

Prosthetic Rehabilitation of Patients with Ocular Defects Using Customized Ocular Prostheses: A Case Series

Authors:

Dr. Shazana Nazir Qazi¹, Prof. (Dr.) Sandeep Kour Bali², *Dr. Mansi Gadhe³, Dr. Shazia Kosar⁴

¹Associate Professor MDS, Prosthodontics, Government Dental College and Hospital, Shireen Bagh, Karan Nagar, Srinagar, Jammu & Kashmir, India.

²Principal and Professor & Head, Department of Prosthodontics, Government Dental College and Hospital, Shireen Bagh, Karan Nagar, Srinagar, Jammu & Kashmir, India.

^{2,3,4}Post Graduate Scholar, Department of Prosthodontics, Government Dental College and Hospital, Shireen Bagh, Karan Nagar, Srinagar, Jammu & Kashmir, India.

Corresponding Author:

Dr. Shazana Nazir Qazi, Associate professor MDS, Prosthodontics, Government Dental College and Hospital, Shireen Bagh, Karan Nagar, Srinagar, Jammu & Kashmir, India.

DOI: <https://doi.org/10.5281/zenodo.23150015>

Received: 02 September 2026, Revised: 16 September, Accepted: 29 September 2026, Online First: 05 October 2026

ABSTRACT

Background: Ocular loss or congenital absence can affect facial symmetry, aesthetics, and psychosocial well-being. Customized ocular prostheses provide individualized rehabilitation according to socket anatomy.

Case Description: This case series presents four customized rehabilitation approaches. A 71-year-old male with congenital absence of the right eye received a lightweight hollow ocular prosthesis fabricated using the lost-salt technique. A 61-year-old male with a traumatic defect following evisceration received a chair-side interim prosthesis using a sectional silicone mold. A 59-year-old female, previously enucleated for neovascular glaucoma, underwent peripheral modification of an existing prosthesis using light-cured acrylic resin to improve retention. A 71-year-old male received individualized scleral characterization to improve aesthetic integration with the contralateral eye.

Conclusion: Individualized modification of conventional ocular prosthetic techniques can address challenges related to prosthesis weight, interim rehabilitation, retention, and aesthetic integration.

Keywords: Ocular prosthesis; congenital anophthalmia; hollow ocular prosthesis; scleral characterization.

INTRODUCTION

The eye is an important component of facial symmetry, expression, and interpersonal communication. Loss or congenital absence of the globe may therefore produce consequences extending beyond loss of vision, including altered facial appearance, reduced self-confidence, social discomfort, and psychological distress. Ocular rehabilitation aims to restore the appearance of the missing or disfigured eye while maintaining the health and function of the surrounding tissues.

Ocular defects may result from congenital abnormalities, trauma, infection, tumors, or surgical procedures such as evisceration and enucleation. Depending on the clinical situation, rehabilitation may involve an ocular implant, stock ocular prosthesis, or customized ocular prosthesis. Stock prostheses provide a relatively simple and economical treatment option but may not reproduce the individual anatomy of the

socket or adequately match the contralateral eye. Customized prostheses, in contrast, are fabricated according to the patient's socket anatomy and permit individualized control of contour, scleral form, iris position, color, and surface characterization. Functional impression techniques may further improve adaptation by recording the tissue bed during controlled ocular movements.^{1,2}

A successful ocular prosthesis should reproduce, as closely as clinically possible, the size, shape, position, color, and orientation of the contralateral natural eye. In addition to aesthetic considerations, the weight and contour of the prosthesis may influence retention and patient comfort. This becomes particularly relevant in large ocular defects, in which a conventional solid acrylic prosthesis may be excessively bulky. Hollow prosthesis designs have therefore been described to reduce prosthesis weight while maintaining the required external form.³

Clinical challenges differ considerably among patients depending on the etiology of the defect, socket anatomy, eyelid relationships, residual tissue morphology, previous surgical procedures, and aesthetic requirements. Consequently, a single standardized fabrication technique may not be suitable for every patient.

The present case series describes four clinical situations requiring individualized modifications of conventional ocular prosthodontic procedures. The techniques were directed toward reduction of prosthesis weight, rapid interim rehabilitation, improvement of retention and peripheral adaptation, and enhancement of scleral characterization.

