Original Article

Titanium Implants used in the Rehabilitation of Maxillofacial Bone Defects: A Cross-Sectional Study at a Tertiary Care Centre of South Punjab, Pakistan

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ABSTRACT

Objective: The purpose of this research is to confirm the efficiency and protective capacity of implants made up of titanium and their effect on the bones found in the maxillofacial region.

Study Design: A Cross Sectional Study

Place and Duration of Study: This study was conducted at the Maxillofacial Surgery, CIMS Dental College, Multan and Multan Medical and Dental College, Multan from January 2023 to December 2023.

Methods: The maxilla, mandible, or zygomatic bone was implanted with titanium implants made by milling, selective laser sintering, or electron beam melting. A 12-month long follow-up was done following the operation. At the most recent follow-up, data on complications, subsidence, osteolysis surrounding the implants, postoperative infection, implant functional outcomes, and bony fusion of the titanium implant body were collected.

Results: This research outlines the difficulties we encountered when using titanium implants, how we dealt with them, and then also assesses patient satisfaction. Ten titanium implants were used in all. There were no adverse events or signs of subsidence or osteolysis in the locality of titanium implants. Every patient in this research was happy and contented with the aesthetic and practical outcomes of their surgeries. Both immediately after surgery and during later follow-ups, no patient had any problems.

Conclusion: Using titanium implants allows for a more precise restoration of maxillofacial abnormalities, avoiding the typical issues with prefabricated implants and it also raises patient satisfaction.

Key Words: Titanium Implants, Maxillofacial defects, Zygomatic reconstruction, Craniomaxillofacial surgery.

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INTRODUCTION

The zygomatic, maxillary, mandibular bones are important skeletal components that help in shaping the facial features and permits chewing along with the other numerous bones that make up the skull(1). Crouzon or Treacher-Collins syndrome, hemi facial microsomal defects, or acquired defects brought on by trauma or tumors are defects that distress the facial skeleton and can cause aesthetic and functional issues like change in symmetry of face, facial disharmony and masticatory issues. The main treatment for such abnormalities is the implantation of implants or autogenous bone grafts. Although autologous bone grafts have a high degree of biocompatibility, they may have issues such as failure of surgery, issues related to donor site, and difficulties undergoing a second operation(2). With more technical advances, the missues related to donor sites were avoided during the implants insertion; however, depending on the material, there were issues with biocompatibility and a rise in the surgical expenditure that goes along with the material cost(3). Additionally, neither technique is defect-oriented by traditional surgical standards; as a result, postoperative facial discord cannot be prevented. The discipline of oral and maxillofacial surgery has undergone a paradigm change as a result of the quick development of digital technologies. For instance, the growth and development of technologies to develop implants have made precise and speedy surgery possible(4). Unlike the early resin materials that were accessible for 3D printers, dental

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implants may now be made from titanium materials that have previously been shown to be biocompatible[5, 6]. This study examines the clinical outcomes of applying implants of titanium designed specifically to a patient- to correct zygomatic, mandibular, and maxillary abnormalities resulting from a variety of inherited and acquired conditions. The union of the implant and the bone was the main factor to be evaluated. Secondary outcomes, such as osteolysis, subsidence of the titanium implant, satisfaction rating, post-surgical infection, and safety, were also accessed.

METHODS

In this study eight patients received a total of 9 titanium implants in the Maxillofacial Surgery, CIMS Dental College, Multan and Multan Medical and Dental College, Multan. No patients had any concomitant condition. They all had preoperative CT scans (1mm thick), which were sent through IPS Gate to the manufacturer (KLS Martin Group, Germany). The manufacturer's engineer and the surgeon connected online to talk about the design and any alterations that could be required. The surgeon was then asked to approve the final design. A quick prototyping machine was used to construct the final implant, which was then delivered to the hospital and preoperatively sterilized. The implants were used during operations on patients. Finally, they had routine follow-ups planned. A 1.2 g intravenous dosage of Augmentin was given to each patient during surgery. Depending on the size and location of the lesion, several surgical techniques were utilized both intra-operatively and postoperatively. Prior to fixation, the titanium implant was examined for fit and shape. Any necessary modifications were done during surgery. Using 1.5 to 2.0 mm screws, the titanium implant fixation was completed. After surgery, the patients were given two intravenous doses of Augmentin. Upon discharge, Augmentin 1 g was administered for a 5-day oral regimen.

