

## Ocular Prosthesis-A Review

Dr Babita Yeshwante<sup>1</sup>, Dr Neha Choudhary<sup>2</sup>, Dr Nazish Baig<sup>3</sup>

### I. Introduction

An unfortunate absence or loss of an eye may be caused by a congenital defect, irreparable trauma, a painful blind eye, Sympathetic ophthalmia or the need for histologic confirmation of a suspected diagnosis.[1] The disfigurement associated with the loss of an eye can cause significant physical and emotional problems. Two surgical procedures are generally used, one is evisceration, which is the removal of the contents of the globe, leaving the sclera and on occasions the cornea in place, and the other procedure is enucleation where the eyeball is completely removed.[2][3]. The prosthetic eye includes:

- oval, whitish outer shell finished to duplicate the white color of the other eye
- round, central portion painted to look like the iris and pupil of the other eye

Ocular prostheses are either readymade (stock) or custom made.[1] Stock prostheses are usually advocated when time is limited and cost is a consideration. No special skills or material are required for its fabrication; and the use of stock ocular prostheses of appropriate contour, size, and color can provide an acceptable esthetic result.[1]

### II. Review Of Literature

The earliest known evidence of the use of ocular prosthesis is that of a woman found in Shahr-I Sokhta, Iran<sup>[4]</sup> dating back to 2900–2800 BCE.<sup>[5]</sup> It has a hemispherical form and a diameter of just over 2.5 cm (1 inch). It consists of very light material, probably bitumen paste. The surface of the artificial eye is covered with a thin layer of gold, engraved with a central circle (representing the iris) and gold lines patterned like sun rays. On both sides of the eye are drilled tiny holes, through which a golden thread could hold the eyeball in place. Since microscopic research has shown that the eye socket showed clear imprints of the golden thread, the eyeball must have been worn during her lifetime. In addition to this, an early Hebrew text references a woman who wore an artificial eye made of gold (Yer. Ned. 41c; comp. Yer. Sanh. 13c). Roman and Egyptian priests are known to have produced artificial eyes as early as the fifth century BCE constructed from painted clay attached to cloth and worn outside the socket.<sup>[6]</sup>

The first in-socket artificial eyes were made of gold with colored enamel, later evolving into the use of glass (thus the name "glass eye") by the Venetians in the later part of the sixteenth century. These were crude, uncomfortable, and fragile and the production methodology remained known only to Venetians until the end of the 18th century, when Parisians took over as the center for artificial eye-making. But the center shifted again, this time to Germany because of their superior glass blowing techniques. Shortly following the introduction of the art of glass eye-making to the United States, German goods became unavailable because of WWII. As a result, the US instead made artificial eyes from acrylic plastic.<sup>[6]</sup>

Modern ocular prosthetics has expanded from simply using glass into many different types of materials.<sup>[6]</sup> The most basic simplification can be to divide implant types into two main groups: non-integrated (non-porous) and integrated (porous).<sup>[7]</sup>

#### Nonintegrated implants

Nonintegrated implants contain no unique apparatus for attachments to the extraocular muscles and do not allow in-growth of organic tissue into their inorganic substance. Such implants have no direct attachment to the ocular prosthesis.<sup>[7]</sup> Usually, these implants are covered with a material that permits fixation of the extraocular recti muscles, such as donor sclera or polyester gauze which improves implant motility, but does not allow for direct mechanical coupling between the implant and the artificial eye.<sup>[4]</sup> Non-integrated implants include the acrylic (PMMA<sup>[7]</sup>), glass, and silicone spheres.<sup>[8]</sup>

#### Integrated implants (porous)

The porous nature of integrated implants allows fibrovascular ingrowth throughout the implant and thus also insertion of pegs or posts.<sup>[8]</sup> The various materials used are hydroxyapatite, porous polythene (Medpor), Bioceramic

