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RESEARCH ARTICLE

CUSTOMISED OCULAR PROSTHESIS FABRICATION - A CASE SERIES

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Abstract

Loss of an eye, whether due to trauma or medical necessity, can lead to significant physical and psychological distress. This article delves into the profound impact of ocular prosthetics in alleviating the physical and psychological repercussions of eye loss. Acrylic resin has been identified as an optimal material for its durability, aesthetic fidelity, and biocompatibility in fabricating ocular prostheses. Beyond restoring facial symmetry and enhancing aesthetics, these prostheses significantly bolster patient self-confidence and overall quality of life. The series comprehensively examines four distinct methods for iris positioning and prosthesis characterization, crucial for imparting natural vitality to the prosthetic eye. Each case underscores the importance of personalized care in ocular prosthetics, emphasizing the advantages over standard stock prostheses.

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Introduction:-

Eyes are generally the first features of the face to be noted. The disfigurement associated with loss of an eye can cause significant physical and emotional problems. Replacement of the lost eye as soon as possible is necessary to promote physical and psychological healing for the patient and to improve social acceptance. Most patients experience significant stress, due primarily to adjusting to the functional disability caused by the loss and to societal reactions to the facial impairment.

An **ocular prosthesis or artificialeye** is a type of craniofacial prosthesis that replaces an absent natural eye. An eye may be missing due to congenital or acquired deformities.

Congenital deformities

1. Anophthalmia
2. Microphthalmia

Acquired deformities

1. Phthisis bulbi
2. Staphyloma
3. Post-evisceration

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4. Post-enucleation
5. Contracted socket following radiation
6. Post-orbital exenteration¹

The art of making artificial eyes has been practiced since ancient times. Egyptian priests made the first ocular prosthesis, called Ectblepharons, as early as the 5th century BC. In those days, artificial eyes were made of enameled metal or painted clay and attached to cloth and worn outside the socket. In the 15th century, the first in-socket artificial eye was made of gold with coloured enamel. In the latter part of the 16th century, the Venetian glass artisans discovered a formula that could be tolerated inside the eye socket. These early glass eyes were crude, uncomfortable to wear and very fragile. Today, a vast majority of patients around the world wear ocular prosthesis made of acrylic. Several techniques are used in fitting and fabricating artificial eyes. Empirically fitting a stock eye, modifying a stock eye by making an impression of the ocular defect (Taicher et al, 1985) and the custom eye technique (Benson, 1977) are the most commonly used techniques.^{2,3} The prosthesis may be ocular (stock or custom prosthesis) or orbital type.

Fabrication and Customization of Ocular Prosthesis

This article explains various techniques for customization of ocular prosthesis:

1. Examination
2. Impression procedure
3. Fabrication of sclera
4. Positioning and fabrication of iris and pupil to match the fellow eye
5. Prosthesis insertion and instructions about hygiene and care of the prosthesis

Examination

Inspect the anophthalmic socket and defect region. Measure the diameter of the iris and pupil on the intact side, preferably in daylight. Ideal socket should have adequate volume and eyelids in correct position, without infection or granuloma.

Impression Procedure

Lightly lubricate the eyebrow and eyelashes with petroleum jelly on the affected side. The diagnostic impression was made with alginate using a sterile injection syringe without a needle to inject alginate into the socket. This served to hold the impression material in place. Alginate was applied to the outer side of the eye socket. The patient was then asked to move eyes sideways, upwards and downwards, and finally in a circular motion to obtain a functional impression of the defect. A backing with dental plaster (Type II) was provided for support. After retrieving the impression, it was invested to obtain a primary sectional cast.

The cast was produced and properly trimmed; sides were marked as superior, inferior, medial, and lateral. Undercuts were blocked with wax, and a special tray was fabricated with self-cure polymethyl methacrylate resin. The tray was customized so that the impression material could be injected through its handle, and the thin flange of the custom tray could be positioned inside the socket (Figure 1). The inner surface of the tray supported the impression material, while the outer surface recorded the inner tissue surface of the eyelids.

The secondary impression was made by injecting light-body elastomeric impression material into the socket via the handle. The patient was asked to perform eye movements, and finally, the impression was supported with heavy-body elastomeric material on the outer surface of the eye (Figure 2). The impression was then retrieved by gently retracting the upper and lower eyelids and drawing the shell handle towards the eyebrows with a side-to-side rocking motion for release. After removal, the shell was immersed in water.



Fig. 1:- Custom tray positioned in the socket.



Fig. 2:- Secondary impression.

Fabrication of Sclera

Beading and boxing of the impression are done using modeling wax. Die stone is poured till the highest contour of the defect, and indexing is performed. A separating medium is applied. Subsequently, the remaining portion of the impression is poured with dental stone to obtain the final sectional cast. The two halves of the cast are then separated, and the final impression is retrieved to prepare the mold space for wax pattern fabrication (Figure 3).