Case Reports

Case 1: Hollow Ocular Prosthesis for Congenital Anophthalmia Using the Lost-Salt

A 12-year-old female presented with facial asymmetry associated with congenital absence of the right eye. Clinical examination revealed a large ocular defect with a relatively small palpebral opening, healthy conjunctival tissues, and synchronous movement of the socket. Considering the relatively large defect and the volume of acrylic resin that would be required for a conventional solid prosthesis, a lightweight hollow ocular prosthesis was planned.

Clinical Procedure

1. Pre-operative evaluation

The patient with congenital absence of the right eye was clinically evaluated to assess the ocular defect, socket anatomy, periocular tissues, and available space for fabrication of the ocular prosthesis (Fig. 1A).

2. Ocular socket impression

An impression of the ocular socket was recorded using a suitable impression material to accurately reproduce the anatomy of the defect (Fig. 1B).

3. Working cast fabrication

The ocular impression was poured in dental stone to obtain a working cast reproducing the anatomy of the socket (Fig. 1C).

4. Wax-pattern fabrication and try-in

A wax pattern was fabricated on the working cast and clinically tried in. The pattern was evaluated and adjusted for adaptation, contour, eyelid support, orientation, and symmetry with the contralateral eye (Fig. 1D).

5. Investing and dewaxing

Following clinical verification, the wax pattern was invested and subsequently dewaxed to obtain the mold space for fabrication of the prosthesis (Fig. 1E).

6. Lost-salt technique and acrylic resin processing

A thin first layer of heat-polymerized acrylic resin was adapted within the mold. Uniformly sized salt granules were incorporated over this layer to create the intended hollow space. A second layer of heat-polymerized acrylic resin was then adapted over the salt, completely

enclosing it, and the prosthesis was processed using the recommended polymerization cycle (Fig. 1F).

7. Removal of salt

Following polymerization, the prosthesis was retrieved and a small access opening was created. The incorporated salt was removed by flushing the internal cavity with water until complete elimination of the salt was achieved, resulting in a hollow ocular prosthesis (Fig. 1G).

8. Sealing, finishing, and polishing

The access opening was sealed with autopolymerizing acrylic resin. The prosthesis was subsequently finished and polished to obtain smooth external surfaces and margins (Fig. 1H).

9. Definitive prosthesis insertion

The completed hollow ocular prosthesis was inserted and clinically evaluated for adaptation, eyelid support, orientation, retention, facial symmetry, and movement. The patient and parents were instructed regarding insertion and removal, cleaning, hygiene maintenance, and the importance of periodic follow-up (Fig. 1I).

Case 2: Chair-Side Interim Ocular Prosthesis Using a Sectional Silicone Mold

A 61-year-old male presented with severe disfigurement of the left eye following trauma and subsequent evisceration. Clinical examination demonstrated an everted lower eyelid, medial canthal tear, and superior soft-tissue retraction. As further surgical correction was anticipated, fabrication of a definitive prosthesis was deferred. An interim ocular prosthesis was therefore planned to provide immediate aesthetic rehabilitation during the transitional period.

Clinical Procedure

1. Preoperative evaluation

The ocular defect and surrounding periocular tissues were clinically evaluated to assess the available socket space, tissue support, and requirements for fabrication of an interim ocular prosthesis (Fig. 2A).

2. Wax conformer fabrication

A wax conformer was fabricated to reproduce the required contour and dimensions of the ocular prosthesis and to provide appropriate support to the surrounding periocular tissues (Fig. 2B).

3. Clinical try-in

The wax conformer was clinically tried in and evaluated for adaptation, contour, orientation, eyelid support, and overall facial symmetry. Necessary adjustments were performed before processing (Fig. 2C).

4. Sectional mold fabrication

Following clinical verification, the wax conformer was invested in heavy-body silicone putty to fabricate a sectional mold for chair-side processing of the interim prosthesis (Fig. 2D).

5. Dewaxing and mold preparation

After polymerization of the silicone material, the mold sections were separated and the wax conformer was removed. The resulting mold cavity was inspected for completeness and prepared for acrylic resin placement (Fig. 2E).