Hydroxyapatite implants are spherical and made in a variety of sizes and different materials (Coralline/Synthetic/ Chinese).<sup>[8][9]</sup> hydroxyapatite is limited to preformed (stock<sup>[6]</sup>) spheres (for enucleation) or granules (for building up defects).<sup>[11]</sup> One main disadvantage of HA is that it needs to be covered with exogenous material, such as sclera, polyethylene terephthalate, or vicryl which can lead to rough surface and infection

.This problem can be overcome by using Medpor( manufactured from linear high-density polyethylene.<sup>[12][13]</sup> ) implants , it is readily available, cost-effective, and can be easily modified or custom-fit for each defect.<sup>[11]</sup> A recent study has shown that HA has a more rapid rate of fibrovascularization than Medpor.<sup>[10]</sup> Bioceramic prosthetics are made of aluminium oxide (Al<sub>2</sub>O<sub>3</sub>). The rate of exposure previously associated with the bioceramic implant (2%) was less than most reports on the HA or porous polyethylene implant (0% to 50%).<sup>[14]</sup>

Conical orbital implant (COI): The COI has unique design elements that have been incorporated into an overall conical shape, including a flat anterior surface, superior projection and preformed channels for the rectus muscles.<sup>[15]</sup> 5-0 Vicryl suture needles can be passed with slight difficulty straight through the implant to be tied on the anterior surface. In addition, this implant features a slightly recessed slot for the superior rectus and a protrusion to fill the superior fornix.<sup>[11]</sup> Multipurpose conical orbital implant (MCOI): The wider anterior portion, combined with the narrower and longer posterior portion of these implants, allows for a more complete and natural replacement of the lost orbital volume. This shape reduces the risk of superior sulcus deformity and puts more volume within the muscle cone.<sup>[16][17]</sup> Muscles can be placed at any location the surgeon desires with these implants.

Two methods discussed in the article for fabrication of ocular prosthesis are the placement of orbital implants and custom made prosthesis

### 1) Surgical Method To Place Orbital Implants

The surgery is done under general anesthesia with the addition of extra subconjunctival and/or retrobulbar anesthetics injected locally in some cases. The following is a description of the surgical procedure performed by Custer et al.:<sup>[9]</sup> The conjunctival peritomy is performed at the corneal limbus, preserving as much healthy tissue as possible. Anterior Tenon's fascia is separated from the sclera. Blunt dissection in the four quadrants between the rectus muscles separates deep Tenon's fascia.

Sutures may be passed through the rectus muscles before their disinsertion from the globe. Some surgeons also suture one or both oblique muscles. Traction sutures or clamps may be applied to the horizontal rectus muscle insertions to assist in rotating and elevating the globe during the ensuing dissection. Tenon's capsule may be opened posteriorly to allow visualization of the optic nerve. The vortex veins and posterior ciliary vessels may be cauterized before dividing the nerve and removing the eye. Alternatively, the optic nerve may be localized with a clamp before transection. Hemostasis is achieved with either cautery or digital pressure.

The orbital implant is inserted at the time of enucleation. An appropriately sized implant should replace the volume of the globe and leave sufficient room for the ocular prosthesis. Enucleation implants are available in a variety of sizes that may be determined by using sizing implants or calculated by measuring globe volume or axial length of the contralateral eye

### 2) Conventional Method Of Fabrication Of Custom Made Ocular Prosthesis

Success of prosthesis always begins with the accurate impression of the site being restored. An acceptable impression should record accurately the posterior wall, the position of the palpebrae in relation to the posterior wall and the superior and inferior fornices of the palpebrae. This could be recorded in several ways

- 1) Direct impression/External impression
- 2) Impression with a stock ocular tray or modified stock ocular tray
- 3) Impression using stock ocular prosthesis
- 4) Wax sclera blank technique
- 5) Taking facial impression for fabricating a custom occlusal tray which could be used in split cast preparation. But patient should be preinformed about the claustrophobia and aculophobia before making the impression and asked to relax.