Fig. 3:- Mold space for wax pattern fabrication.

Molten wax is poured into the secondary cast through the sprue channel. Once the wax has set, the cast is separated, and the wax pattern is retrieved and carved (Figure 4).

The wax pattern is then tried in the patient to correct any extensions. This allows assessment of the contour and support for the final prosthesis. The wax pattern is invested in the conventional manner in a crown and bridge flask, and the mold space is packed with tooth-colored heat-cured acrylic resin to obtain the sclera (Figure 5).



Fig. 4:- Wax pattern



Fig. 5:- Processed sclera.

Positioning And Fabrication of Iris and Pupil to Match the Contralateral Eye

This is the most important step in custom ocular prosthesis fabrication.

This article discusses four different methods used for positioning of iris and characterization of the ocular prostheses.

The methods for positioning of the iris mentioned in this article include:

1. The divider method
2. Transparent graph grid method
3. Eyewear and graph paper method
4. Facebow and transparent graph grid method

There are several methods for characterization of the ocular prosthesis:

1. The iris of the existing stock prosthesis can be cut and attached to the scleral pattern, which is one of the easiest methods (Figure 6).



Fig. 6:- Iris button of existing prosthesis on scleral pattern.

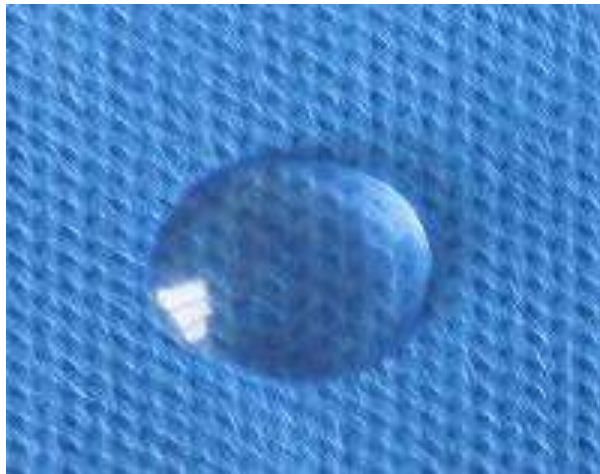


Fig. 7:- Fabricated iris button.

2. Another method for iris pattern fabrication involves creating an iris button wax pattern based on the obtained iris dimensions with a thickness of 1mm. This pattern is invested and fabricated using heat-cured clear polymethyl methacrylate resin (Figure7). Characterization of the iris is achieved by painting the iris pattern with acrylic colors. A pupil dot is placed in the center, and the flat portion of the iris is painted with a base color similar to the remaining eye.
3. An alternative method for iris characterization involves using photographic paper (Figure 17). Close-up photographs of the patient are taken using a DSLR camera to obtain an image of appropriate dimensions on

photographic paper. This image can then be cut and fixed onto the iris button using cyanoacrylate glue. In the sclera pattern, a 1mm marked area is trimmed, and the iris pattern is attached to it. Cotton, rayon threads are used to simulate blood vessels. Dry, stable, natural finely ground color pigments are applied to achieve the exact shade of the sclera corresponding to the patient's fellow eye. A thin layer of heat-cured clear acrylic resin is evenly spread around the iris. This characterization process aims to achieve the necessary vitality for a lifelike appearance that blends with the patient's natural appearance and cosmetics (Figure 8).

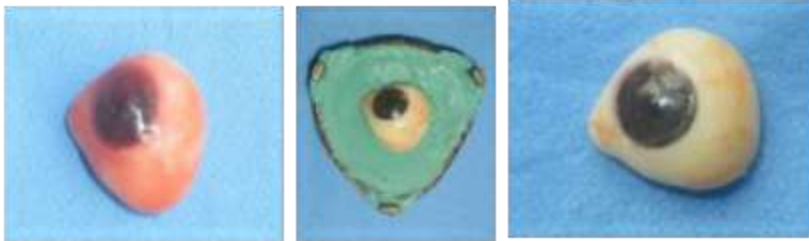


Fig. 8: - Final ocular prosthesis.

CASE 1: Iris positioning is achieved using a divider (Figure 9,10)



Fig.9: -Divider method

Fig.10: -Iris position marked



Fig. 11: - Pre-treatment



Fig. 12: -Post-treatment

CASE 2: Iris positioning is done using a transparent graph grid (Figure 13).



Fig.13:- Transparent graph grid method.



