Osteo-Odonto Keratoprosthesis (OOKP): A Review of Surgical Techniques and Clinical Outcomes

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Abstract

Osteo-odonto keratoprosthesis (OOKP) is a multi-staged procedure for the treatment of blindness due to bilateral severe end-stage corneal disease. Developed by Strampelli over fifty years ago and modified thereafter by Falcinelli, the OOKP is by far the only keratoprosthesis that has been retained in eyes for over twenty to thirty years. This procedure can be performed in eyes with bone dry and keratinized ocular surfaces and basically consists of an optical cylinder held in place by a skirt of dento-alveolar bone. This review describes the surgical technique of OOKP and the clinical outcomes reported by various series including the author’s personal experience with this keratoprosthesis.

Osteo-odonto-keratoprosthesis (OOKP) surgery is a technique developed half a century ago by the Italian ophthalmologist Strampelli and uses the patient’s own tooth root and alveolar bone to support an optical cylinder.1 This multi-staged procedure is indicated in cases of severe bilateral corneal blindness, when conventional corneal transplantation or even the Boston type1 keratoprosthesis is doomed to failure. Although initially conceptualized by Pellier de Quengsy, a French ophthalmologist, the first keratoprosthesis implantation in a human was performed by Nussbaum in 1855. This was a quartz crystal implant that remained in the eye for six months. Subsequently owing to the inevitable extrusion of the early implants and also due to the increasing popularity of penetrating keratoplasty, the initial enthusiasm surrounding keratoprosthesis died down. However, as experience with penetrating keratoplasty grew, surgeons the world over realized that there were still some forms of corneal blindness that were not amenable to treatment by replacing the diseased cornea with a healthy donor cornea. Thus interest in keratoprosthesis was renewed and numerous designs and techniques were subsequently described.2

An ideal keratoprosthesis should be a suitable replacement of the cornea being optically clear, bio-integrable, resistant to infection and most importantly it should be long-lasting.3,4 Keratoprosthesis can be classified based on the material of the optical cylinder (optic) and the support for the optical cylinder (haptic). Most models have a non-biological haptic (Boston KPro, Pintucci, Leon-Barraquer, Legeais and AlphaCor), while few use biological haptics (Strampelli OOKP, Casey and Temprano). Among these the Boston type 1 keratoprosthesis is currently the most popular while the OOKP has the longest follow-up and best retention rate. The OOKP can also be used in bone dry eyes with keratinized ocular surface and it is the only potentially vision restoring surgery that is possible in such eyes. The original technique of OOKP described by Strampelli has been modified by Falcinelli to improve visual results and retention of the device.5,6 Therefore this technique is now also referred to as the modified OOKP or MOOKP.

Indications:

Patients with bilateral corneal blindness resulting from severe end-stage Stevens-Johnson syndrome (SJS), ocular cicatricial pemphigoid (OCP), chemical burns, trachoma, dry eyes or multiple corneal graft failure may be considered for OOKP surgery. However, this technique is best reserved for bilateral corneal blindness with dry and keratinized ocular surfaces. In wet eyes the Boston type 1 keratoprosthesis is preferred over the OOKP.

Contraindications:

This procedure should not be recommended for patients who are otherwise well adjusted to their visual handicap, children under the age of 17, or in cases of doubtful or no visual potential. Another important consideration is the patient’s expectations from surgery. Since the final look of
the eye after all stages of OOKP is unnatural, the procedure should not be considered in patients who aspire to have both vision and cosmesis (Figure 1). There have been anecdotal reports of patients who after regaining vision and looking at themselves in the mirror have asked for the OOKP to be removed or even committed suicide.

**Pre operative assessment:**

The most important preoperative examination involves determining the visual potential. This can be done by checking accurate light projection in all quadrants, B-scan ultrasonography, and electrophysiological tests like flash ERG and VEP. However certain macular pathologies like a macular hole or scar can still be missed. The intra-ocular pressure is determined digitally and past records are checked to find out if the patient has been treated for glaucoma. A-scan is performed to measure the axial length which is used to calculate the power of the optical cylinder. After ruling out any contraindications to the procedure as described above, the patient is explained about the risks and complications, the need for frequent and lengthy follow-up. The patient must be encouraged to take an informed decision after consultation with family and friends.

**Pre-operative oral assessment:**

The buccal mucosa is inspected to look for areas of keratinisation or scarring. Patients who smoke or chew betel nut should be advised to discontinue such habits before surgery. For patients with poor oral hygiene, a prophylactic antiseptic mouthwash may be advised prior to surgery. Similarly the condition and health of the teeth are also inspected. The ideal donor tooth is the canine because it is mono-radicular. It is not mandatory to perform radiographs, but they can help in identifying the proximity of the floor of the maxillary antrum to the root of the tooth which can help avoid inadvertent oro-antral fistula creation during surgery.