6. Acrylic resin packing and polymerization

Autopolymerizing acrylic resin was mixed according to the manufacturer's instructions, packed into the prepared mold, and allowed to polymerize completely (Fig. 2F).

7. Retrieval, finishing, and polishing

Following polymerization, the prosthesis was retrieved from the sectional mold. Excess acrylic resin was removed, the borders and contours were refined, and the prosthesis was finished and polished to obtain a smooth surface (Fig. 2G).

8. Insertion and postoperative evaluation

The completed interim ocular prosthesis was inserted and evaluated for adaptation, contour, eyelid support, orientation, retention, and overall facial appearance (Fig. 2H). The patient was instructed regarding insertion and removal of the prosthesis, cleaning and hygiene maintenance, and the need for periodic follow-up. The interim nature of the prosthesis was emphasized, as further surgical management was anticipated.

Case 3: Modification of an Existing Ocular Prosthesis with a Light-Cured Acrylic Peripheral Retainer

A 59-year-old female who had previously undergone enucleation for neovascular glaucoma presented with repeated dislodgement of her ocular prosthesis. Clinical examination demonstrated an irregular socket with anatomical deficiencies that compromised the stability and retention of the existing prosthesis. As the existing prosthesis was otherwise clinically acceptable, modification of its peripheral contour was planned rather than complete replacement.

Clinical Procedure

1. Preoperative evaluation

The existing ocular prosthesis was clinically evaluated for adaptation, retention, stability, contour, eyelid support, and possible factors contributing to repeated dislodgement (Fig. 3A).

2. Peripheral reduction

The peripheral aspect of the existing ocular prosthesis was selectively reduced to create adequate space for the addition of light-cured acrylic resin (Fig. 3B).

3. Application of light-cured acrylic resin

A thin layer of light-cured acrylic resin was adapted uniformly over the reduced peripheral surface of the prosthesis (Fig. 3C).

4. Intra-socket positioning and functional contouring

The prosthesis with the uncured resin was positioned passively within the ocular socket. The patient was instructed to perform gentle ocular movements,

allowing the surrounding mobile tissues to functionally contour the peripheral material. Once satisfactory adaptation and positioning were achieved, the prosthesis was removed and the resin was polymerized using a light-curing unit (Fig. 3D).

5. Finishing, polishing, and reinsertion

Following polymerization, excess acrylic resin was removed and the modified peripheral surfaces were finished and polished to obtain smooth, clinically acceptable borders. The prosthesis was reinserted and evaluated for passive seating, peripheral adaptation, retention, stability, eyelid support, and ocular movement (Fig. 3E).

Case 4: Individualized Scleral Characterization for Enhanced Aesthetic Integration

A 71-year-old male presented with dissatisfaction regarding the appearance of an existing ocular prosthesis. His primary concern was the mismatch between the prosthetic eye and the natural contralateral eye, particularly with respect to scleral color, vascular markings, and surface characterization. A customized ocular prosthesis with individualized scleral characterization was therefore planned.

Clinical Procedure

1. Functional ocular impression

A functional impression of the ocular socket was obtained using a light-body elastomeric impression material while the patient performed controlled ocular movements to record the socket anatomy and functional tissue contours (Fig. 4A).

2. Putty index fabrication

The functional ocular impression was indexed using silicone putty to obtain a mold reproducing the recorded dimensions and contours of the ocular socket for subsequent fabrication of the wax pattern (Fig. 4B).

3. Wax-pattern fabrication and evaluation

A wax pattern was fabricated using the putty index and clinically evaluated for adaptation, contour, eyelid support, orientation, and relationship with the contralateral eye. Necessary modifications were performed to achieve satisfactory form and symmetry (Fig. 4C).

4. Iris positioning

The position and orientation of the iris were established by comparison with the contralateral eye, with particular attention to the interpupillary relationship and horizontal and vertical alignment (Fig. 4D).

5. Individualized scleral characterization and processing

The scleral portion of the prosthesis was individually characterized to reproduce the appearance of the contralateral natural sclera. Appropriate acrylic pigments and red acrylic fibers were used to simulate subtle variations in scleral color and conjunctival vascular markings. A polymer-in-monomer syrup was used to facilitate the incorporation and stabilization of

the selected characterization materials. The characterized prosthesis was subsequently processed using conventional acrylic resin processing procedures and finished and polished to obtain a smooth external surface (Fig. 4E).

