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RESEARCH ARTICLE

OSTEO-ODONTO-KERATOPROSTHESIS-A GROUNDBREAKING PROSTHESIS

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Abstract

Corneal Blindness is a leading cause of blindness globally.Various conditions like Stevens Johnsons syndrome, severe chemical burns, cicatrical pemphigoid, end stage trachoma, multiple failed grafts and gr aft versus host disease lead to end stage cornealdisease.Advancedcorne al disease leads to blindness.When traditional treatment modes failure o ccurs, a keratoprosthesis named osteo odonto keratoprosthesis develope d by Strampelli in Italy is a life-changing prosthesis.This technique comprises of biological components like tooth bone complex whichis used as a skirt to mount an optical cylinder and the buccal mucous membrane is used to cover it.Osteo-odonto-keratoprosthesis surgery comprises of 2 stages.In stage 1,the defective eye is prepared and buccal mucosa is sutured over the sclera.The osteo odonto lamina is prepared to support an optical cylinder and placed under the contralat eral eye.After 24 months, in stage 2, the lamina is retrieved and implant ed in the defective eye and the buccal mucosal graft is reflected back an d sutured.This surgery requires a multidisciplinary approach of opthalm ologists, dentists, radiologists.This review paper highlights the backgro ud,history,indications,contraindications,pre operative patient assessmen t,surgicalprocedure,post operative care with follow up, prostheticrehabi litation, complications.

Introduction:-

The worldwide prevalence of blindness as recorded in 2020was 0.62% of the global population that is around 43·3 million people.[1] Corneal disease is one of the leading common cause of blindness affecting around 8 million

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population worldwide.[2]Different eye disordersalter the transparency of the cornea, leading to corneal scarring and blindness.In the most severe cases, the scarring is accompanied by extreme dryness and keratinization of the ocular surface.[3]Conditions like Stevens–Johnson's syndrome, severe chemical burns, cicatrical pemphigoid, end-stage trachoma, multiple failed grafts and graft-versus-host disease lead to advanced end-stage corneal disease.Corneal grafts, corneal transplantation, other forms of ocular surface reconstruction surgery are the modes of treatments for damaged cornea. In severe compromised cases when these treatment modes proves to be a doomed failure comes the role of keratoprosthesis.Amongst the keratoprosthesis,the osteo-odonto-keratoprosthesis (OOKP) is a groundbreaking prosthesis.The osteo-odonto-keratoprosthesis is a keratoprosthesis technique in which an autologous tooth–bone complex is used to mount an optical cylinder, as an artificial cornea, stabilized by an overlying autologous buccal mucosal graft.[4]

Background And History

History of keratoprosthesis dates back more than 200 years when a French ophthalmologist, Pellier de Quengsy proposed implanting a glass plate into an opaque cornea.In 1855Nussbaum performed thefirst surgical case inahumanwithaquartz crystal implant.Different keratoprostheses (KPros) and techniques (vonHippel 1877, Dimmer 1889, andSalzer1895) were develoved over the next half-century.[5] In 1963 the osteo-odonto-keratoprosthesis (OOKP), was first developed in Italy by Strampelli and later modified by Falcinell .Strampelli had noted that gutta-perchawill remain in root canal of the tooth indefinitely but will be rejected if it is implanted into the soft tissues.Hence ,its most likely that if an optical cylinder if implanted in the tooth-bone complex and then placed in a corneal envelope,the whole complex will form an autograft and prevent the extrusion of the optical cylinder.[3,6]

Indications

Bilateral blindness from severe, end-stage corneal and ocular surface diseases, such as severe dry eye conditions, and eyes with intact retinal and optic nerve function whose conjunctival and lid abnormalities are incompatible with standard corneal grafting or ocular surface transplantation procedures.[7]Common conditions include-

1. Severe end-staged stevens –johnson syndrome
2. Mucous membrane pemphigoid
3. Chemical injury
4. Thermal Injury
5. Trachoma

Contraindications

The following are the contraindications [7]-

1. Age under 18 years
2. Eyes having no perception to light
3. Pthisis bulbi
4. Persons having advanced glaucoma
5. Retinal detachment cases
6. Psychologically unstable patients

Pre-Operative Patient Assessment

Proper pre-operative assessment is very essential before undergoing the surgical procedures .These include [8]-

1. **Ophthalmological investigations**-VA (intact light perception),digital estimation of Intraocular pressure are necessary.
2. **Intraoral assessment**- Proper clinical evaluation of the tooth and buccal mucosa health is very essential.
3. **Radiological Investigations-** Ultrasonography (A-scan and B-scan) for eye,Orthopantomography
   IOPA Xray
4. **Psychological Assessment-**Patient needed to be mentally stable as this procedure needs multiple surgeries and life-long follow-ups.

