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Facial Reconstruction Using Polymethylmethacrylate: A Case Report

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ABSTRACT: Many etiological factors lead to the development of oral and maxillofacial deformities, such as traumatic injuries, congenital conditions and the removal of abnormal growths. In this context, biomaterial implants have emerged as a viable option for patient rehabilitation. This paper aims to report a case of reconstruction of the orbital zygomatic complex using polymethylmethacrylate, so as to highlight the advantages of this type of intervention, which has become an every-day feature of oral and maxillofacial surgery. A 53-year-old woman suffered a trauma that resulted in considerable loss of bone structure and, in order to rehabilitate her, a polymethylmethacrylate facial implant was made based on 3d printed models. Polymethylmethacrylate has proven to be an interesting biomaterial for crafting facial implants, restoring the patient's quality of life and self-esteem.

KEYWORDS: Dentofacial Deformities; Bone Substitutes; Polymethylmethacrylate.

I. INTRODUCTION

[1] Oral and maxillofacial deformities are abnormalities of the face and skull that may result from traumatic injury, congenital conditions, or the removal of abnormal growths. [2]. To address these problems, oral and maxillofacial reconstructive dentistry can employ one of the following groups of materials: implants (autologous, heterologous, or xenogenous) and synthetic compounds (such as titanium, hydroxyapatite, and polymethylmethacrylate).

[3] In the field of oral and maxillofacial surgery, reconstructive procedures are routinely performed to manage bone deformities that are due to a variety of etiologic factors. Although autogenous bone grafts are considered the gold standard for rehabilitation of severe facial deformities, they may be associated with potential resorption and surgical morbidity at the donor site. [4]. Therefore, allografts have become an increasingly used alternative.

[5] The choice of a material must meet criteria such as: being bio-compatible, chemically inert, radiopaque, non-allergenic or carcinogenic, easy to handle and shape, stable, cost-effective and sterilizable without altering its chemical composition. [2] The research of biomaterials is thus strongly driven by the reconstruction of bone defects.

[5] Among the biomaterials currently available for the treatment of oral and maxillofacial deformities, polymethylmethacrylate (PMMA) has proven to be a viable option with low costs and satisfactory aesthetic results. PMMA is easy to handle, physically resistant, and readily available. Its mechanical characteristics enable the material to evenly distribute stresses and loads from the prosthesis to the bone. [6] Biologically, PMMA is considered inert and stable. It is insoluble and does not degrade over time, making it suitable for various applications. Due to these factors, PMMA is widely accepted as a reliable material.

[7]. In addition, new technologies such as 3D prototyping make it possible to design a good treatment plan, enhancing the chances of a successful outcome.

The purpose of this study is to report a clinical case of orbital zygomatic complex reconstruction using PMMA in an attempt to enrich the discussion on the use of alloplastics as facial implants.

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II. CASE REPORT

A 53-year-old woman suffered a fall from a ladder resulting in a complex fracture involving the middle third of the malar bone and the left fronto-orbital region. The patient exhibited sequelae comprising ocular deformity, diplopia, enophthalmos and hypophthalmos. She was referred to surgery for the correction of the sequelae of the malar fracture using a polymethylmethacrylate (PMMA) facial implant.

To this end, the patient underwent computed tomography and the image was reconstructed using the InVesalius 3.0 ® software (CTI - Centro de Tecnologia da Informação Renato Archer, Campinas, Brazil). With this technology, it was possible to create an STL surface, a file format that allows three-dimensional work. The image was then processed using ExoCad® version 3.0 Galway (ExoCad - GmbH, Hesse, Germany) to remove artifacts and delimit the area of interest. Finally, 3D Builder® (Microsoft Corporation) was used to mirror the image and create the necessary guides for implantation using the subtraction technique. It was decided to divide the workpiece into smaller pieces, thereby building three models. These were printed on the 3D printer (Figure 1A-B) to form the muffles.

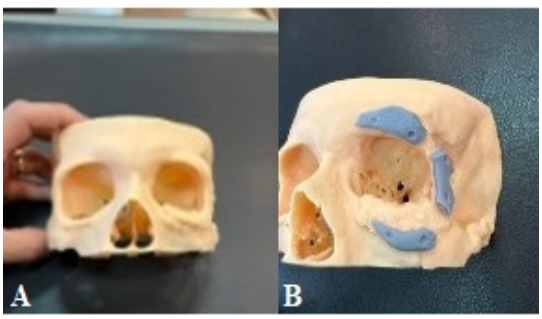

Figure 1- A) Image of the individualized prototype of the area to be restored. B) Models of the piece to be grafted divided into three parts.

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The implant was built during surgery (Figure 2A-B-C-D-F-G-H).

