

A LIVING PROSTHETIC EYE: A PARADIGM SHIFT IN MAXILLOFACIAL AND OCULAR PROSTHETICS

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Abstract:

The eye is a vital organ and an important component of facial expression. Loss of an eye has a crippling effect on the psychology of the patient. Restoring the defect with a silicone- or acrylic-based prosthesis not only restores esthetics but also gives back the lost confidence to the patient. It is also important to realize that the rehabilitation of the blind is a very complex problem, requiring extraordinarily diverse, lengthy and intimate collaborations among basic scientists, engineers, clinicians, educators and rehabilitative experts.

Key words: ocular prosthesis, cosmetic rehabilitation, bionic eye.

Introduction

Ocular prosthesis is an artificial eye, which is implanted in patients who have lost their eye due to various causes such as trauma, surgery, cancer, or in patients with shrunken damaged eyes (phthisical eyes), congenital absence (anophthalmos) or abnormally small

sized eyes (microphthalmos) with no visual potential. These conditions result in cosmetic disfigurement of the face which impacts the patients psychologically and acts as a social stigma. Cosmetic rehabilitation for these patients through the implantation of ocular prosthesis helps in restoring the patients' confidence by improving their external appearance. The ocular prostheses are fitted behind the eyelids over a shrunken eyeball or an orbital implant placed following surgical removal of the eye.^{1,2,3}

History

Artificial eye prostheses have been around for nearly 5,000 years, beginning with the earliest known example—a bitumen and gold ocular device from Shahr-i Sokhta, Iran (c. 2900-2800 BCE), and progressing to painted clay and metal eyes used in ancient Egypt and the Greco-Roman era, which were usually worn externally for cosmetic purposes. During the renaissance, Venetian glassblowers pioneered

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hollow glass eyes that could be put underneath the eyelids, with Germany subsequently refining thin-walled, enamelled versions in the 18th and 19th centuries. A significant breakthrough occurred in the 1940s, when World War II shortages prompted the creation of durable acrylic resin (PMMA) prostheses in the United States, allowing for lightweight, custom-made, and shatter-resistant designs. Contemporary ocular prosthetics employ medical-grade acrylics, silicone elastomers, computer-aided design and manufacturing (CAD-CAM), and three-dimensional (3D) printing technologies to improve precision, aesthetics, and patient comfort, while emerging research is investigating into biointegrated and electronically responsive models for future clinical application.^{1,2,4,5,7}

Indication for ocular prosthesis :

- After Enucleation and Evisceration with or without implant.
- Over Pthisical eyes.
- Blind eye with scarred corneas.
- Congenital anophthalmia / microphthalmia.

The Various ocular prosthesis available include:

- **Stock Shells:** These are readymade shells made of acrylic and are available in standard sizes and shapes. The stock shells do not provide accurate colour match when compared with the other eye.
- **Custom made prosthesis:** These are made of high quality acrylic material and are customized to fit the patients' eye socket (space which holds the prosthesis) accurately and hand painted to match the colour of the other eye.^{4,7}

Prosthetic Eye Surgery : What to Expect

After surgery to remove the natural eye, a ball-

shaped ocular implant is permanently and deeply implanted. Later, the removable prosthesis is created to fit over it. After healing is complete, a specialist in prosthetic eyes (ocularist) makes wax impressions of the front of the eye socket. The ocularist builds a custom prosthetic eye to fit over the ocular implant. A new iris (coloured part of the eye) and blood vessels on the white area are carefully painted on by hand to match the healthy eye. A prosthetic eye moves, but often not as fully or briskly as your other healthy eye.^{3,6,8}

The following signs should not be over looked and must be corrected in order to maintain a healthy and cosmetically accepted prosthesis

- Excessive excreta.
- Droopy lids.
- Heavy yellowing in the mucus.
- Recession of the orbital area.
- Color changes in the sclera and iris.
- Discomfort while wearing the prosthesis.
- Repeated removing of the prosthesis to gain relief.
- Inflammation of the conjunctiva with excessive redness.

