



Case Report

Novel techniques for precise fixation of gaze in ocular prosthesis - Case series

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ABSTRACT

Primary goal in successful rehabilitation of a patient with ocular defect is to fabricate a well-fitted ocular prosthesis that mimics the original shape and position of the residual anatomical structures and restores volume of the defective socket. Adequate palpebral opening, iris-scleral visibility, color and size of iris, centering of pupil, shade of sclera, proper fixation of gaze and characterization of prosthesis are the key aspects that deserve meticulous attention. Fixation of gaze and selection of iris size can be achieved by various techniques. Four techniques involving usage of millimeter markings and numerical values with armamentarium such as spectacles with graphic grid, cassette holder with grid, modified graphic grid ruler, RS-3 Ophthalmic pupil distance meter coupled with digital imaging technique for iris selection are highlighted through these case series.

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1. Introduction

Anophthalmia (loss of eye) leads to loss of form, function and esthetics and has deep psychological impact on the overall well-being of an individual. Surgical management of ocular pathologies include enucleation, evisceration and exenteration depending on anatomical structures involved.¹ Various challenges faced while rehabilitating ocular defects include ptosis, ectropion, contracted socket, sagging lower eyelid, fixing of the gaze, movement of tissue bed, recurrent infections, orbital cellulitis, marked edema of lids and adhesions.² An ideal custom made ocular prosthesis should mimic natural scleral visibility by allowing adequate palpebral opening similar to that of healthy eye. The size and shape of the prosthesis should permit proper curvature and natural closure of eyelids. An oversized prosthesis can lead to irritation and discharge, while an undersized prosthesis induces loss of muscle tone leading to sunken appearance. Selection of natural gaze permits alignment in an apparent focus when looking straight. The shape and

color of iris and sclera should be as close as possible to natural eye to meet the esthetic demands of the patient. It should be able to restore and maintain the residual tissue volume to its original contour and a healthy state.³

Materials used for fabrication of ocular prosthesis have evolved from the use of prefabricated glass eye and acrylic stock shells in the past to custom made ocular prosthesis fabricated using reinforced, esthetically sound newer materials used in present day practice. A well fitted ocular prosthesis helps in retaining the shape of the socket, prevents collapsing of fornices and loss of shape of lids, allows proper action of muscles and soft tissue, helps retain the tear ducts, protects socket from foreign bodies, thereby restoring the cosmetic outcome for the patient.⁴

This article depicts two cases where four different techniques have been used for selection of natural gaze along with digital imaging for selection of iris. These techniques yielded highly satisfactory outcomes and can be implemented into clinical prosthodontic practice.

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2. Cases History

3. Case 1

A 05 yrs old girl reported to Department of Prosthodontics for rehabilitation of a residual ocular defect of left eye. Past medical history revealed that the patient was diagnosed with retinoblastoma of left eye when she was six months old and had undergone enucleation for the same (Figure 1). Present prosthesis was in form of a modified stock ocular shell which was ill-fitting with a sunken appearance due to increase in size of the surrounding structures with age. Local examination showed a healthy tissue bed with adequate tissue depth and retentive anatomical undercuts along upper and lower eyelids. The patient was diagnosed with residual ocular defect secondary to enucleation (It eye) and treatment plan was rehabilitation using custom made ocular prosthesis with digital imaging technique for selection of iris and fixation of natural gaze using two different graphic methods namely graph grid attached to spectacle and a graphic grid ruler.

Impression was made using customized tray and light body consistency of polyvinyl siloxane impression material (Betasil). Impression obtained was checked for proper extent and poured in type III dental stone (Kalabai) to fabricate a split mold into which wax was flown to obtain a wax pattern. The wax pattern was tried on the patient and necessary adjustments were made. For selection of iris and fixing of natural gaze a transparent graph sheet was attached to a clear glass spectacle. Care was taken in selecting the spectacle so that it covered the entire anatomical extent of both the eyes. Markings were made on the frame of the spectacle to coincide with facial midline and permit same orientation every time. Medio-lateral and supero-inferior dimensions of healthy eye were also transferred onto the graph paper and similar markings were made on the defect site using the 'graph grid'. These markings provided as a reference for the selection of size of iris. A digital image of iris of the healthy eye was obtained using a DSLR camera (Nikon) and printed on high quality photographic paper (180 GSM, Kodak) which was then attached on the wax pattern using 'iris button technique'. The same spectacle with graph grid was used for gaze fixation (Figure 2). The patient was instructed to stand upright with eyes focused at a distant point. The centre of iris marked on the graph grid and millimeter markings helped in centering of gaze similar to the healthy eye. The exact position of iris and gaze was also confirmed using a graphic ruler with millimeter markings (Figure 3). The wax pattern was invested in a specialized flask and subjected to dewaxing. Stains were added to clear heat polymerized polymethyl methacrylate to obtain desired scleral shade and intrinsic characterization was done with red flocking agent. The polymer and monomer were mixed as per manufacturer's instructions and packed in the flask. Long curing cycle was followed to reduce residual monomer

content. The prosthesis was finished, polished, tried and inserted (Figure 4). Instructions were given to the patient and recall appointments were scheduled at 1 week, 3 weeks and 3 months post-insertion.⁵