Surgical Procedure

The OOKP surgical procedure consists of 2 stages.These are:

Stage 1- A single-rooted toothusually a healthy canineis ostectomized (Figure-1)with attached periosteum and osteo-odonto lamina is prepared.In order to expose the pulp chamber to the axial middle of the root, the other side of the tooth is hemishaved and the bone is smoothed parallel to the tooth's mid-sagittal plane using a diamond disk(Figure-2).This process is accompanied by constant saline irrigation.Then complete removal of the pulp is done.

A hole is drilled perpendicular in the centre of the lamina.[4] An optical cylinder (Figure-3) of appropriate power(based on A-scan biometry) is cemented into the osteo-odonto lamina.[8]The entire keratoprosthesis measures around 12 mmx 6mm x3mm, which is having an optical cylinder with a minimum 1 mm dentine margin around.The optical cylinder is available in two different diameter(3.5 and 4.0 mm) and standard 8.75 mm length.Theentire keratoprosthesis is implanted in the submuscular pouch below thecontralateral eye so that a fibrovascular coating can form over the lamina.[4]

A 3cm-diameter full-thickness buccal mucosal graft is harvested below the parotid ductavoiding the parotid duct orifice (Figure-4).Excess fat and muscle are removed from the graft.Before the mucosal graft is sutured over the corneal and scleralsurfaces of the eye, it is soaked in an antibiotic solution, such as cefuroxime.[4]On the suggested eye, a 360-degree limbal peritonectomy is performed. In order to remove the epithelium and scar tissues over the cornea superficial keratectomy is done.Bridle sutures are used to isolate the rectus muscles.The buccal mucosal graft is transferred and sutured over the sclera (Figure-5)bounded by the insertion sites of rectus muscles.[8,9]

Figure 1:- Raising of the flap and the ostectomized tooth is removed.
(Courtesy- Tay et Al)

Figure2:- Use of a diamond disk to smoothen the bone parallel to the mid-sagital plane (Courtesy-Tay et Al)

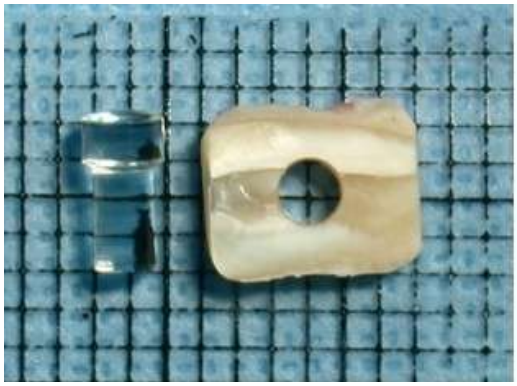


Figure3:- Optical cylinder and drilled hole in the osteo-odonto lamina
(Courtesy- Tay et Al)

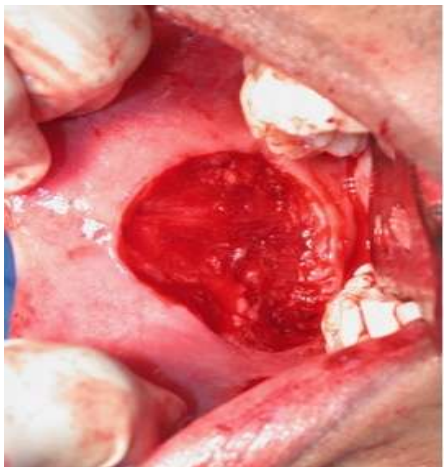


Figure4:- Harvesting of a buccal mucosal graft
(Courtesy- Tay et Al)