Maintenance of Ocular Prosthesis:

Adequate care and maintenance adds life to the prosthesis. Patients may experience minimal discomfort for a transient period initially, until they get adjusted to it.

Dos and Dont's in Prosthesis care : ^{1,10}

1. Minimal handling of the prosthesis.
 - i. The shell can be removed once in a month and washed well with soap and water, dried and fitted by the patients themselves. Always sleep with the

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prosthesis in place.

- ii. A plunger is provided to every patient, which helps in easy removal and fitting of the prosthesis.
- iii. Frequent removal of the shell on a daily basis may lead to discharge, watering, eyelid laxity, eyelid eversion and inadequacy of the space to fit the shell.

2. Use of lubricating eye drops over the shell.

- i. Provides a smooth surface for the eyelid movements over the shell and
- ii. Washes off the debris deposited on the shell surface.

3. Yearly polishing of the prosthesis

- i. To ensure smooth regular surface and rounded edges thus preventing undue friction between the eyelids and the prosthesis.
- ii. This prevents any inflammatory reaction such as a socket granuloma formation and giant papillary reaction in the eyelids.

4. Change of prosthesis once in every five years is ideal depending on changes taking place in the socket.

5. A fully-framed protective polycarbonate glass should be worn to protect the normal eye from injury as well as camouflage the minimal differences between the normal eye and the prosthetic eye.

The Future - BIONIC EYE

A visual prosthesis, often referred to as a bionic eye, is an experimental visual device intended to restore functional vision in those suffering from partial or total blindness. A bionic eye is not the same thing as a prosthetic eye. Prosthetic eyes

(also called "glass eyes" or "artificial eyes") replace the physical structure and appearance of an eye that must be removed due to trauma, pain, disfigurement or disease. Bionic eye implants, on the other hand, work inside the existing eye structures or in the brain. They are designed to achieve functional vision goals — as opposed to physical, cosmetic ones.⁹

Discussion

Rehabilitation of patients with anophthalmia has generally been based on inert implantable prosthetic eyes, which, while successful in providing esthetics and social confidence, are limited in their biological and functional potential. Complications like discharge of the socket, microbial colonization, and chronic irritation of tissues point out the limitations of standard prostheses. The concept of a bioengineered prosthetic eye has been developed based on dramatic progress in tissue engineering, stem cell biology, and regenerative medicine. By using autologous or allogenic stem cells, the development of vascularized scaffolds, and engineered ocular surface constructs, researchers aim to develop prosthetic devices that can be integrated within local orbital tissues. The constructs are capable of improving socket health, mimicking physiological behaviour of natural eyes, and potentially allowing future interfaces with electronic or neural systems to restore function. While promising, there are significant hurdles to overcome. One of the biggest difficulties is in guaranteeing vascularity and tissue viability in a living organism. Issues of immunological risk, the risk of fibrosis, and susceptibility to infection require rigorous safety testing. Ethical issues, particularly in the sourcing of the stem cells, require careful attention. Finally, the financial costs and the technical complexities of the fabrication of such devices may limit their availability in routine clinical practice. Despite these obstacles, the living prosthetic eye represents a revolutionary

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shift, favouring biological integration over simple inert replacement.^{1,2,3,4,9,10}

Conclusion

Biologically integrated living prosthetic eyes are a new development in ocular rehabilitation that incorporates the principles of prosthodontics, ophthalmology, biomaterials, and regenerative medicine. Although newer developments are still predominantly experimental-based, preliminary findings show that these prostheses can be more comfortable, have improved socket fit, and provide more long-term effectiveness than conventional designs. Scientific, ethical, and economic issues need to be addressed in an orderly way before they are adopted in clinical practice. With continued interdisciplinary research and development, biologically integrated prosthetic eyes can well bridge the gap from theoretical research to practical application, revolutionizing the principles of prosthetic rehabilitation.

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