6. Evaluation of the previously fabricated prosthesis

The previously fabricated ocular prosthesis was evaluated with particular attention to its scleral

appearance and the need for improved individualized characterization (Fig. 4F).

7. Definitive characterized prosthesis

The definitive prosthesis with individualized scleral characterization was evaluated for color matching, vascular pattern, overall esthetics, adaptation, orientation, and harmony with the contralateral eye. The patient expressed satisfaction with the final esthetic outcome (Fig. 4G).

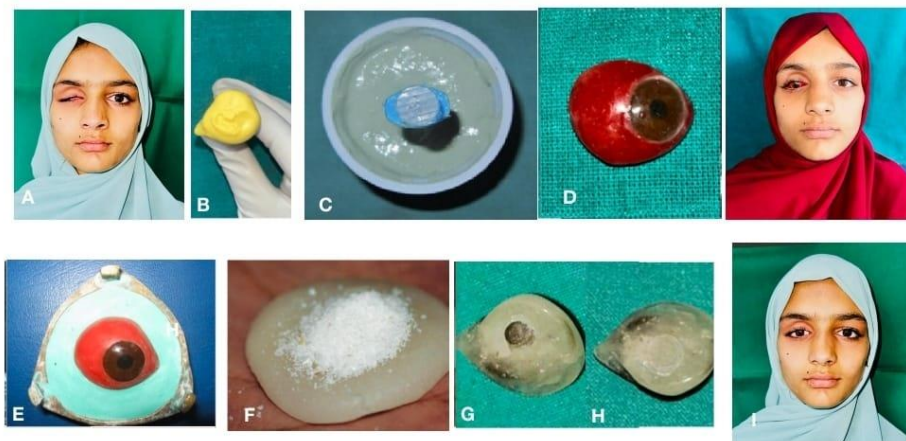


Figure 1(A-I). Fabrication of a hollow ocular prosthesis for a patient with congenital absence of the right eye using the lost-salt technique: (A) Pre-operative photograph (B) ocular socket impression; (C) working cast fabrication; (D) wax-pattern fabrication and try-in; (E) investing and dewaxing; (F) first acrylic resin layer, incorporation of salt granules and second acrylic layer and processing; (G) removal of salt through an access opening; (H) sealed, finished, and polished prosthesis; (I) definitive prosthesis after insertion.



Figure 2 (A-H): Chair-side fabrication of an interim ocular prosthesis: (A) preoperative view; (B) wax conformer; (C) clinical try-in; (D) wax conformer invested in sectional mold; (E) mold after dewaxing; (F) autopolymerizing acrylic resin packed in the mold; (G) finished ocular prosthesis; and (H) postoperative view.



Figure 3. Peripheral modification of an existing ocular prosthesis using light-cured acrylic resin: (A) Preoperative photograph (B) Peripheral reduction on existing ocular prosthesis; (C) application of light-cured acrylic resin; (D) intra-socket positioning and functional contouring; (E) finished and polished modified prosthesis after reinsertion.



Figure 4. Individualized scleral characterization of a customized ocular prosthesis: (A) functional ocular impression; (B) putty index fabricated from impression; (C) wax-pattern fabrication and evaluation; (D) iris positioning; (E) processed prosthesis with individualized scleral characterization (F) previously fabricated prosthesis (G) definitive prosthesis with characterisation.

DISCUSSION

Successful ocular prosthetic rehabilitation involves more than reproducing the color and dimensions of the contralateral eye. The prosthesis must be compatible with socket anatomy, eyelid position, residual tissues, and available muscular movement. Assessment of socket depth, palpebral fissure, tissue mobility, conjunctival condition, eyelid support, and the contralateral eye is therefore fundamental to treatment planning.

Individualized ocular impressions determine the tissue-contacting surface of the prosthesis and consequently influence its adaptation. Functional impression procedures record the socket while the surrounding tissues are activated through controlled ocular movements. Such techniques may provide a more representative record of the functional space and thereby facilitate adaptation, stability, comfort, and movement. Jethwani et al.¹ described a functional impression technique for ocular prostheses, an approach particularly relevant to Case 4, in which adaptation to mobile socket tissues was required.