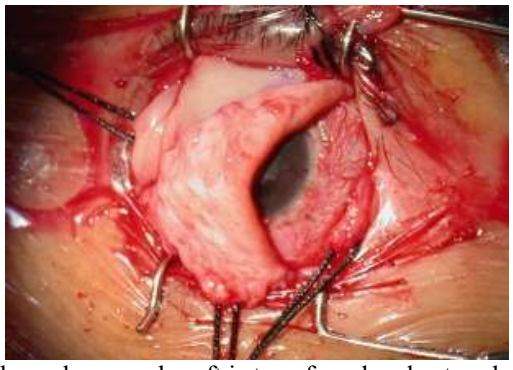


Figure 5:- The buccal mucosal graft is transferred and sutured over the sclera.
(Courtesy- Tay et Al)

Stage 2- The stage 2 surgery is undergone 2-4 months after the stage1.The lamina is retrieved (Figure-6) and is kept in heparinized venous blood of the patient till the time of implantation.[8] The fibrovascular capsule is examined andtrimmed away from the anterior and posterior surfaces of the optical cylinder.The buccal mucosal graft is reflected superiorly,eye to be restored is prepared (Figure-7).The cornea is exposed.Corneal trephination of 5mm in diameter is done to create a central opening in the eye.[4] Cryoextraction of the lens is done ,iris is removed from its root, a core vitrectomy is carried out.The lamina is then positioned into the corneal opening.The lamina is anchored tightly with vicryl sutures to the globe and to reform the globe air is injected.The optical cylinder's centering is verified by intraoperative indirect ophthalmoscopy.[8]The BM graft is reflected back and sutured.A trephination (Figure-8) of 3mm in diameter is done over the centre of the graft so that the anterior portion of the optical cylinder can protrude.This allows clear visual axis and light to be transmitted and focussed on retina for clear vision(Figure-8,9) [4]

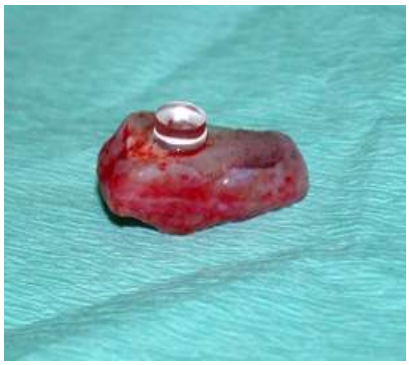
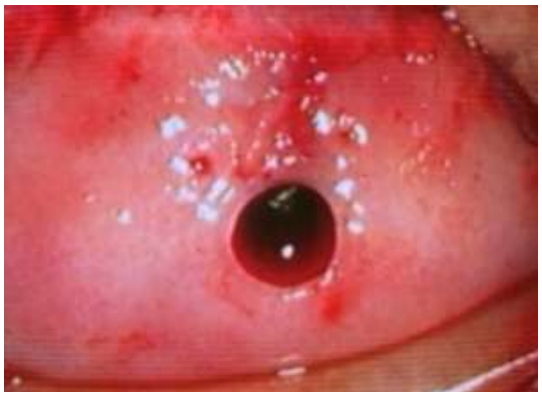


Figure6:- Retrieval of the osteo-odonto lamina (Courtesy- Tay et Al).

Figure 7:- Preparation of the eye which is to be restored (Courtesy- Tay et Al).



Figre8:- A trephination is done over the centre of the graft so that the anterior portion of the optical cylinder can protrude (Courtesy- Tay et Al).

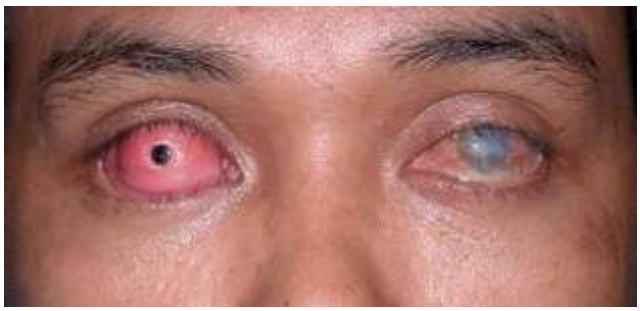


Figure9:-Completed OOKP in a patient with ocular blindness(Courtesy- Tay et Al).

