CASE STUDY

CONTENTS

# Orbital floor reconstruction based on 3d printed model – case report

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## ABSTRACT

Orbital fractures, constituting 10-25% of facial traumas, result from diverse mechanisms such as traffic accidents and assaults. These fractures present with characteristic symptoms like edema, diplopia, and infraorbital paraesthesia. Timely diagnosis and surgical intervention are paramount to mitigate long-term complications. Recent advancements in materials science and surgical methodologies have ushered in innovative approaches including 3D printing and computer-aided design implants. This article details a case study of successful reconstructive orbital surgery in a patient following a traumatic incident where a car accident caused extensive facial fractures. Leveraging 3D printing technology, a precisely tailored titanium mesh aided in the meticulous restoration of the orbital floor. During surgery, entrapped soft tissues were released, and the zygomatic-maxillary complex was carefully repositioned. Postoperative evaluation revealed promising outcomes, affirming the efficacy of contemporary surgical strategies. This case highlights the evolving role of 3D printing in enhancing the accuracy, cost-effectiveness, and accessibility of orbital reconstruction procedures, demonstrating its potential for broader clinical applications.

**KEY WORDS:** trauma, 3d print, orbital floor reconstrution

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## INTRODUCTION

Orbital fractures occur through various mechanisms and account for 10-25% of facial fractures [1]. They most commonly result from traffic accidents and assaults [2]. The fracture patterns are stereotypical with predictable short, medium, and long-term symptoms such as edema, infraorbital paraesthesia, blurred vision, subconjunctival hemorrhage, diplopia, orbital dystopia, and enophthalmos [3, 4]. All of these can be minimized by rapid diagnosis and anatomical repair. An early aggressive surgical approach within 14 days is recommended and is more effective than secondary reconstructive procedures [5]. The development of materials science and surgical techniques has led to innovations such as prefabricated titanium mesh, computer-aided design implants, 3D printing, and surgical navigation [6, 7]. The origins of reconstructive orbital surgery date back to the late 19th century when reconstructions were performed using steel wires and antral bone grafts [8]. Since the 1950s, alloplastic materials and bone substitutes have been used [9]. Despite the advances in reconstructive techniques, the goal of treatment has remained the same: to restore the bony walls of the orbit, as well as function and aesthetics. Currently used materials include autogenous materials that are biocompatible, reliable, and cheap but offer limited shaping ability and are associated with donor site morbidity [4]. Allogenic materials are osteoconductive but carry the risk of severe disease transmission [10]. Alloplastic materials allow for the most precise implant design but always carry the risk associated with a permanent foreign body [11]. The disadvantage of resorbable alloplastic materials is that once resorption occurs, the orbital tissues, deprived of support, may tend to collapse [12].

## AIM

This article details a case study of successful reconstructive orbital surgery in a patient following a traumatic incident where a car accident caused extensive facial fractures.

## CASE REPORT

On April 4, 2023, shortly after midnight, a patient was hit by a car while crossing the street. Initially transported to the Emergency Department of the Hospital in Dąbrowa Górnicza with head injuries, a CT scan revealed a right subdural and epidural hematoma