**Surgical technique:**

**Stage 1A:** Before the implantation of the keratoprosthesis a complete iridectomy, lens extraction and anterior vitrectomy is performed. During this procedure the surgeon gets an opportunity to examine the posterior segment by performing intra-operative indirect opthalmoscopy. After suturing the limbal wound, the cornea is covered by advancing the Tenon’s capsule and residual conjunctiva (Figure 2, A to D).

**Stage 1B:** The ocular surface is de-epithelized and a buccal mucous membrane graft is placed on it. The graft is sutured to the four recti and underlying epiclera as well as the surrounding Tenon’s capsule and conjunctiva (Figure 2 E and F).
Stage 1C: A monoradicular tooth (preferably canine) is harvested to prepare an osteo-odontolamina. The root and surrounding jaw bone is removed using a cutting mechanised saw. The bone is thinned on one side to expose the dentine and a small hole is drilled through it. The PMMA optical cylinder is cemented in place and the assembled osteo-dental lamina is placed in a sub-muscular pocket just below the lower eye lid for a period of 8 to 10 weeks.

Stage 2: The osteo-odontolamina along with its fibrovascular capsule is removed from the sub-muscular pocket and cleaned, the soft tissue is excised from the posterior surface and trimmed from the anterior. The buccal mucosa is incised and a flap hinged inferiorly is raised to expose the cornea. A Flieringa ring large enough to accommodate the lamina is secured to the episclera. The center of the cornea is marked and a central opening just large enough to fit the posterior part of the optical cylinder is made with a trephine and scissors. After adequate anterior vitrectomy the lamina is fitted in place and sutured to the episclera. The buccal mucosal flap is repositioned and an opening is made in the flap to expose the anterior part of the optical cylinder (Figure 2, M to P).
Stage 1B and 1C are frequently combined together as the first step and Stage 1A and Stage 2 as the second step. This separates the extra-ocular and intra-ocular parts of the procedure and makes the procedure a two-stage affair. Others combine stage 1B and 1C as a single procedure reducing the number of procedures to three. We prefer a four-staged procedure as it gives time for the patient to recover from each operative insult and reduces the chances of inflammatory complications which can be quite unpredictable in patients with SJS or OCP.

**Post operative care and follow up:**

Systemic antibiotics, corticosteroids and ocular hypotensive agents are administered for the operated eye. Patients are usually seen after one week of discharge from the hospital and again at one month, three months and six monthly thereafter. At the follow-up visits the best spectacle corrected vision is assessed. Additionally, the digital assessment of the intra-ocular pressure, health of the buccal mucous membrane and stability of the optical cylinder is also assessed. Fundoscopy is carried out to check the optic disc and macula, B-scan to detect early peripheral detachments and visual field assessments are made 6 monthly for diagnosis and monitoring glaucoma.

**Clinical outcomes**

Anatomical retention rates and visual outcomes in eyes with blindness due to sequelae of inflammatory disease have been better with the OOKP as compared to purely synthetic prostheses. The overall results with OOKP are good compared with those reported in literature for other available methods in patients with end stage ocular surface disease due to severe inflammatory syndromes like SJS and OCP. Tan et al reviewed the largest eight case series of OOKP published in the scientific literature with sample sizes ranging from 4-181 eyes. The most common indications for surgery were severe cases of SJS and ocular burns. Anatomical survival rate in all the studies was 87.8% (range 67-100%) at 5 years, and three studies showed survival rates of 81% (range 65-98%) at 20 years. Visual acuity was more than 6/18 in 52% (range 46-72%) of the eyes with OOKP surgery. The most common intraoperative complication was vitreous hemorrhage (0-52%) and the most common long-term blinding complication was glaucoma (7-47%). Endophthalmitis ranged from 2-8%. The most common repeat surgical procedure was mucosal trimming due to mucosal overgrowth at the optical cylinder and mucosal grafting for extrusion of the OOKP or mucosal ulceration.

In our series we performed OOKP in 31 eyes of 30 patients blinded by SJS and one patient blinded by severe ocular burns. The anatomical success rate was 100% at a mean follow-up of 14.2±7.2 months. The visual acuity improved from hand motions or light perception to 20/40 or better in 18 eyes, 20/50 to 20/200 in 9 eyes, 20/400 in two eyes and remained hand motions or light perception in 2 eyes. Retinal detachment occurred in 2 eyes, mucosal ulceration in 9 eyes and mucosal overgrowth in one eye.

**Conclusion:**

Although the surgical procedure of OOKP is very tedious, the overall results are very satisfying. Most patients regain good vision and maintain this for long periods of time. There is no doubt that the retention rate of the OOKP is still unparalleled among all keratoprosthesis designs. However, setting up of an OOKP practice requires a dedicated team of surgeons and a multi-disciplinary approach. Complications are common but mostly manageable, provided they are addressed early and appropriately. The most important caveat in OOKP surgery is choosing the right patients, who do not have unrealistic expectations, are committed to come for long follow-ups and are ready to face the prospect of additional surgery for management of complications. It is entirely heartening for an OOKP surgeon to see patients completely blinded for decades to resume the near normal life of a sighted individual free of dependence after OOKP.

**References**