The impression material (light-bodied elastomer) is injected into the left eye socket and the patient is instructed to perform all the movements of the eye, before the impression material is set, metal wire loops are placed over the impression to aid in retention , and then plaster is placed over the impression to back up . After removal from the eye socket, boxing of the impression is done, the impression is invested first with dental stone up to the height of the contour, and then with die stone to get a two-piece mold . Wax pattern fabrication is done , stock eye that matched the sclera and the iris-pupil complex of the contralateral natural eye is selected, and it is trimmed precisely until it accurately fit into the socket, characterized staining is also done accordingly and try-in is done . Bulge of the eye is corrected by the addition of wax. Once the correct bulge is obtained, the tissue surface of the prosthesis is again relined with soft tissue conditioner and placed into the socket to record the functional movements of the eye

The relined tissue side of the ocular prosthesis is invested, dewaxed, and packed with heat-cured clear acrylic resin and curing is carried out. After the flask is cooled, deflasking is done, prosthesis is separated from the investment and it is polished. The polished prosthesis must be free of roughness that could irritate the eye socket and encourage secretions to accumulate for additional irritation.

Prior to the insertion of the polished prosthesis, it is disinfected in a solution of 0.5% chlorhexidine and 70% isopropyl alcohol for 5 min. After disinfection, the prosthesis is rinsed in sterile saline solution to avoid chemical irritation and finally the ocular prosthesis is delivered and postdelivery instructions were given.

### Comparison Of Movement Of Non Integrated And Integrated Implants

Implant and prosthesis movement are important aspects of the overall cosmetic appearance after enucleation and are essential to the ideal objective of crafting a lifelike eye similar in all aspects to the normal fellow eye.<sup>[7][18]</sup> The motility of a nonintegrated artificial eye may be caused by at least two forces. (1) The rubbing force between the posterior surface of the artificial eye and the conjunctiva that covers the implant may cause the artificial eye to move. Because this force is likely to be approximately equal in all directions, it would cause comparable horizontal and vertical artificial eye amplitudes. (2) An artificial eye usually fits snugly in the conjunctival space (possibly not in the superior fornix). Therefore, any movement of the conjunctival fornices will cause a similar movement of the artificial eye, whereas lack of movement of the fornices will restrict its motility.<sup>[6]</sup> Imbrication of the rectus muscles over a nonintegrated implant traditionally was thought to impart movement to the implant and prosthesis. Like a ball-and-socket joint, when the implant moves, the prosthesis moves. However, because the so-called ball and socket are separated by layers of Tenon's capsule, imbricated muscles, and conjunctiva, the mechanical efficiency of transmission of movement from the implant to the prosthesis is suboptimal. Moreover, the concern is that imbrication of the recti over nonintegrated implants actually can result in implant migration.<sup>[20]</sup> The recent myoconjunctival technique of enucleation is an alternative to muscle imbrication.<sup>[19][21]</sup> And although the porous implants have been reported to offer improved implant movement,<sup>[22]</sup> these clearly are more expensive and intrusive, requiring wrapping, and subsequent imaging to determine vascularization and pegging to provide for better transmission of implant movement to the prosthesis, and also are prone to implant exposure.<sup>[7]</sup>

### Notable people with prosthetic eyes

- Baz Bstien – Canadian ice hockey player, coach (right eye)<sup>[23]</sup>
- Mokhtar Belmokhtar – Algerian smuggler, kidnapper, weapons dealer, and terrorist; lost his eye mishandling explosives(left eye)<sup>[24]</sup>
- Sammy Davis, Jr. – American singer (left eye)<sup>[25]</sup>
- Peter Falk – American actor (right eye)<sup>[26]</sup>
- Leo Fender – Musical instrument architect; founded what is now known as the Fender Musical Instruments Corporation, and is well known for inventing, among other instruments, the Fender Stratocaster and the Fender Precision Bass (left eye).
- Ry Cooder - Famous musician best known for his slide guitar work. (left eye)<sup>[27]</sup>
- Nick Griffin – BNP leader (left eye)<sup>[28]</sup>
- Jeff Healey – Canadian blues guitarist (both eyes)
- Leo McKern – actor (left eye)<sup>[29]</sup>
- Carl Ouellet – Canadian professional wrestler (right eye)<sup>[30]</sup>
- Park Jie-won – South Korean politician (left eye)
- Claus Schenk Graf von Stauffenberg – German career army officer and resistance leader (left eye)<sup>[31]</sup>
- Dean Shiels – Northern Irish professional footballer who lost his eye during a childhood accident (right eye).
- Robert Thurman – writer (left eye)<sup>[32]</sup>
- Mo Udall – politician (right eye)<sup>[33]</sup>
- Henry Lee Lucas - serial killer (left eye)