The first case presented an additional challenge because the ocular defect resulted from congenital absence of the eye. In a growing child, prosthetic rehabilitation should take into consideration both the existing anatomy and the need for periodic clinical reassessment as craniofacial and orbital structures develop. In the present case, the relatively large defect necessitated a prosthesis of considerable volume. Fabrication of the prosthesis as a solid acrylic structure would have increased its weight. Hollowing therefore provided a practical method of reducing the acrylic mass while maintaining the required external contour. Weight reduction is particularly relevant when the volume of the ocular prosthesis is large, as excessive prosthesis weight may adversely influence comfort and retention. Maskey et al.³ described a simplified hollow ocular prosthesis technique intended to reduce weight

while maintaining the required prosthetic form. In Case 1, incorporation and subsequent removal of salt provided a straightforward means of creating an internal hollow space after processing.

The second case illustrates the role of an interim prosthesis when definitive rehabilitation is inappropriate because of anticipated anatomical or surgical changes. Trauma, eyelid deformities, soft-tissue retraction, and planned surgical correction may limit the usefulness of a definitive prosthesis fabricated before the tissues have stabilized. A sectional silicone mold permitted relatively rapid fabrication of an interim acrylic prosthesis in this patient. Simplified techniques for ocular rehabilitation have similarly been described when conventional laboratory procedures are impractical or rapid rehabilitation is required.⁵ Such prostheses should nevertheless be regarded as interim restorations when substantial changes in socket anatomy are expected.

Retention of an ocular prosthesis depends on several interacting factors, including socket anatomy, eyelid support, prosthesis contour, tissue mobility, and adaptation of the tissue-contacting surface. Case 3 involved a patient who had undergone enucleation for neovascular glaucoma and subsequently experienced repeated dislodgement of the existing prosthesis. Rather than increasing the overall dimensions of the prosthesis indiscriminately, selective peripheral modification with light-cured acrylic resin allowed the contour to be established in relation to the functional anatomy of the socket. The technique therefore provided a conservative approach in a patient whose existing prosthesis was otherwise clinically acceptable. Variations in residual orbital anatomy and eyelid relationships can substantially influence prosthetic treatment planning. Aggarwal et al.⁴ proposed a treatment-oriented classification for patients with phthisis bulbi to facilitate selection of appropriate rehabilitation strategies. Such classification systems

may aid treatment planning in applicable patients; however, congenital anophthalmia should be distinguished from phthisis bulbi, as the two represent different clinical conditions and should not be used interchangeably.

Aesthetic integration of an ocular prosthesis depends greatly on accurate iris positioning and reproduction of the scleral appearance. Iris position should be established in relation to the facial midline, interpupillary relationship, eyelid position, and contralateral eye because even relatively small positional discrepancies may become noticeable during facial interaction.

Similarly, a uniformly white scleral surface may fail to reproduce the appearance of the natural eye. Individualized incorporation of acrylic pigments and fibers permits reproduction of subtle color variation, pigmentation, and vascular markings.⁶ In Case 4, these characterization materials were used in conjunction with a polymer-in-monomer syrup during the characterization procedure. Careful reproduction of scleral features and corneal-limbal form provided greater visual integration with the contralateral eye without assuming that the acrylic material itself possessed antimicrobial properties.

The four cases consequently demonstrate different applications of individualized ocular prosthodontic treatment: Case 1: weight reduction through hollowing in congenital anophthalmia; Case 2: rapid interim rehabilitation following traumatic ocular loss; Case 3: functional peripheral modification to improve retention following enucleation for neovascular glaucoma; and Case 4: individualized scleral characterization for improved aesthetic integration.

The present case series has several limitations. It comprises only four clinical cases and does not include standardized quantitative measurements of prosthesis retention, mobility, aesthetic outcomes, or validated patient-reported outcome measures. Long-term follow-up was also limited. Consequently, the cases should be interpreted as clinical demonstrations of individualized techniques rather than evidence of comparative superiority or quantified improvement in quality of life.

Periodic follow-up remains essential to evaluate prosthesis fit, surface integrity, hygiene, conjunctival health, discharge, irritation, changes in socket anatomy, and patient comfort. This is particularly important in pediatric patients, in whom growth-related anatomical changes may necessitate periodic modification or replacement of the prosthesis. Future clinical studies incorporating standardized objective assessments and validated patient-reported outcome measures would be valuable in evaluating the reproducibility and long-term effectiveness of individualized ocular prosthetic techniques.

