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A NEWLY CUSTOM MADE DIGITALLY PRINTED IMAGE -EYEGLASSES FOR UNILATERAL ORBITAL DEFECT (DENTAL TECHNIQUE)

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ABSTRACT

INTRODUCTION: Unilateral orbital defects can result from various conditions, including trauma, congenital anomalies, or surgical resections due to tumors. These defects can severely impact an individual's physical appearance, psychological well-being, and social interactions. Patients often report feelings of self-consciousness, anxiety, and reduced quality of life due to the visible nature of these defects.

There have been several techniques to restore orbital defects either surgical, prosthetically or combination between them. While definitive prostheses are the gold standard for rehabilitation, a significant number of patients cannot receive them due to medical contraindications, financial constraints, or personal choices.

AIM OF STUDY: The current approach seeks to improve social interaction and quality of life for patients with unilateral orbital defects. It can be used as an alternative for patients who are unable to receive a conventional orbital prosthesis or as a temporary option until a permanent prothesis is received.

METHODS: This study presents a newly designed captivating 2D High-Definition printed image that is attached to a customized lens that has been attached to a customized 3D-printed eyeglass created by replicating the unaltered eye using the mirror image technique. Using state-of-the-art digital technologies.

CONCLUSIONS: For patients with unilateral orbital abnormalities, the novel technique described in this study provides a flexible means of enhancing social engagement and quality of life. It offers an alternative to traditional prosthetic rehabilitation by utilizing cutting-edge digital technologies, and it may be customized to meet the needs of each patient to function as a temporary or permanent solution.

Clinical Significance: For individuals who are unable to tolerate or accept a conventional orbital prosthesis, this approach can be used as an alternative. It can also be used as a stopgap measure until a long-term prosthesis becomes available. And it can improve social interaction and quality of life by using of a 3D-printed eyeglass frame and a personalized 2D high-definition printed image affixed to a lens.

KEYWORDS: Anaplastology, orbital defects, eye-glass, 3D scan, 2D image

RUNNING TITTLE: A newly custom made digitally printed image -eyeglasses for unilateral orbital defect

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INTRODUCTION

The eye is crucial for facial expression and vision. [1] Annually, around 50,000 people lose an eye. [2] When a facial feature, especially an eye, is missing, patients can face significant physical, psychological, and emotional challenges. [3,4] Restoring an eye with a prosthetic requires a team effort involving a surgeon, prosthetist, and ophthalmologist. [5]

Rehabilitating these individuals is a complex process that demands substantial time and effort. Silicone prosthetics may not be an option for patients with high risk of cancer recurrence or undergoing radiation/chemotherapy. [6] Other limitations like lack of functional undercuts or medical conditions can also make conventional silicone prostheses unsuitable. For young patients, using implant-retained, adhesive, or frame-supported silicone prostheses has limitations.[7,8] Patients may not cooperate with follow-ups and modifications. Adhesive-retained prostheses are expensive, require dexterity, and can cause pigmentation issues or allergic reactions. [9,10] Achieving natural intrinsic and extrinsic pigmentation of prosthetics is also difficult, especially given weathering conditions. Overall, orbital rehabilitation involves complex considerations for each patient. [11]Recent studies have explored digital techniques for fabricating maxillofacial prosthetics.[12,13] Integrating AI and 3D printing allows for rapid, cost-effective, and aesthetically pleasing custom facial prostheses. The current study developed an efficient, fully digital workflow for creating orbital prostheses, minimizing construction time and maintaining detailed patient data. [12] Using 3D scanning, [14] this method enables the creation of custom-fitted eyeglass frames that improve comfort and functionality - an important advancement in eyewear technology. [15,16]

This method not only enhances the orbital prosthetic spectacle frame's overall appeal, but it also gives patients a sense of confidence and normalcy. To get beyond the limitation of silicone orbital prostheses, this technique details a novel development in the digital manufacturing of newly custom-made designed orbital prosthesis.

TECHNIQUE

A 36-year-old male patient with a unilateral orbital defect that was surgically enucleated was seeking for a prosthetic treatment. (Fig. 1). The patient was instructed to wear an eye patch or sunglasses due to the inability of prosthetic construction and his refusal to undergo any corrective implant surgery to receive ocular prosthesis. A written consent was obtained from the patient after a thorough explanation of the treatment options and the advantages and limitations of the current technique. Ethical approval was granted (IORG0008839) and written consent was ascertained for the utilization of facial images and data for research and publication. This technique was performed in 3 different phases:

A. Fabrication of 3D custom-made eyeglass frame.

Wash the patient’s face with Cleanser (CeraVe Hydrating) with gentle massaging of the skin in a circular motion followed by warm water to ensure proper facial cleaning. Then dry the face using a dry towel. Measure the dimensions of the patient's eye socket and surrounding facial structures using a digital caliper (Westport Corporation, NY.).

