

**Review Article***Copyright © All rights are reserved by Kristian Bugeja*

# The Evolution of Zygomatic Reconstruction: Comparing Zygomatic Osteotomy and Patient-Specific Implants

**Kristian Bugeja<sup>1\*</sup>, David Borg<sup>2</sup> and Claudia Debono<sup>3</sup>***MSc Craniofacial Trauma Reconstruction, Queen Mary University, London***\*Corresponding author:** MSc Craniofacial Trauma Reconstruction, Queen Mary University, London**Received Date:** August 12, 2024**Published Date:** August 20, 2024**Abstract**

This review examines the evolving approaches to zygomatic reconstruction, particularly comparing traditional zygomatic osteotomy techniques with modern patient-specific implants (PSIs). The secondary reconstruction of the zygomatic bone presents unique challenges that diverge significantly from acute settings, involving not only skeletal correction but also meticulous modification of the soft tissue envelope to achieve optimal aesthetic and functional outcomes. PSIs, customized based on detailed imaging and digital planning, offer a less invasive and more precise alternative to traditional techniques, potentially marking a significant shift in reconstructive surgery.

**Introduction**

The secondary reconstruction of the zygomatic bone presents a set of complex challenges that diverge significantly from those encountered in acute trauma settings. Unlike initial reconstructions, where the primary goal is to restore structural integrity, secondary reconstructions must navigate a more nuanced landscape. This process requires not only the correction of existing skeletal deformities but also a meticulous reconfiguration of the surrounding soft tissues, which is crucial for achieving both optimal aesthetic and functional outcomes. The success of zygomatic osteotomy, in particular, hinges on the precise manipulation of key articulations, including the frontal and posterior aspects of the maxillary buttress, the temporal articulation, and the posterior

component of the zygomatic process of the temporal bone. These articulations must be handled with great care to ensure the stability and correct positioning of the zygomatic bone.

**Zygomatic Osteotomy: Complexities and Challenges**

Zygomatic osteotomy is a highly specialized and technically demanding surgical procedure, requiring extensive surgical exposure that inherently carries significant risks. Among these risks are potential damage to the facial nerve, which can lead to partial facial paralysis, and the possibility of blindness if the optic nerve is compromised during surgery. The broad and robust nature of the zygomatic bone presents additional challenges, necessitating extremely precise bone cuts. These cuts must ensure that the medial

wall is positioned accurately, preventing complications related to muscle attachments and soft tissue discrepancies, which can affect both the function and appearance of the face.

One of the most critical aspects of zygomatic osteotomy is managing patient expectations and securing informed consent. Patients must be made aware that the soft tissues surrounding the zygomatic bone may not immediately adapt to the new bone positioning. The remodeling process can take time, and there may be a period where the final aesthetic outcome is not yet fully realized. The surgeon must also take into account the significant role that soft tissues play in the success of the procedure. Key structures, including the cheek ligaments, orbital, zygomatic, and buccal tissues, must be carefully detached and resupported during the surgery to maintain their functional and aesthetic roles. Additionally, the fat pads, both superficial and deep, are crucial in maintaining the soft tissue contour. Strategies such as fat grafting are often employed to address volume loss, which is a common issue post-surgery. The temporal fat pad, in particular, is highly susceptible to damage during surgery and may require augmentation to restore its volume and support.

Despite its effectiveness in certain clinical scenarios, zygomatic osteotomy has limitations, especially in the context of secondary reconstruction, where malunions and other complications may be present. The procedure is most effective for lateral reconstructions, where the zygoma can be repositioned to recreate the natural contour of the face. However, medial reconstructions are more challenging due to the complexity of the anatomy and the proximity of critical structures, such as the lacrimal apparatus, which is responsible for tear production and drainage. In such cases, alternative methods, such as prosthetic onlays or other reconstructive techniques, may offer a safer and more effective solution.