Post Operative Care And Follow Up Visits

Analgesics,antibiotics,prednisolone 20 mg and lansoprazole 30 mg are prescribed for 5 days post-operatively.Following stage 1, glass rodding is done to keep the fornicesopen.Different mouthwashes like chlorhexidine,nystatin are used.After stage 2,diamox, steroids and antibiotics are prescribed.Buccal mucous membrane are monitered and the optical cylinder is cleaned using a fresh sliced lemon's juice on a sterile cotton-tipped applicator.[5,8]Lifelong follow-up is required.During follow-ups vision is checked, digital estimation of intraocular pressure,assessment of the buccal mucous membrane,examination of the optical cylinder,assessment of resorption of the bone is done.[5]

Prosthetic Rehabilitation

Patients are then referred to a prosthodontist for replacement of the missing tooth along with adjacent tissues. The esthetically correct treatment of a localized alveolar ridge defect is a common prosthetic challenge.Andrew's bridge is the best option available. It combines advantages of removable and fixed prosthesis.Other options include ridge augmentation followed by fixed prosthesis or implant retained prosthesis.

Complications

Oromaxillary fistula formation and damage to the adjacent teeth during preparation of the osteo-odontolamina may occur..Ifinadvertent perforation of the cornea occurs then a full-thickness graft may be required.Resortion of the lamina, bone infection if occurs implanted keratoprosthesis should be explanted and treated prior to continuation of the procedure. Intravitreal haemorrhage from the iris,expulsive suprachoroidal hemorrhage which is devastating and rare may occur.Early postoperative complications includechoroidal detachment, decentration of the optical cylinder.Latepostoperative complications include buccal membrane overgrowth or melting, endophthalmitis, glaucoma, and retinal detachment.[7]

Discussion:-

This innovative prosthesis osteoodontokeratoprosthesis remains the keratoprosthesis of choice for end-stage corneal blindness.

The optical cylinder transmits light onto the fovea of the retina in the central axis of the eyeball.The autogenous hard tissue skirting keeps the optical cylinder steady in the eye. Various keratoprosthesis surgeries have utilized to support the optical cylinder.e.g., PMMA(Cardonakeratoprosthesis), polytetrafluoroethylene (Legeaiskeratoprosthesis)aluminium oxide ceramic (Polack keratoprosthesis), Dacron (Pintucci keratoprosthesis).The extrusion rates of theses keratoprosthesis are significantly higher than those of OOKP, ranging from 10% (Pintucci) to 21% (Cardona).[10,11]It is seen that the stability and longevity of the osteo-odontolamina in osteo-odonto-keratoprosthersis surgery is much better than other keratoprosthesis.

Bioceramics can also be used for supporting the optical cylinder.Butat pH 6.5–5.0, associated with infectious and inflamed tissues, bioceramics degrade more rapidly as compared to tooth and bone.[12]

Tan A et Al conducted a systemic review upon surgical outcomes and found that the anatomical survival rate in all the studies was 87.8% (range 67-100%) at 5 years.Visual acuity was more than 6/18 in 52% (range 46-72%) in this surgery.[7]

R Michael et Al in 2008 conducted a study to assess the long-term anatomical and functional survival rates between osteo-odonto-keratoprosthesis and osteokeratoprosthesis.Based on Kaplan-Meier analyses, 10-year anatomical survival was 66% for OOKP and 47% for OKP. and 10-year functional survival was 38% for OOKP and 17% for OKP.[13]

Iyer et al.,[20] reported a 96% anatomical success of OOKP laminae in 50 cases with a mean follow-up of 15.38 months (range: 1-54 months).[14]

Among all the available biological and synthetic keratoprostheses, the OOKP have a higher success rate.

Conclusion:-

This innovative Osteo Odonto Keratoprosthesis success is attributed to the biological constitution of its components. It provides the best long term anatomical and visual outcomes even in the most challenging cases of ocular surface disease, ultimately increasing the quality of the life.

Source of Funding
None.

Conflict of Interest
None.

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