4. Case 2

A 30 years old lady reported with the chief complaint of loss of vision and sunken appearance of right eye since birth. Examination revealed shrunken contents of eye with whitish keratinized tissue, complete loss of vision, obliteration of infraorbital fold (Rt) with adequate volume of the defect (Figure 5). The case was diagnosed as 'Phthisis Bulbi' of right eye. Treatment plan was to fabricate a custom made ocular prosthesis using digital imaging technique for selection of iris and use of a graph attached to a 'cassette holder' and 'pupil distance meter' (RS-3 Ophthalmic Equipment Pd meter) for fixation of gaze. Impression, wax pattern fabrication and digital image for iris selection was done similar to the first case. The wax pattern with iris was tried on the patient and selection of gaze was done using a transparent graph grid attached to a cassette holder. Facial midline, medial and lateral canthus and iris position were marked on the transparent graphic grid on both the sides (Figure 6). Digital photograph of iris was attached to iris button and centered onto the wax pattern based on these markings. For fixation of gaze, patient was instructed to sit upright in natural head position, holding the graphic grid over the face and focusing at a distance. The markings made earlier helped in orientation of graph grid and centering of iris and its position was ascertained using the millimeter markings. The position of iris was confirmed using a Pupil Distance Meter for which, the patient was instructed to hold the equipment parallel to the floor, resting the nasal holder over the bridge of the nose and to look straight (Figure 7). The 'viewfinder' at the other end of the equipment allowed unobstructed focused view of both the eyes and the interpupillary distance was adjusted. This provided precise positioning by comparing the distance from centre of iris to facial midline on normal side and duplicating the same in prosthesis. The prosthesis was processed and fabricated in heat polymerized PMMA and was delivered. Home maintenance instructions were given and patient was followed up as per protocol (Figure 8).

5. Discussion

Ocular prosthesis has evolved with various modifications in materials, techniques and technologies aiming to improve precision and accuracy for desired clinical outcome.⁶ Benson suggested use of a wax scleral blank with iris button for fabrication of ocular prosthesis.⁷ Methods for selection of iris include using an appropriate stock shell, iris painting technique⁸ and digital imaging technique.^{9,10} Color of sclera, iris dimensions and fixation of gaze are the

Table 1: (++) strongly agree, + agree, - disagree)

	Ease of use	Feasibility in clinical set-up	Chances of errors	Iris positioning	Fixation of gaze
Standard measurements from midline	++	++	++	+	-
Use of graph grid on spectacle	+	++	+	+	+
Use of graph grid using cassette holder	+	++	+	+	+
Use of graphic scale	++	++	+	+	+
Pupil distance meter	++	++	-	++	++

**Fig. 1:** Pre-operative**Fig. 2:** Selection of iris & Fixation of gaze using graphic grid attached to spectacle

most crucial steps for successful rehabilitation.

For determination of correct iris position, the pattern is inserted into socket and patient is asked to look straight at a distant point, centre of pupil is marked with a marking pencil and iris markings are scribed. The size and location of iris must match with that of normal eye. According to Bethke, correct focus can be determined by holding a light at about a distance of 14 inches in front of the patient. Natural head position is a reproducible, standardized head position with eyes focused on a distant point at eye level in an upright posture implying that the visual axis is horizontal.¹¹ In this position, the upper half of iris is covered by upper eyelid while the lower border lies slightly above the lower eyelid.

Graph sheet has been used by various authors for estimation of size and position of iris.^{12 13 14} Transparent grid paper on frontoparallel acrylic glasses,¹⁵ graph grid printed on a transparent sheet placed directly over patient's face¹⁶ or attached to suitable eyewear¹⁷ has been highlighted in literature. In the present case series modification of graph grid using spectacle, cassette holder

and graphic ruler have been utilized. The advantages of using a graph grid is that the millimeter markings provide accuracy and precision in selection of iris position and gaze, reduces chairside time as compared to arbitrary methods, the spectacle or cassette holder ensure same orientation on repeated appointments without any deviation in readings, which is more feasible for younger patients and those with disabilities. The limitations include the need to set up the graphic grid, selection of a suitable mode for holding of the same and the distance between eye and the graphic grid may produce minor errors in the readings.

