during these follow-up visits.

Post-surgical Prosthesis

The patient is referred to an oral prosthodontist to replace the missing tooth as per patient's choice.

COMPLICATIONS

Complications in the oral cavity include exposure of roots in relation to adjacent tooth, possibility of damage to maxillary sinus, and parotid gland duct damage are high and scarring of buccal mucosa.

Complications in Stage 1 surgery include perforation of globe, infection of operative sight, bone resorption, and lamina resorption and in Stage 2 surgery, infection or any damage to adjacent tissues can occur. Chances of retinal detachment or vitreous humor can occur.

Late post-operative complications include secondary glaucoma due to rise in intraocular pressure, optic nerve damage which can lead to irreversible vision loss and also resorption of lamina may lead to extrusion of keratoprosthesis.^[8,9]

Imaging techniques such as the electron beam tomography and multidetector computed tomography are valuable in detecting laminar resorption and more.^[20]

DISCUSSION

The advantages of this surgery include the biological support by dentin instead of any allograft aids in stability and help to achieve a tight seal preventing leakage. It also protects from infection. The disadvantages include long-term requirement of follow-up, two-stage procedure, and less esthetic.^[19]

With 40 years of history, proper improvement of the procedure has been done and also slight modifications to improve the outcome and now more than 8 centers extensively practice OOKP surgery all over the world.^[21]

Fau and Nabzo stated a case report corresponding to the first patient operated with modified osteo-odonto-keratoprosthesis (MOOKP) in America, which was performed in the MOOKP Centre – Latin America in the Clinical Hospital of the University of Chile, in Santiago, Chile. The case report gives a visually impaired patient for 4 years being operated with OOKP and has successful results with 1 year follow-up.^[22]

Hille *et al.* reported 100% retention of OOKP lamina in a 5-year follow-up case.^[23] Iyer *et al.* reported 96% anatomical success of OOKP laminae in 50 cases with an average follow-up of 15 months.^[24] Stoiber *et al.* reported 2% resorption and extrusion of the OOKP lamina, which will cause decentration of the optical cylinder.^[25]

The improvements on the surgical technique were improved such as using mitomycin C which prevented epithelial growth over the prosthesis. This, in turn, reduced post-operative complications significantly and long-term results were improved.^[26]

The OOKP was offered to a patient for the 1st time in Malaysia with failed keratoplasty hoping to recover some functional vision. He underwent a two-stage surgery to implant the OOKP into his right eye. However, 2 months post-operative, he developed vitreous hemorrhage but was able to mobilize more independently, feed, dress himself, and read large print after managing the complication.^[21]

Many other studies have been carried out regarding the procedure of OOKP and so many modifications have brought to reduce the post-operative complications, few of which are discussed above.

CONCLUSION

On discussing the OOKP procedure in detail, we get to know that there are more advantages and success rates over this procedure which would help more people to get back their vision. The patient should be prepared mentally and physically for the long procedure and follow-up so that they can gain their vision. This review concludes that more evidence-based studies if established can make this technique more popular and help out the people who want their vision.

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