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Case Report

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Large Temporoparietal Cranioplasty by Customized Prosthesis: A Case Report

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ABSTRACT

A 15-year-old male presented at a neurosurgeon's office following a traffic accident. A CT scan revealed bone deficiency in the temporoparietal area. The surgical solution involved implanting a 3D-printed prosthesis into the skull. Axial 3D created the model using stereolithography 3D printing technology with Poly Methyl Methacrylate (PMMA). The use of 3D printing as a surgical aid is gaining popularity. Our experience with the presurgical model demonstrates its utility in individualized surgical planning for skull defects.

Introduction

This case report details the innovative application of Axial 3D printing technology in Iran, specifically focusing on its role in facilitating surgical decision-making in the temporoparietal area. The integration of a 3D-printed skull model significantly informed our choice of intervention, demonstrating how 3D printing is increasingly valuable as a surgical aid. This technology not only enhances preoperative planning but also serves as an effective teaching tool for medical professionals, allowing for a better understanding and visualization of complex anatomical structures.

Moreover, while traditional solutions such as titanium mesh are often deemed unsuitable for large cranial defects, the 3D printing of skull bone substitutes offers a precise match to the patient's unique anatomy, thereby improving surgical outcomes. Customized 3D-printed prostheses yield better clinical and aesthetic results than conventional methods, aligning with the principles established by the SCARE 2020 criteria [1]. This report underscores the transformative potential of 3D printing in surgical practice, highlighting its ability to enhance both educational and clinical outcomes in complex cranial surgery.

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Case Presentation

A 15-year-old Iranian male presented to a neurosurgeon outpatient clinic with an aesthetic complaint related to his temporoparietal area. Notably, he was a non-smoker and had no significant past medical history, family history, or regular medications. The damage to his temporoparietal area resulted from a traffic accident that occurred 10 months ago, leading to the removal of parts of the affected region (Figure 2). Computed tomography (CT) imaging confirmed the extent of the damage.

The patient was subsequently referred to a neurosurgeon specialist for surgical planning. During the consultation, the surgical option discussed with the patient involved the implantation of a 3D-printed skull prosthesis. Axial 3D utilized stereolithography 3D printing technology with PMMA to create a patient-specific 3D skull model. The skull was meticulously designed in a 1:1 scale, considering shape and edges, to minimize complications during surgery.

The estimated cost for this customized 3D-printed skull model would be £800.

The patient's brain had no protection, and as shown, the scalp was in contact with the brain (Figure 1). In this situation, the surgery was performed using a customized PMMA implant. Implant fixation was done by the use of titanium screws and mesh by a consultant neurosurgeon in a District General Hospital, without complication. The patient recovered well and was discharged the following day. There were no precautions or considerations regarding the prosthesis after surgery.

When the patient was followed up in the clinic 2 months after his operation, there was residual inflammation from surgery. He was reviewed again 6 months after his operation. The patient was pleased with his management and grateful for the less invasive approach (Figure 3).

Discussion

The use of 3D-printed models has gained popularity as a valuable aid in surgical planning. In our case, the 3D-printed skull provided clear visualization of the relationship to surrounding anatomy, particularly highlighting the absence of the temporoparietal area. This clarity informed the decision to pursue less invasive surgery, ultimately providing confidence for a more conservative approach. Both the patient and surgeon expressed satisfaction with the surgical outcome [2].

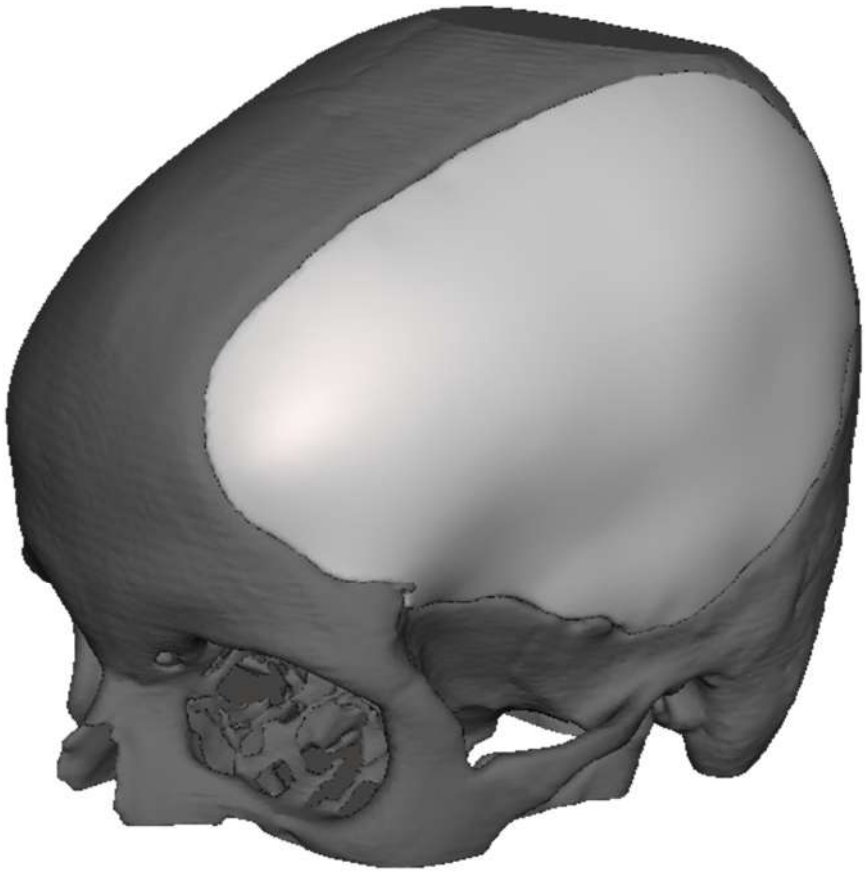

Fig. 1. Frontal view of 3D skull

Fig. 2. Patient 10 months after accident

Fig. 3. Patient after surgery

The patient benefited significantly from the less invasive surgery, resulting in reduced potential for complications and minimized post-operative scarring or deformity. Additionally, the hospital experienced improved efficiency. The less invasive approach reduced operating theater time, allowing for more cases to be performed on the same day [3]. Patient-specific 3D-printed models serve as valuable tools for both surgical practice and education. Given the wide array of software options, printing technologies, and materials available, clinical teams should consider investing in a 3D printer tailored to their specific application [4]. While the 3D-printed skull incurred an £800 cost, the overall financial benefits justified its use.

Conclusion

The increasing popularity of 3D printing as a surgical aid is evident. In this specific case, the use of a 3D-printed prosthesis proved valuable for patient-specific implants in cranioplasty. Notably, it facilitated less invasive procedures, leading to shorter patient surgery times. Additionally, the organization benefited from reduced resource requirements. Once its primary purpose is fulfilled, the 3D skull can serve as a teaching tool. We recommend conducting a case series to explore 3D printing's broader applications within the field of cranioplasty.

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Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this article.

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Conflict of Interests

The authors have no conflict of interest to declare.

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