CLINICAL TECHNIQUE

# Eye Mapping: Innovative Technique for Precise Iris Positioning in Prosthetic Eye

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## Abstract

**Aim:** The aim of this technique is to institute "Augmented Reality Tool" in the field of maxillofacial prosthesis for an accurate and precise iris positioning in a prosthetic eye.

**Background:** A congenital defect, irreversible damage, a painful blind eye, sympathetic ophthalmia, or the requirement for histological confirmation of a suspected illness can all result in the absence or loss of an eye. In such circumstances, meticulous preoperative, surgical, and prosthetic planning using a multidisciplinary approach is imperative for successful rehabilitation.

**Technique:** Augmented reality filter was used to provide precise mapping of facial landmarks and to aid in iris positioning. Smartphone device (S22) was used and artificial intelligence (AI)-generated Instagram application was unfurled and augmented reality (AR) filter was instituted. The filter available in the application made it possible to see and confirm the iris shell's location in three dimensions from various angles. The dimensions thus provided, aided in the correct positioning of the iris in the prosthetic eye.

**Conclusion:** Iris positioning stands as one of the crucial steps in fabricating a patient-specific ocular prosthesis. In the present case report, iris positioning was done using AI has provided an excellent esthetics results and patient compliance was met with satisfaction.

**Clinical significance:** Accurate positioning of iris can be done using AR tool which is popular, easily accessible, less technique sensitive, and can be performed with slightest efforts in small clinical set-ups. Relating to patient, it is comfortable, economic, and trouble-free procedure.


**Keywords:** Artificial intelligence, Augmented reality, Eye prosthesis, Iris positioning, Patient-specific eye, Prosthetic eye.

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## Introduction

Eyes are the "stars of the face" reflect the profound connection between one's eyes and their innermost emotions, intentions, and personality.[1] Certainly, anophthalmia, the absence of one or both eyes, can arise from various causes including carcinoma, trauma, sympathetic ophthalmic, painful blind eye, or congenital defects.[2] In response to these clinical situations, surgical interventions such as orbital evisceration, enucleation, or exenteration may be indicated. One of the methods to restore the missing ocular globe in these patients is through prosthodontic rehabilitation using an ocular prosthesis.[3]

Prosthodontists face a significant challenge in iris positioning in the prosthetic eye. Iris positioning is a key factor in ocular prosthesis. In the event of wrongly placed iris in the prosthetic eye, a squinted eyes appearance is seen.[4] These prostheses not only enhance the patient's psychological condition but also improve their appearance and level of comfort.[5] There are many documented techniques for iris positioning in prosthetic eye, majority of them are subjective in nature such as facial measurements, visual perceptions, and use of window light methods, which does not allow the operator to place the iris precisely.[6,7] To overcome the lacunae of subjective methods documented in the literature objective approaches came into picture but available objective methods are expensive and technique sensitive like computer-aided design–computer-aided manufacturing (CAD/CAM), modified Hanau wide-view spring bow, digital photographs, electronic vernier caliper, and laser pointer apparatus.[8–11] These technique cater to varying needs and preferences of clinicians, providing a comprehensive tool kit for ocular prosthesis.[12]

Technology known as artificial intelligence (AI), makes it possible for computers and other devices to mimic human intelligence and problem-solving skills. The uses of AI are expanding daily. The development of AI paves the way for large data analysis, which enhances decision-making and yields dependable information.[13] Augmented reality (AR), can overlay digital data in real-time, in order to provide a more precise and comprehensive visualization during procedures, this can encompass treatment plans, anatomical structures, and procedural guidance. The AR technology can be used to create precise and personalized treatment plans. By visualizing the expected outcomes and potential complications, dentists can refine their strategies for treatment procedures.[13] The AR is widely

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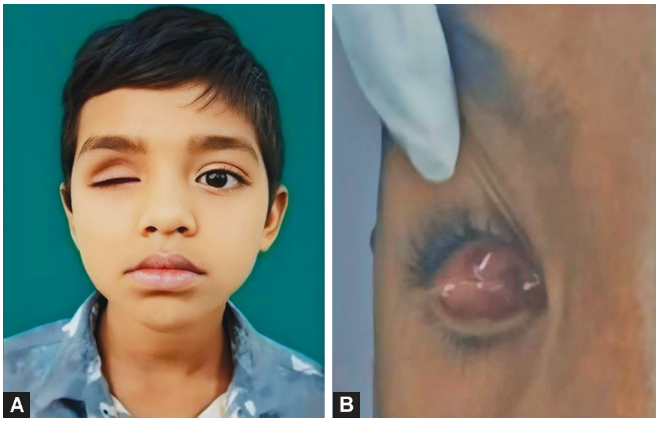
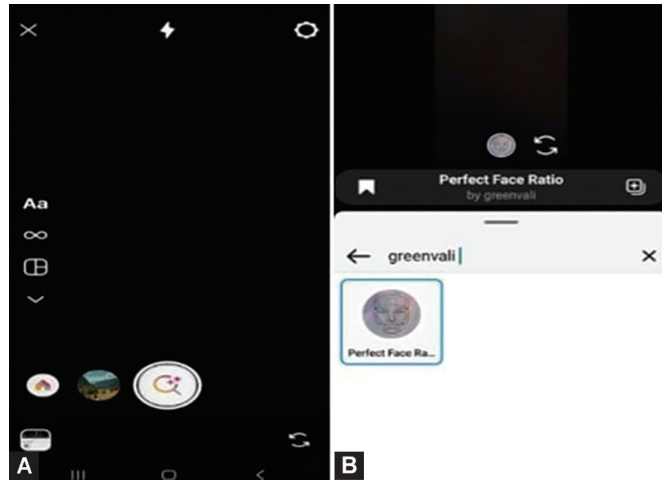