### III. Conclusion

A prosthetic eye can help improve the appearance of people who have lost an eye to injury or disease. Implant retained ocular prosthesis will be best option to the average patient who can afford the expensive treatment options available. The esthetic and functional outcome of the prosthesis is superior to the stock ocular prosthesis. Next comes the use of custom-made ocular prosthesis which has been a boon to the average patients who cannot afford implants Although many treatment options are available, the conventional method is most widely followed all over India.

## Photographs



The normal eye



Orbital Prosthesis

Orbital Prosthesis

## References

- [1]. Siddesh Kumar Ch. and Chandra Shekar Sajjan Prosthetic management of an ocular defect *Contemp Clin Dent*. 2010 Jul-Sep; 1(3): 201–203.
- [2]. Artopolou I, Mountgomery P, Lemon J. Digital imaging in fabrication of orbital prosthesis. *J Prostho Dent* 2006;95:327-30
- [3]. Colen, TP; Paridaens, DA; Lemij, HG; Mourits, MP; Van Den Bosch, WA (2000). "Comparison of artificial eye amplitudes with acrylic and hydroxyapatite spherical enucleation implants". *Ophthalmology* 107 (10): 1889–94. doi:10.1016/S0161-6420(00)00348-1. PMID 11013194.
- [4]. 3rd Millennium BC Artificial Eyeball Discovered in Burnt City, December 10, 2006
- [5]. London Times (February 20, 2007). "5,000-Year-Old Artificial Eye Found on Iran-Afghan Border". foxnews. Retrieved December 14, 2
- [6]. Frequently asked questions, American Society of Ocularists
- [7]. Shome, D; Honavar, SG; Raizada, K; Raizada, D (2010). "Implant and prosthesis movement after enucleation: a randomized controlled trial". *Ophthalmology* 117 (8):163844. doi:10.1016/j.ophtha.2009.12.035. PMID 20417565
- [8]. Chuah, CT; Chee, SP; Fong, KS; Por, YM; Choo, CT; Luu, C; Seah, LL (2004). "Integrated hydroxyapatite implant and non-integrated implants in enucleated Asian patients". *Annals of the Academy of Medicine, Singapore* 33 (4): 477–83. PMID 15329760.
- [9]. Custer, PL; Kennedy, RH; Woog, JJ; Kaltreider, SA; Meyer, DR (2003). "Orbital implants in enucleation surgery: a report by the American Academy of Ophthalmology". *Ophthalmology* 110 (10): 2054–61. doi:10.1016/S0161-6420(03)00857-1. PMID 14522788.
- [10]. Sadiq, SA; Mengher, LS; Lowry, J; Downes, R (2008). "Integrated orbital implants—a comparison of hydroxyapatite and porous polyethylene implants". *Orbit (Amsterdam, Netherlands)* 27(1): 37–40. doi:10.1080/01676830701512585. PMID 18307145
- [11]. Duffy, M., Biesman, B. (2000). "Porous polyethylene expands orbitofacial options". *Ophthalmology Times* 25 (7): 18.
- [12]. OPTIONS: MEDPOR Biomaterial and Surgical Implants
- [13]. Chen, YH; Cui, HG (2006). "High density porous polyethylene material (Medpor) as an unwrapped orbital implant". *Journal of Zhejiang University. Science. B* 7 (8):67982. doi:10.1631/jzus.2006.B0679. PMC 1533749. PMID 16845724.
- [14]. Su, GW; Yen, MT (2004). "Current trends in managing the anophthalmic socket after primary enucleation and evisceration". *Ophthalmic plastic and reconstructive surgery* 20 (4):27480..doi:10.1097/01.IOP.0000129528.16938.1E. PMID 15266140.
- [15]. Conical Orbital Implant (COI)
- [16]. Marshak, H; Dresner, SC (2005). "Multipurpose conical orbital implant in evisceration". *Ophthalmic plastic and reconstructive surgery* 21 (5): 376–8. doi:10.1097/01.iop.0000173191.24824.40. PMID 16234704.
- [17]. Kostick, DA; Linberg, JV (1995). "Evisceration with hydroxyapatite implant. Surgical technique and review of 31 case reports". *Ophthalmology* 102 (10): 1542–8; discussion 1548–9. doi:10.1016/s0161-6420(95)30833-0. PMID 9097804.
- [18]. Byron C. Smith; Frank A. Nesi; Mark R. Levine; Richard D. Lisman (1998). *Smith's Ophthalmic Plastic and Reconstructive Surgery*. Mosby Incorporated. ISBN 978-0-8151-6356-5.
- [19]. Custer, PL; Trinkaus, KM; Fornoff, J (1999). "Comparative motility of hydroxyapatite and alloplastic enucleation implants". *Ophthalmology* 106 (3): 513–6. doi:10.1016/S0161-6420(99)90109-4. PMID 10080207
- [20]. Custer, PL; Trinkaus, KM; Fornoff, J (1999). "Comparative motility of hydroxyapatite and alloplastic enucleation implants". *Ophthalmology* 106 (3): 513–6. doi:10.1016/S0161-6420(99)90109-4. PMID 10080207
- [21]. Yadava U, Sachdeva P, Arora A. (2004). "Myoconjunctival enucleation for enhanced implant movement: result of a randomised prospective study". *Indian J Ophthalmol* 52 (3): 221–226. PMID 15510462
- [22]. Jordan, DR; Chan, S; Mawn, L; Gilberg, S; Dean, T; Brownstein, S; Hill, VE (1999). "Complications associated with pegging hydroxyapatite orbital implants". *Ophthalmology* 106 (3): 505–12. doi:10.1016/S0161-6420(99)90108-2. PMID 10080206.
- [23]. Starkey, Joe (2006). *Tales from the Pittsburgh Penguins*. Sports Publishing LLC (Sports Publishing LLC). p. 45. ISBN 978-1-58261-199-0. Retrieved September 18, 2011.
- [24]. "Profile: Mokhtar Belmokhtar". BBC News. June 4, 2013.
- [25]. "Nice Fellow". *Time* (Time Warner). April 18, 1955. Retrieved September 18, 2009.
- [26]. "Peter Falk". *Bio*. (UK). Retrieved January 30, 2009.