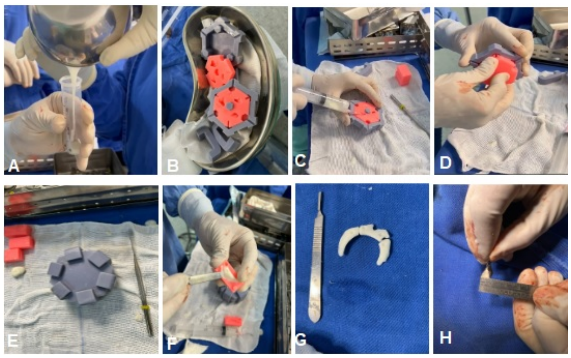

Figure 2- A) Insertion of the PMMA resin in liquid phase into the syringe, B) Sterilized muffles for molding the piece to be implanted, C) Placement of the resin into the muffles, D) Closing of the muffles, E) Closed muffle with resin already filled in, F) Removal of the piece to be implanted from the muffle. G) Piece of the implant to be inserted, H) measurement of the thickness of the piece to be implanted.

For the surgical intervention, general anesthesia was applied and both infraorbital and supraorbital accesses were performed on the left side (Figure 3A-B). In addition, the administration of local anesthesia with 2% lidocaine and vasoconstrictor made it possible to install the facial implants and reconstruct the floor of the orbit with a titanium mesh and PMMA.

Figure 3A) Implant placement in the infraorbital region. B) Implant inserted in the supraorbital region.

After the surgical procedure, the patient was followed up for four months and showed a highly satisfactory recovery. Post-operative pain was carefully managed through an analgesia protocol, ensuring the patient's well-being in the post-operative period with minimal discomfort. Effective edema control measures were applied, resulting in a significant reduction of swelling in the surgical area, which contributed to normal appearance and function.

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To prevent potential infection, the patient was on a course of antibiotics for one week after the procedure. This was to ensure that the surgical site would remain free from any infectious complications.

The patient's sutures were removed without any issues ten days after the surgery. Throughout the post-surgical follow-up, the patient had a smooth recovery and did not experience any significant complications. Six months after the surgery, she was discharged with an improvement in her enophthalmos and diplopia.

This description reinforces the effectiveness of the treatment, post-operative care and the absence of complications, favoring a successful recovery process for the patient.

III. DISCUSSION

[9]. Polymethylmethacrylate (PMMA) is a biocompatible and non-resorbable material that is widely used for facial reconstruction. It was first used in mid-1902, and in 1945 it began to be legally used in dentistry, initially for dental prostheses and then it was gradually recommended for oral and maxillofacial surgery.

[10]. The usage of PMMA in surgical procedures offers several advantages, such as easy handling, non-degradability, low thermal conductivity, radiopacity and the possibility of combining it with antibiotics such as gentamicin or tobramycin. It is also impermeable. This leads to the formation of a fibrous capsule and does not integrate with tissue. [6]. PMMA prostheses can be preformed and have several advantages such as shorter operating times, easy technical processing and good aesthetic results. [11]. According to the literature, the prefabrication of implant models through individualized 3D printing guarantees aesthetic results, minimized costs, shorter surgical time due to the simplicity of the procedure, and a reduction in complications associated with the use of PMMA.

[12]. The use of 3D printing in the world of craniofacial surgery has made it possible to create individual craniofacial prototype models using data from individual CT scans. These prototype models provide detailed tissue analysis. In this way, alloplastic material can be designed to match the actual defect. Advances have led to the use of mirror imaging, which, in the case of unilateral facial fractures, allows images from the contralateral unaffected side to be reflected onto the traumatized side, providing a satisfactory reconstruction of the affected area and favoring symmetry of the structures involved.

[13]. Therefore, with the development of new technologies, there have been advances in the inspection, measurement, and testing of materials within a single prototype, which now allows for more detailed planning, which makes surgical procedures faster and more successful. Research shows that the use of virtual planning and 3D prototyping are good tools to ensure proper positioning of alloplastic implants and orbital reanatomization. For the patient reported in this study, we chose to use the 3D planning technique and create the implant using a silicone model due to the convenience, cost savings, and predictability of the final result.

The technique employed avoids the need to collaborate with laboratories to fabricate the implant, having a positive impact on the rapidity of the surgical procedure. Even though autogenous bone grafts are considered the gold standard for reconstructing bone defects, the use of alloplastic material is justified by the fact that there is no need to remove material from the patient's donor site, thus reducing the morbidity of the procedure.

IV. CONCLUSION

Polymethylmethacrylate is a valuable tool for reconstructing facial bone defects due to its numerous advantages and excellent clinical results. Technological approaches, such as 3D printing and surgical manipulation software, have significantly optimized these procedures. The use of biomaterials, such as polymethylmethacrylate, is a promising option for improving the quality of life and self-esteem of patients undergoing maxillofacial reconstructions. Further studies are imperative in the field of oral and maxillofacial surgery and traumatology to assess the efficacy of technologies and materials utilized in maxillofacial reconstructions, thereby enhancing clinical outcomes and procedure safety.

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