Strengths of the Case Series

The major strength of this case series is the presentation of four clinically distinct ocular prosthodontic situations managed using individualized modifications of conventional prosthetic techniques. The cases demonstrate practical approaches to reducing prosthesis weight, providing interim rehabilitation, improving retention through peripheral modification, and enhancing aesthetic integration through individualized scleral characterization. Another strength is the detailed description of the clinical procedures, which may facilitate understanding and clinical application of these techniques in appropriately selected patients. The cases also highlight the importance of tailoring ocular prosthetic rehabilitation according to socket anatomy, tissue characteristics, functional requirements, and patient-specific aesthetic concerns.

Limitations

This case series has several limitations. The sample size was limited to four clinical cases, and there was no control or comparison group. Standardized quantitative measurements of prosthesis retention, mobility, weight reduction, aesthetic outcome, or patient satisfaction were not performed. Validated patient-reported outcome measures were also not used. In addition, the duration of follow-up was limited, and therefore long-term stability, durability, and maintenance requirements could not be systematically assessed. Because of the descriptive nature of the case series, the findings should be interpreted as clinical demonstrations of individualized prosthodontic techniques rather than evidence of comparative superiority or generalizable treatment effectiveness.

Future Directions

Future studies should evaluate individualized ocular prosthetic techniques in larger patient populations using standardized clinical and patient-reported outcome measures. Objective assessment of prosthesis retention, mobility, weight, adaptation, aesthetic integration, and patient satisfaction would allow more systematic comparison between conventional and modified techniques. Longer follow-up is also required to assess prosthesis durability, socket health, hygiene, complications, and the need for subsequent modification or replacement. In pediatric patients, longitudinal studies may be particularly useful because changes associated with craniofacial and orbital growth can influence prosthetic fit and treatment requirements. Development of standardized clinical protocols for selecting and applying individualized techniques may further improve reproducibility and clinical outcomes.

CONCLUSION

Customized ocular prosthetic rehabilitation requires integration of anatomical assessment, accurate

impression procedures, appropriate prosthesis design, controlled iris positioning, scleral contouring, and individualized characterization.

The four cases demonstrate how conventional ocular prosthodontic procedures can be modified according to specific clinical requirements. Hollow prosthesis fabrication can reduce prosthetic weight in a large defect; an interim chair-side prosthesis can provide transitional rehabilitation when further surgical treatment is anticipated; selective peripheral modification can improve the stability of an otherwise acceptable prosthesis; and individualized scleral characterization can enhance aesthetic integration with the contralateral eye.

A patient-specific approach allows the prosthodontist to address functional and aesthetic requirements while accommodating variations in socket anatomy and clinical presentation. Long-term success additionally depends on patient education, appropriate hygiene, periodic clinical review, and coordination with ophthalmic and surgical care whenever required.

Declarations

Ethics Approval

Ethics approval was not separately reported for this descriptive case series. The authors should confirm the institutional requirements applicable to the reported cases and provide the relevant ethics committee approval or exemption statement, if applicable.

Patient Consent

The authors certify that appropriate informed consent was obtained from the patients or their legal guardians for clinical treatment and for publication of the clinical information and accompanying images. The patients or their legal guardians were informed that their names and initials would not be published and that reasonable efforts would be made to protect their identity. However, complete anonymity cannot be guaranteed.

Conflict of Interest

The authors declare no conflict of interest.

Funding

No external funding was received for this case series.

Author Contributions

All authors contributed to the clinical management, documentation, interpretation of the cases, preparation and/or critical revision of the manuscript, and

approved the final version for publication. All authors agree to be accountable for the work and ensure that questions related to the accuracy or integrity of the manuscript are appropriately investigated and resolved.

Data Availability Statement

The clinical information supporting the findings of this case series is contained within the manuscript. Additional patient-level information is not publicly available because of patient privacy and confidentiality considerations.

AI Use Disclosure

The authors declare that no generative artificial intelligence tools were used to generate or substantially modify the scientific content of this manuscript.

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