**Figs 1A and B:** Patient clinical images of right eye (A) Preoperative image; (B) Healed tissue bed




**Figs 2A and B:** Directions for using the Instagram application filter to position the iris. (A) Select the browse effect tab; (B) Search for the greenvali filter

used in digital radiographs, dental scans, CAD-CAM restorations, orthodontic aligners, oral surgery, and implantology.[13] The AR technology is also useful in preclinical as well as clinical education, training, and evaluation. The AR can be considered as objective method for iris positioning as it transfers the virtual data in the real world and this data precisely assess its position, size, and alignment relative to the surrounding structures. A study has demonstrated the use of AR filters in the development and fitting of orbital prosthesis.[3] However, this innovative application has not been extensively explored or utilized for ocular prosthesis. There is significant potential for AR technology to enhance the precision and customization of ocular prostheses, offering improved outcomes and patient satisfaction. Further research and development in this area could lead to more widespread adoption and new advancements in the field of ocular prosthesis.

The current article aims at a novel technique of precise iris positioning in prosthetic by using the existing AI software, i.e., "Instagram application" which is easy to use and easily accessible.

## Technique

A 10-year-old boy reported in the February 2024 to the Department of Prosthodontics, Sharad Pawar Dental College of Wardha district of Maharashtra, India, with the chief complaint of missing right eye since 3 months. Medical history revealed a stick injury to his right eye 6 years back while playing lead to damage of optic nerve resulted in loss of vision followed by enucleation 3 months back. Examining the eyelids revealed that the tissue bed was in good condition as shown in Figure 1 and that there was sufficient depth between the upper and lower eyelids to support a patient-specific ocular prosthesis. No other relevant medical history was found. No gross facial asymmetry was noted. Following a thorough discussion with the patient's parent and gaining insight into his esthetic and functional requirements, the decision was made to plan for the fabrication of an ocular prosthesis. An informed consent was taken from the patient's parent before starting the treatment.

Irreversible hydrocolloid impression material was used to create a preliminary impression, which was then put into type III gypsum (Kalabai). Clear acrylic was used to create a special tray on primary cast. Light body polyvinyl siloxane material (Zhermack) was used to create the final impression, and type IV gypsum (Kalabai) was used to pour the final cast. An iris shell space was carved into a wax design, and a stock iris shell that matched the contralateral eye was selected. An iris shell space was carved into a wax design (Modeling Wax No. 4), and a stock iris shell that matched the contralateral eye was selected.

**Fig. 3:** Augmented reality applied for iris positioning

Patient was instructed to sit up straight once the wax pattern was placed. On a smartphone (Samsung S 22), the Instagram app (Instagram from Meta) was opened, and the screen scrolled to the right to position the iris. To access the AR filters in story mode, swipe the screen left after selecting "browse effects" as shown in Figure 2A. The "browse effect" symbol was selected in order to search the filter. "Perfect face ratio" was entered into the search bar, and the Instagram user greenvali's filter was selected (Fig. 2B). The camera was positioned to record the patient's whole face with the focus point in the middle of the screen, and the patient was told to focus on a distant object. A symmetrical pattern of lines was digitally projected onto his face by the AR filter as it began loading, utilizing facial landmarks for precise mapping. These proportionate lines provided a visual reference to precisely position the iris button, guaranteeing alignment with the contralateral eye's orientation as seen in Figure 3. The filter facilitated the observation and confirmation of the iris shell's position in three dimensions,

**Fig. 4:** Postoperative view of rehabilitated right ocular defect using AR-guided tool

allowing for viewing from various angles. Subsequently, the photos were stored in the gallery for later consultation.