### Patient-Specific Implants: A Modern Approach

The advent of patient-specific implants (PSIs) has introduced a transformative approach to zygomatic reconstruction, offering a compelling alternative to the traditional osteotomy. PSIs are custom-designed implants that are meticulously tailored to fit the unique anatomical contours of each patient's bone structure. This customization is achieved through advanced imaging techniques and digital planning tools that allow for the precise replication of the patient's anatomy. The use of PSIs reduces the need for extensive surgical exposure, which in turn minimizes the associated risks, such as nerve damage and infection. This is particularly advantageous in complex cases where the zygomatic bone has been severely comminuted, making traditional bone manipulation insufficient for achieving a satisfactory result.

The design and implementation of PSIs are guided by a comprehensive understanding of the patient's specific anatomical needs. Detailed imaging, such as CT scans, is used to create a three-dimensional model of the patient's bone structure. This model is then used to design an implant that precisely matches the patient's anatomy, ensuring a perfect fit and optimal aesthetic and functional outcomes. The precision offered by PSIs not only enhances the

surgical outcome but also reduces the overall operative time, as the implant fits seamlessly without the need for extensive intraoperative adjustments.

### Assessment and Planning

Thorough assessment and meticulous planning are paramount to the success of zygomatic reconstruction, whether employing traditional osteotomy techniques or modern PSIs. The planning process must take into account a range of factors, including the patient's aesthetic and functional goals, the extent of bone displacement, and the condition of the surrounding soft tissues. A comprehensive medical history, including details of the initial injury and any previous treatments, is essential for understanding the patient's current condition and planning the appropriate course of action for secondary intervention.

During the assessment phase, it is crucial to document any symptoms the patient may be experiencing, such as changes in visual acuity, double vision, altered sensation, or facial asymmetry. These symptoms can provide important clues about the severity of the injury and the areas that may require focused attention during reconstruction. The physical examination should include a detailed evaluation of facial symmetry, cheek prominence, eye position, and jaw movement. Accurate positioning of the patient during the examination is essential to reveal the true ocular position and to measure the zygomatic prominences precisely. This information is critical for planning the surgical approach and for ensuring that the reconstructed zygomatic bone will restore both form and function.

CT imaging plays a crucial role in the planning process, providing detailed insights into the patient's bone structure and the extent of the deformity. It allows the surgeon to visualize the precise contours of the bone and to plan the placement of PSIs or the bone cuts needed for osteotomy. Reviewing previous imaging, including acute and postoperative scans, is also important for understanding the progression of the injury and identifying areas that may require further intervention.

### Techniques and Materials

A wide array of techniques and materials is available for the reconstruction of the zygomatic bone, each offering distinct advantages and considerations. Traditional bone grafts have long been used in reconstructive surgery, offering the benefit of using the patient's own bone tissue to achieve a natural repair. However, bone grafts carry risks, including donor site morbidity and the potential for unpredictable resorption, where the grafted bone is reabsorbed by the body over time, leading to a loss of structural integrity.

Off-the-shelf implants, such as those made from Medpor, offer a stable and porous structure that encourages tissue ingrowth, providing a secure foundation for soft tissue and bone integration. However, these implants may not always provide the precise fit needed for complex reconstructions, particularly in cases where the bone structure has been significantly altered by trauma. Custom-made implants, designed using advanced imaging and

rapid prototyping technologies, offer the highest level of precision and are increasingly becoming the gold standard in zygomatic reconstruction.

The materials used for PSIs are selected based on the specific needs of the patient and the nature of the deformity. High-density polyethylene (Medpor) is favored for its stability and tissue integration properties, making it a reliable choice for many reconstructions. PEEK and PAEKs are valued for their inertness, biocompatibility, and minimal MRI artifacts, which make them suitable for patients who may require ongoing imaging studies. Polymethylmethacrylate (PMMA) and hydroxyapatite offer high strength and the potential for osseointegration, where the implant becomes integrated with the surrounding bone tissue, further enhancing the stability and longevity of the reconstruction.