Seat the patient in an upright position and adjust the light system to capture a high-quality 3D scan of the patient's full head and face for both the affected and unaffected eye. Provide enough lighting, with an average from 500 to 1000 lux which is being conducted using the luximeter mobile app (myLightMeter pro-iOS. Scan the patient's full head and face to obtain a 3D model using the extraoral scanner (EINSTAR, Shining 3D).

Use SOLIDWORK 2023 software computer-aided design (CAD) to create a 3D model of a customized eyeglass frame, incorporating features like lateral camouflaging wings and compatibility with the patient's lens requirements (Fig. 2A, Fig. 2B, Fig. 2C). Convert the 3D eyeglass frame model to a stereolithography (STL) file format and print it using selective laser sintering 3D printing technology (Fuse 1+ 30W formlab) after checking the adaptation of eyeglasses frame on head scan using EXOCAD software (DentalCAD 3.2 Elefsina).

Try the generated 3D eyeglasses frame on the patient after Finishing (Fig. 3A, Fig. 3B, Fig. 3C, Fig. 5D) and connecting the components using tightening screws (Fig. 3E, Fig. 3F) and make necessary modifications to ensure a precise comfortable fit of printed eyeglasses.

B. A 2D Image production.

Seat the patient in an upright position while wearing the 3D-printed custom-made eyeglass frame. (Fig. 4). Capture high-quality photographs of the patient's unaffected eye from various angles under the same natural lighting conditions using (a Canon EOS 800D camera with a Sigma 85mm f/1.4 DG HSM lens).

Extract carefully the unaffected eye from the reference image using selection tools in Adobe Photoshop 2023 (version 24.6.0), Apply a mirroring technique to obtain a reverse image of the healthy eye, and position and resize it to fit the empty eye socket area. Blend the edges of the image with the surrounding skin using Photoshop tools to create seamless integration. Adjust the color, brightness, and contrast of the prosthetic eye to match the reference image, accounting for details like reflections and shadows. And ensure the final image resolution is 300 DPI, which is recommended for high-quality printing.

Insert the prosthetic eye image into a transparent paper shield, place it on the image holder of the eyeglass frame's paper-bearing lens, and vacuum seal it. Choose a semi-transparent, darker-shaded lens for the unaffected orbit based on the patient's visual assessment (Fig. 5A, Fig. 5B).

Insertion and evaluation of the patient quality-of-life using a by using SF-12 and GAD-7 questionnaires. [15] (Fig. 6).

Figure 1. Patient with ocular defect.

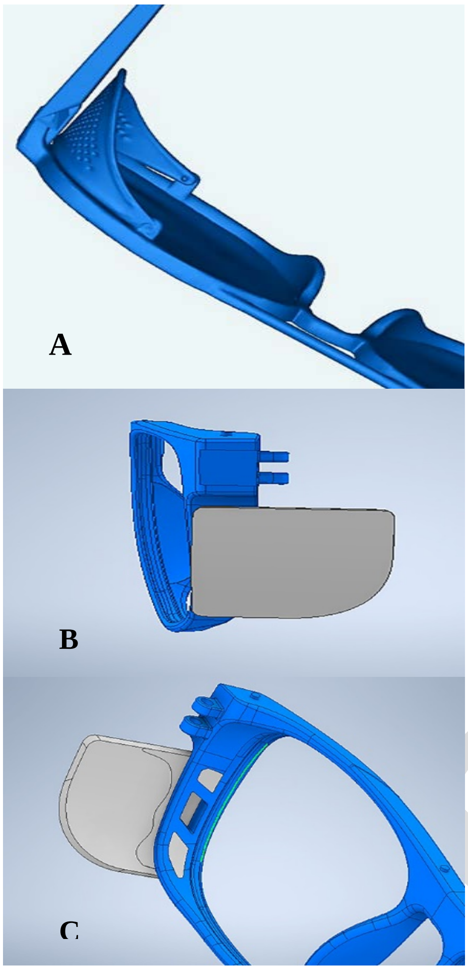

Figure 2. Fabrication of Camouflaging part of eyeglasses frame. A, Screwing concept. B, Snap-fit concept external view. C, Snap-fit concept internal view.