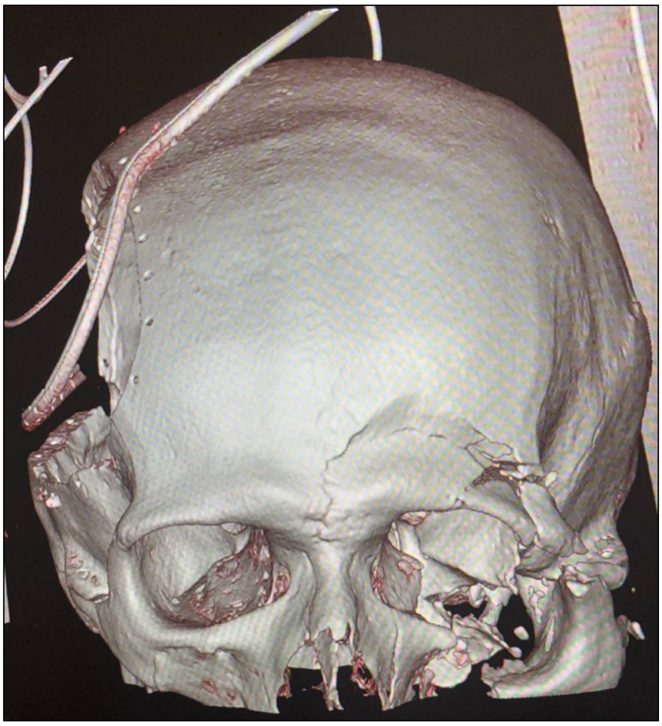

**Fig. 1.** CT scan before reconstruction.

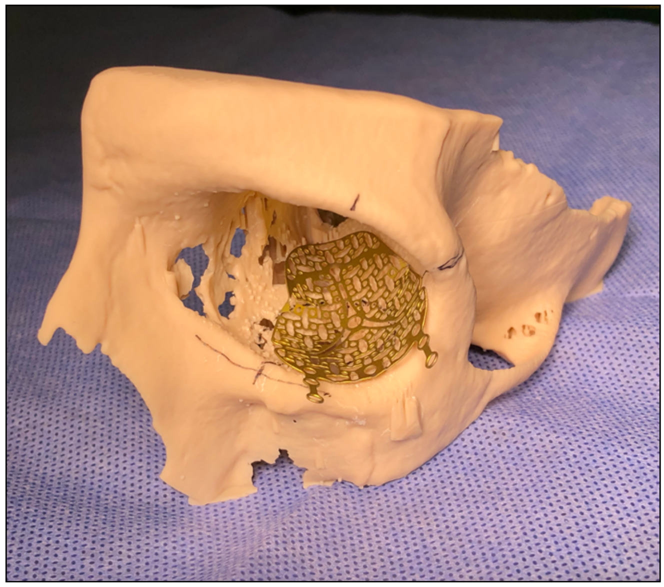

**Fig. 2.** 3d printed mirror image of the left orbit with shaped titanium mesh.

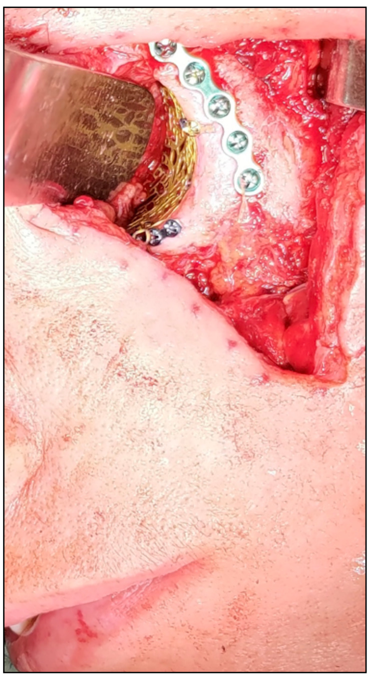

**Fig. 3.** Reconstructed orbital contour, intraoperative view.

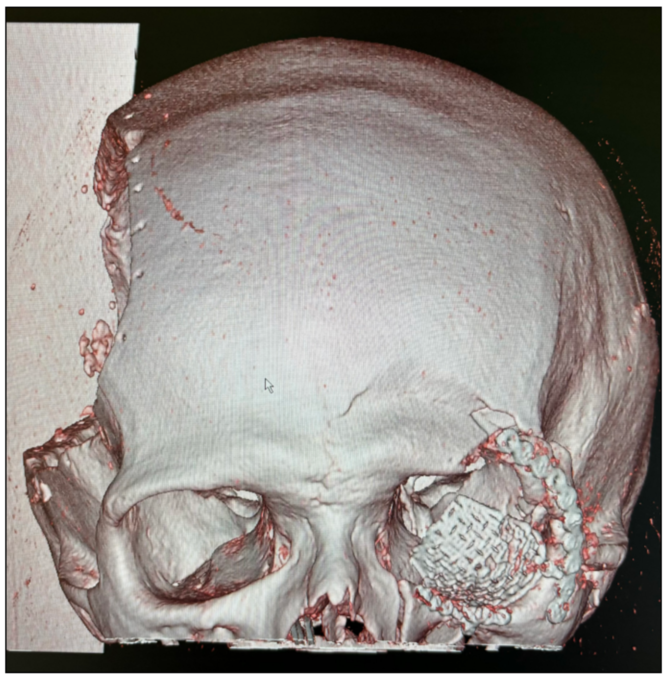

**Fig. 4.** CT scan after the reconstruction.

along with multiple facial fractures (Fig. 1). After initial wound management, the patient was transferred to Provincial Specialist Hospital No. 5 in Sosnowiec where a frontal-temporal-parietal craniotomy was performed 3 hours after the accident. Mechanically ventilated and pharmacologically sedated, the patient was admitted to the Department of Anesthesiology and Intensive Care, where on the 12th day, empirical antibiotic therapy with ceftriaxone 3x2 g was initiated. Additionally, edema treatment with mannitol 5x100 mg and hemostatic therapy using tranexamic acid 3x1 g were started. Based on follow-up brain CT scans and neurosurgical recommendations, anti-edema treatment was gradually reduced. 10 days after the injury, the patient, in stable general condition, sedated, mechanically ventilated, and with efficient circulatory and respiratory systems, was transported to the Maxillofacial Surgery operating room for the repositioning and osteosynthesis of the right zygomatic-maxillary-orbital fracture. A mirror image of the left orbit, printed based on the CT scan, was prepared for the surgery. The model was used as a template to shape the titanium reconstruction mesh to restore the destroyed floor of the left orbit (Fig. 2). From an expanded approach in the traumatic wound, access to the orbital floor was gained. After releasing the entrapped soft tissues protruding into the maxillary sinus, the orbital floor was reconstructed using a titanium mesh shaped on the model. Subsequently, the zygomatic-maxillary complex was repositioned, the bony contour of the orbit was restored, and the fragments were fixed with two titanium plates (Fig. 3). The patient was transferred back to the Department of Anesthesiology and Intensive Care, where edema treatment with dexamethasone 3x4 mg was administered and a follow-up examination confirmed the reconstruction of the original shape of the orbit (Fig. 4). In the 12th day, antithrombotic treatment with dalteparin 5000 units were initiated. On the 13th day, due to the appearance of fever and increased inflammatory parameters, targeted antibiotic therapy with meropenem 3x1g and vancomycin 4x500 mg was started. The patient was extubated and weaned off the ventilator on the 16th day with inflammatory parameters decreasing. On the 21 day after the injury, she was transferred to the Department of Neurosurgery. The patient was in simple logical contact, with no signs of enophthalmos or impaired eye movement.