### Surgical Technique and Outcomes

The surgical placement of PSIs involves a highly detailed and carefully executed process, beginning with meticulous preoperative planning using CT imaging. This planning stage is crucial for ensuring that the implant will fit perfectly and that the surgery can be performed with minimal risks and complications. During the procedure, proper exposure is achieved through carefully chosen incisions, which may include lower eyelid, intraoral, or facelift approaches, depending on the specific needs of the patient and the location of the implant. These incisions allow for subperiosteal dissection, which is essential for protecting critical structures such as the infraorbital nerve.

The stability of the implant is a primary concern during surgery, as any movement or displacement can compromise the outcome. Meticulous attention is given to securing the implant in place and ensuring that the wound is closed carefully to minimize the risk of infection or extrusion, where the implant might protrude through the skin. Preoperative and postoperative antibiotics are typically administered to further reduce the risk of infection, which is a common concern in facial reconstructive surgery.

PSIs offer several advantages over traditional zygomatic osteotomy, including a reduction in surgical risks, enhanced precision in reconstruction, and improved aesthetic outcomes. These benefits make PSIs particularly effective in cases where traditional methods are insufficient, providing a customizable and less invasive option for addressing complex zygomatic secondary trauma. The use of PSIs also shortens the recovery time for patients, as the surgery is generally less invasive and the precision of the implants reduces the likelihood of complications.

### Aesthetic Strategies and Plate Removal

Achieving optimal aesthetic outcomes in zygomatic reconstruction involves more than just restoring the bone structure; it requires careful attention to the soft tissues that contribute to the overall contour and appearance of the face. To ensure proper soft tissue support and positioning, various aesthetic strategies are

employed. These include the use of Endotine prostheses, which help to reposition and secure the soft tissues in a natural and aesthetically pleasing manner. Neo-ligaments, created using the pericranium, can also be used to provide additional support, while suspension sutures help to re-drape the soft tissue envelope, ensuring that the final result is both functional and visually appealing.

Plate removal is another critical aspect of the reconstruction process, often presenting its own set of challenges. The removal of plates and screws, which are typically used to secure the zygomatic bone during the initial reconstruction, can be a time-consuming and technically demanding process. Surgeons must carefully consider the type of screws and plates used, as well as the potential for new bone growth over the plates, which can complicate their removal. Despite these challenges, plate removal is often necessary to prevent complications and to achieve the best possible aesthetic and functional outcomes.

### Conclusion

Zygomatic osteotomy remains a valuable and effective technique in the reconstructive surgeon's toolkit, particularly for addressing certain types of zygomatic deformities. However, the emergence of patient-specific implants (PSIs) has ushered in a new era in the management of complex zygomatic secondary trauma. PSIs offer a safer, more precise, and often more effective alternative to traditional osteotomy, especially in cases involving significant comminution or complex three-dimensional defects. As surgical technology continues to advance, the role of PSIs in zygomatic reconstruction is likely to expand, potentially reducing the reliance on traditional osteotomy techniques and setting a new standard for the field of facial reconstruction.

### Acknowledgement

None.

### Conflict of interest

No conflict of interest.

### Reference

1. Peel S, Eggbeer D, Sugar A, Evans PL (2016) Post-traumatic zygomatic osteotomy and orbital floor reconstruction. *Rapid Prototyp J* 22(6): 878-886.
2. Marwan H, Sawatari Y, Peleg M (2020) Management of Post-Traumatic Orbital Zygomaticomaxillary Deformities and Secondary Reconstruction. In: *Management of Orbito-zygomaticomaxillary Fractures*. Springer, Cham. 2020:107-112.
3. Mian SH, Umer U, Alkhalefeh H, Ahmed F, Hashmi FH (2023) Design, analysis, and 3D printing of a patient-specific polyetheretherketone implant for the reconstruction of zygomatic deformities. *Polymers* 15(4): 886.
4. Chepurnyi Y, Chernogorskyi D, Kopchak A, Petrenko O (2010) Clinical efficacy of PEEK patient-specific implants in orbital reconstruction. *J Oral Biol Craniofac Res* 10(2): 49-53.