Fig. 14:- Stock ocular prosthesis



Fig. 15:- Customized ocular prosthesis

CASE 3: Iris positioning is achieved using eyewear and graph paper. An eyewear of appropriate size is selected, and the lenses are removed. A printout of the graph paper is taken onto a transparent sheet, which is then cut to fit precisely onto the eyewear. It is positioned on the patient, and the iris position is determined accordingly (Figure 16).



Fig.16: - Eyewear and graph paper method.



Fig. 17:- Iris with photographic paper.



Fig. 18:- Pre-treatment



Fig. 19: - Post-treatment

CASE4: Iris positioning is facilitated by a face bow to which transparent graph grids are attached (Figure 20).

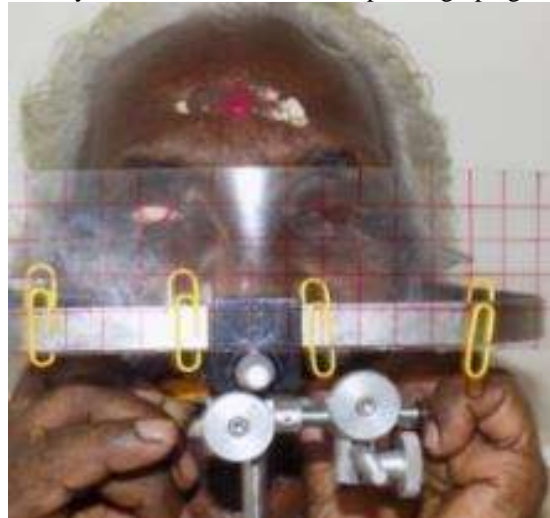


Fig.20: - Facebow and transparent graph grid method.



Fig. 21:- Pre-treatment Fig. 22:-Post-treatment

- Instructions for care of the prosthesis: The prosthesis is best cleaned with water and a mild soap or baby shampoo. All soap must be rinsed from the prosthesis and fingers before reinsertion of the prosthesis. It is advisable to always carry a pocket pack of tissue to facilitate removal of any secretions.

Discussion:-

An ocular prosthesis is a technique-sensitive procedure aimed at accurately duplicating natural color, size, contour, and ocular orientation to provide realism and symmetry as needed for the patient. There are specific steps in constructing an ocular prosthesis, highlighting critical areas of fabrication and important artistic techniques crucial for successful prosthetic treatment.

The advantages of a custom ocular prosthesis include retaining the shape of the socket, preventing lid collapse, supporting proper muscular activity of the lids, preventing fluid accumulation in the cavity, maintaining a palpebral opening and achieving a gaze similar to natural eye⁴.

The techniques for custom ocular prostheses vary based on operator preference and defect morphology. The most common techniques are the molded shell or stock ocular tray techniques and the external tray technique. The molded shell technique uses a stock ocular impression tray and works well for the majority of surgical enucleation and evisceration cases, though there is a risk of creating an overextended impression with the tray.

The external tray technique is used for patients with less favorable defect morphology due to factors such as trauma or infection. In this technique, an external ocular impression tray is placed outside the defect after injecting alginate into the defect area⁵.

This article discusses the importance of a customised ocular tray. A customised ocular tray can accurately record the defect area and inner portion of the eyelids. The acrylic resin tray is based on the patient's existing anatomy from the primary cast, ensuring an accurate fit to the socket. It is easily adjustable, and integration of a syringe into the custom tray allows direct dispensing of impression material⁶. The two-piece working model also simplifies the removal of the wax pattern.

Iris positioning and customisation can be approached in various ways, each with its own advantages depending on operator preference. It is advisable to choose a technique that offers precision and a more aesthetic outcome. The double curing procedure involves curing the base sclera initially and a second curing cycle for the clear superficial layer.

Ocular prostheses can be fabricated from different materials. Glass is rarely used due to handling difficulties and susceptibility to fractures from accidental drops. Acrylic resin ocular prostheses, developed by the United States Armed Forces in 1939, are superior to other materials. Polymethyl methacrylate (PMMA) resin is tissue-compatible, easy to manipulate, cost-effective compared to glass, allows easy color modifications, and offers superior aesthetic appearance.

Recent advancements in customized ocular prosthesis fabrication include Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), and rapid manufacturing techniques such as 3D printing⁷. These technologies represent current trends in improving fabrication precision and efficiency.

Conclusion:-

Stock or prefabricated ocular prostheses often fit poorly due to being either undersized or oversized. Overextended borders can lead to lid incompetence, irritation, and an increased risk of secondary infection. A properly fabricated custom-made prosthesis enhances the patient’s comfort and confidence through improved adaptability and a natural appearance. It also maintains its orientation when the patient performs various eye movements. In short, customised ocular prosthesis goes a long way in completing psychological rehabilitation in situations where loss of vision is permanent⁸.

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