## DISCUSSION

The advancement of medicine undoubtedly aims to optimize procedures to achieve the best postoperative results and patient satisfaction. One of the factors influencing positive outcomes in orbital reconstruction procedures, based on 3D printing and subsequent shaping of a titanium mesh on a model printed as the mirrored reflection of the healthy orbit, is undoubtedly the precision and individualization of this approach. Research by Hahn et al. has demonstrated the effectiveness of using "mirroring" in reconstructing orbital wall fractures, as there is no significant difference in the size of patients' orbits. Hahn et al. proved that using "mirroring" in the reconstruction of orbital wall fractures is a precise technique because there is no significant difference in the size of patients' orbits [14]. Reconstructive technologies are constantly evolving, as restoring function and appearance remains a paramount goal in trauma surgery. The most technologically advanced method of orbital reconstruction is patient-specific implants (PSI), designed individually for each patient in a computer program and then custom-made. A meta-analysis conducted by Sanjeev et al. showed that despite the tendency to favor PSI, no statistically significant differences were found compared to conventional methods in terms of postoperative outcomes [15]. Scientific literature focused on reconstructions of the maxillofacial area also agrees that the duration of surgical procedures is a significant factor affecting postoperative recovery time, and the restoration of function depends on the duration of the surgery. The study by Kallaverja et al. conducted research demonstrating greater accuracy and significantly shorter procedure times in orbital floor reconstruction using a preformed titanium mesh based on a stereolithographic model produced with 3D printers compared to intraoperatively shaped titanium mesh [13].

## CONCLUSIONS

Although the patient's neurological deficits do not allow for a full assessment of the restoration of all functions, the examination and analysis of CT documentation indicate that the goals of the reconstructive surgery were achieved. 3D print is becoming an increasingly cost effective and accessible method that allows for more precise and predictable orbital reconstruction procedures.

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## CONFLICT OF INTEREST

The Authors declare no conflict of interest

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