Roberts used a pupillometer to select appropriate interpupillary distance and achieve desired pupil alignment. The instrument consisted of parallel cylindrical tubes with lens having graduated markings which helped in determining the position of artificial eye.¹⁸ Pupil distance meter is an optical instrument used in ophthalmology to measure the interpupillary distance and ensure centering

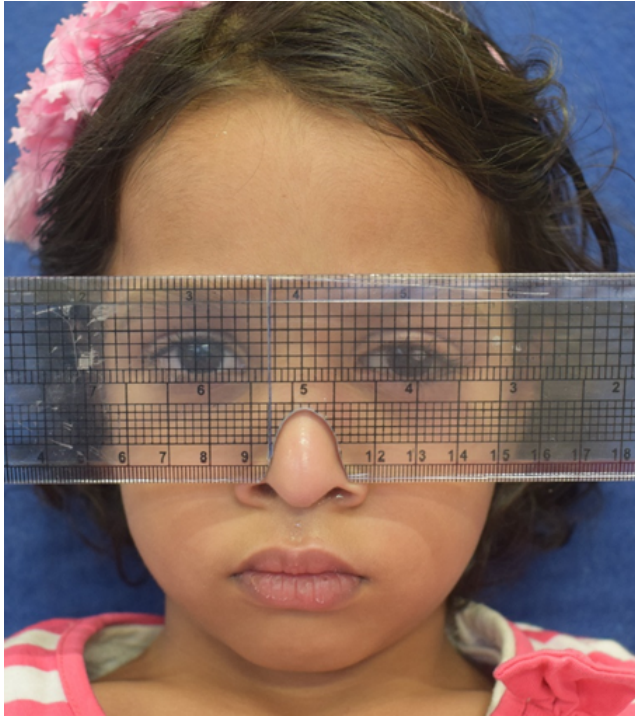


Fig. 3: Graphic Ruler for verification of iris position and gaze



Fig. 5: Pre-operative



Fig. 4: Prosthesis in-situ



Fig. 6: Selection of iris & Fixation of gaze using graphic grid attached to cassette holder



Fig. 7: Pupil Distance Meter for verification of iris position and gaze



Fig. 8: Prosthesis in-situ

of lenses in visual axis. Patient is instructed to secure the equipment parallel to the floor, the 'open forehead bracket' rests on patient's forehead with 'nose support' over the nasal bridge. The operator views from the 'viewfinder' at the other end. The vertical markings can be centered by 'measurement slide controls' and the wax pattern with iris in position can be verified for its centering to exact numerical value. The average normal interpupillary distance observed in Indian population is approximately 46-70mm in males and 46-75mm in females.¹⁹ The pupil distance meter is a common instrument available as a part of inventory at every optician and department of ophthalmology, saves the effort of setting up a graphic grid, provides unhindered view of area of interest, specific features for characterization of prosthesis can be viewed and duplicated in final prosthesis to minute details, saves chairside time, convenient for the patient and clinician and provides accurate positioning and dimensions for iris selection. The limitation of the equipment is that only a single operator can view at one time, additional expenditure if it is to be included as a part of inventory, younger patients might find it difficult to hold the equipment and look straight ahead at the same time.

Table 1 Shows comparison of standard measurements from midline and techniques highlighted based on the ease of use, feasibility, chances of errors, iris positioning and fixation of gaze. Amongst the various methods, pupil distance meter was found to be the most reliable method based on observed parameters. The advantages include its portability, location of exact iris position using vertical markings and unobstructed view of both the eyes. The limitation was that it had to be secured by the patient and only single operator could view at one time. In the case series an innovative combination of techniques, equipment and armamentarium has been utilized. The use of digital imaging for iris selection allowed exact duplication of iris color for the prosthetic eye. The graphic grid attached to spectacle and cassette holder helped in selection of iris and gaze fixation while graphic grid ruler and pupil distance meter helped in verification. This reduced the chances of errors with more predictable clinical outcome and pleasing esthetics in both the cases.

6. Conclusion

Iris size, color, positioning and fixation of gaze are the most critical steps for fabrication of esthetically pleasing ocular prosthesis. Conventional treatment sequence has seen various modifications to simplify the clinical procedure. Utilization of graph sheet with various aids like spectacle, graphic grid ruler or cassette holder allows precise positioning of iris and accurate fixation of gaze. Specialized optical instruments like Ophthalmic Pupil distance meter is a viable option that has been explored and appears to be a potent alternative for implementation into clinical practice for successful rehabilitation of ocular defects.

7. Source of Funding

None.

8. Conflict of Interest

None.

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