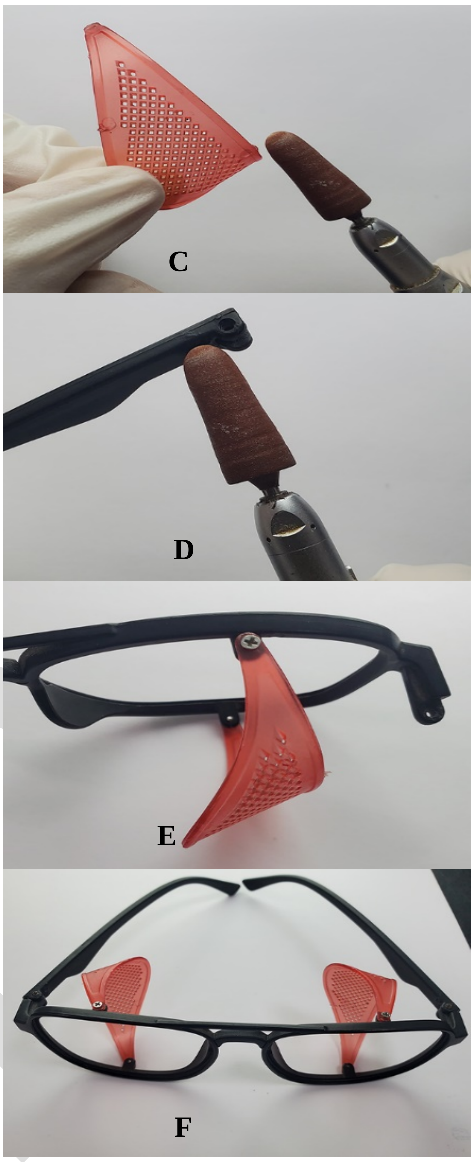

Figure 3. Fabrication and try in of eyeglasses frame. A, All parts of eyeglasses frame after printing. B, Finishing of lens rim holder of eyeglasses frame. C, Finishing of camouflaging screwing wing of eyeglasses frame. D, Finishing of temples part of eyeglasses frame. E, Screwing of camouflaging wing. F, Screwing of temples.

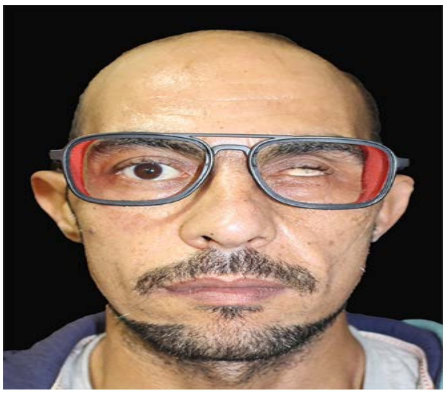

Figure 4. Spectacle frame try in.

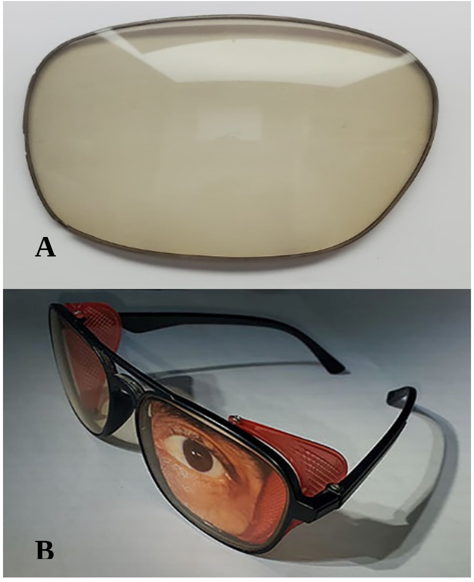

Figure 5. Fabrication of prosthetic eyeglasses A, the brown lens serves as an optical filter to modulate the spectral composition of incident light. B, prosthetic eyeglasses.

Figure 6. Insertion of the final prosthesis.

DISCUSSION

The current technique implements a fully digital customized workflow to all candidates who failed or were not considered candidates for prosthetic rehabilitation due to radiotherapy or immediate post-surgical. Moreover, young patients who refuse to wear their orbital prostheses due to loss of retention or psychological impairment as well as patients with ocular space contraction or being prepared to undergo a massive ocular or orbital removal can use the eyeglass framework as a transitional phase before constructing an ocular or orbital protheses.[13,14]

On assessing the patient's satisfaction by using SF-12 and GAD-7 questionnaires,[15] a significant enhancement of self-esteem allowed him to engage back in the social community and enhance his to be able to communicate. This method combines 3D scanning, 3D printing, and image fabrication which avoids the discomfort and potential inaccuracies of traditional impressions to register the defected eye. Additionally, this approach reduces hazardous waste from impression materials and eliminates the risk of excessive pressure on the ophthalmic tissues and dimensional changes associated with conventional impression techniques.[16]

The prototype-designed eyeglasses frame exhibits the ability to be resized according to the dimensional specifications to well fitment to each patient well. Additionally, the technique allows data preservation for the scans that enables duplication in case of loss or damage. This technique has some limitations including being technique-sensitive required to deal with different 3D design programs to manufacture suitable custom-made eyeglasses and proper handling of eyeglasses during their use.

SUMMARY

The current technique emphasizes the importance of prosthetic rehabilitation to restore both quality of life and social interaction. However, it does not exclude the importance of using prosthetic silicone rehabilitation for unilateral orbital defects however it presents an alternative definitive option for those patients with clinical or medical contraindications of using prosthetic rehabilitation. It also serves as a temporary option for clinical cases; young, adult, and geriatric immediately post-surgical. In addition to that, patients undergo either radiotherapy or chemotherapy.

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