- [27]. Entry for "Ry Cooder", in *The Rolling Stone Encyclopedia of Rock & Roll, Touchstone* (revised, updated edition); November 8, 2001; ISBN 978-0743201209
- [28]. Ross, Deborah (April 30, 2010). "Deborah Ross: How exciting! I've never met proper racists before". London: independent.co.uk. Retrieved May 12, 2010.
- [29]. *Australian letters*. Sun Books 1. 1957. p. 1963. Retrieved September 18, 2011.
- [30]. "Pierre Carl Ouellet Profile". *Slam! Sports*. Canadian Online Explorer. Retrieved August 6, 2008.
- [31]. Commire, Anne (1994). *Historic World Leaders: Europe (L-Z)*. Gale Research Inc. (Gale Research International, Limited). p. 769. ISBN 978-0-8103-8411-8. Retrieved September 18, 2011.
- [32]. Roberts, John B.; Roberts, Elizabeth A. (2009). *Freeing Tibet: 50 years of struggle, resilience, and hope*. AMACOM Div American Mgmt Assn (AMACOM Div American Mgmt Assn). p. 160. ISBN 978-0-8144-0983-1. Retrieved September 19, 2011.
- [33]. Kaufman, Burton Ira (2006). *The Carter years*. Infobase Publishing (Facts on File). p. 485. ISBN 978-0-8160-5369-8. Retrieved September 19, 2011.