Both fit and esthetics of the wax trial prosthesis were evaluated and approved from the patient. Shade matching was completed in natural light, and then the traditional methods of flaking, dewaxing, and curing were carried out using heat-cured clear acrylic resin (DPI heat cure resin). And after finishing and polishing, the prosthesis was inserted in patients' eye (Fig. 4). The patient was satisfied and happy with the final outcome of the prosthesis, as it was enhancing his quality of life and appearance by addressing both functional and esthetic aspects. Patient was guided about the pattern of wearing and removing of the prosthesis. Post-insertion instructions in care of prosthesis were explained to the patient. He was advised to keep the prosthesis clean with mild soap and water, patient was asked to rinse the prosthesis thoroughly and to remove any soap residue before reinserting it. Along with that lubricants (Carboxymethyl cellulose sodium 3%) were prescribed to the patient to keep the prosthesis as well as eye socket moist to avoid the dryness or discomfort and he was also scheduled for first follow-up appointment within 24 hours to evaluate the fitting and addressed any discomfort or issues. After that, appointments were scheduled for 1, 3, and 6 months, respectively.

## Discussion

Surgical treatment might be necessary for conditions present since birth, unforeseen injuries, or illnesses that could necessitate the enucleation of the eye.[14] Since the prehistoric era, mankind has been able to fabricate prosthetic eyes.[15] A prosthodontist's difficult job is to rehabilitate individuals who have an eye deformity.[16] Iris positioning stands as the most critical stage in the fabrication of a patient-specific ocular prosthesis.[17]

Various techniques have been documented for assessing iris position in the fabrication of ocular prostheses. Among these, traditional methods such as the plastic strip template have been widely used for their simplicity and effectiveness in evaluating iris placement.[7] Additionally, tools like Boley's gauge, millimeter ruler, and pupillometer offer precise measurements of iris dimensions and alignment.[9,10] However, subjective methods such as visual assessment and window light examination have also been employed, although they may lack objectivity and consistency.[6] The transparent graph grid method provides a structured approach to determining iris position, offering visual guidance for prosthodontists.[18]

Furthermore, modern approaches leveraging digital photography and three-dimensional (3D) facial modeling have emerged as innovative solutions, offering enhanced accuracy and efficiency in assessing iris position and overall prosthetic fit, but limitations of this technique are, they are very expensive, technique sensitive, time-consuming, and need assistance.[8] So to overcome this limitation, there is a need for a user-friendly, portable, non-technique sensitive, reliable, instant and inexpensive method that can be used in small clinical setups.

The AI technology can and should be used in healthcare to improve treatment outcomes. Presently, AI is being used in dentistry in the field of imaging, periodontology, cariology, and AI-assisted maxillofacial surgeries. The AR stands as a transformative technology that seamlessly blends virtual information with the real world through sophisticated 3D modeling and real-time tracking capabilities. Recent advancements in social networking sites and quick delivery messaging platforms, notably Instagram by Meta Platforms and Snapchat by Snap Inc., have propelled the evolution of AR applications. Leveraging AR filters, these platforms have introduced immersive experiences that overlay digital content onto users' surroundings in real-time.[19]

In order to facilitate fiber post removal in maxillary molars, Martinho et al., assessed the viability of an AR head-mounted device (HMD) that showed a dynamic navigation system (DNS) at the surgical site and compared it with the DNS technique. They found that the AR HMD can safely display DNS in the surgical site for fiber post-removal in maxillary molars.[20] Jiang et al. aimed to assess the viability of a 3D AR navigation approach that combined virtual images with the actual environment for dental implants through the use of a 3D image overlay.[21] The method used point cloud-based image-patient registration. They found that compared with the conventional 2D image navigation approach, dental implant insertion guided by the suggested 3D AR navigation system demonstrated higher efficiency, better accuracy, and greater application.

Wang et al. describes a study of a workable marker-less image registration technique for AR-guided oral and maxillofacial surgery, which created a virtual setting and combines it with the actual world to guide surgery or provide visibility of surgical outcomes through a see-through overlay of a video.[22] Touati et al. did a smile design using AR and found esthetic results.[23] Nimonkar et al. used AR in shade selection of maxillofacial silicon through mobile phone colorimeter app and found it to be as reliable source of shade selection.[2]

In prosthodontics, AR is heavily utilized in implantology, CAD-CAM restorations, and esthetic planning. It helps with restoration design and precisely mills a restoration that provides excellent function and esthetics.[23] This article has achieved a goal of using AR in craniofacial prostheses as till date there is no documented technique or case report on use of AR in any clinical step assistances of maxillofacial prosthesis.

In the current technique, no specialized appliance, equipment, or software system was employed, only commonly accessible mobile phones with a strong internet source and the Instagram app were used. While using this technique it should be noted by the operator that the filters will not allow the alterations of mapped lines that will not allow any kind of technical bias in the procedure.

The novelty of this method is, it allows 3D visualization of the determined position of iris, simple and affordable and which does not require any specific equipment or software program.

## Conclusion

The success of ocular prostheses is largely dependent on the proper alignment of the iris. The core component of esthetics is symmetry, and an ocular prosthesis is not different. Notably, it offers enhanced visualization of the final outcome. Present technique has explored utility of AR filters which is a user friendly and trendy application of AI for iris positioning in a prosthetic eye. We found high compliances from patients toward the final outcome of the prosthesis fabricated using these AR filters. However, further research is warranted to ascertain its universal applicability.

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