RESULTS

A total of 8 patients were enrolled, with a mean age of 31.5 ±12.9 years (range, 9–45 years) and 3 women and 5 males. Patients were monitored on an average for 12 months. During an average observation period of 12 months, one of the eight patients who got treatment for craniofacial anomalies suffered a screw fracture. One of the eight patients who had cheekbone repair had revision surgery after an average observation period of 10 months due to cosmetic dissatisfaction. A total of eight defect sites in all were operated on, comprising 3 maxillary areas, 2 zygomas, 2 mandibular bodies, angles, or chins. The average surgical procedure lasted 70 minutes, with a 30-190 minute range. A CBCT study revealed 100% bone fusion at 6 to 7 months after surgery. There was no evidence of osteolysis around the titanium implants. Depending on whether bone-to-implant contact was required for stability, it was either solid or mesh-designed. We preferred the mesh-type titanium implant for the load-bearing mandible because the uneven surface of the mesh-type titanium implant was effective for osteointegration with the recipient's bone. When compared to the efficiency tested before the surgery, the objective mastication efficiency enhanced by more than three times. One patient out of eight encountered issues such as screw fracture, a fixation failure, or postoperative discontent. However, there were no problems since the implant and bone had already formed a strong bond, and the patients were happy with the way their faces looked. After an average of 11 months, all patients had experienced a successful surgical recovery with substantial improvements in their facial appearance and masticatory function. Table 1 lists the specifics of the surgical outcomes and side effects.

Table No. 1: Surgical outcomes and side effects of maxillofacial titanium implants

Sample size	(n=8)
Implant's number	(n=9)
Patient age (years)	9 to 45 (31.5) (Mean Age)
Gender	5M/3F
Mandibular segments	1
Mandibular bodies, angles, or chins	2
Zygomas	2
Maxillary areas	3
Time of surgery (minutes)	35 to 190 (70) (Mean Time)
Duration in Hospital	
Two days	5
Three days	2
Four days	1
Satisfaction (VAS, 0–10)	
Function based	9.01±0.83
Visual	8.19±1.01
Fusion of bones	10/10 (100%)
Post-surgical infection	0/8 (0%)
Change of implant	0/8 (0%)
Re-operation	1/8 (12.5%)
Subsidence of Implant	0/8 (0%)
Osteolysis	0/8 (0%)
Adversative Effects	0/8 (0%)

DISCUSSION

The result of reconstructive procedures has been revolutionized by the use of titanium alloy implants. In affluent nations, it is now employed in orthopedic, neurological and craniomaxillofacial surgery[7]. Prior research focused primarily on the calvaria[8,9], orbital floor[10–12], maxilla[13,14], and alveolar bone[15] since these structures had low functional loads. However, this

research demonstrated that titanium implants may operate satisfactorily in the zygoma, maxilla and mandible. Previously, limited studies were conducted on titanium implants for locations exposed to greater functional strains, such as the mandible and zygoma. It has been found helpful in reconstructing the mandible and other structures that bear a heavy functional strain. Titanium implant's strength was adequate to endure recurrent severe loads above the pressure of mastication, as shown in our prior research[16]. The patient's original look may be accurately restored. With respect to surgeon's expertise throughout surgery, autologous tissue repair will decide the outcome of reconstruction. However, patient-tailored titanium implants made by using 3D digital technology may be precisely replicated in a virtual setting beforehand, minimizing mistakes during real surgery and exactly recreating the look of the defect. An earlier investigation of a chin implant made for a particular patient found accuracy of 0.69 mm in mediolateral translation[17]. According to a different research, the maxillary position discrepancy for double-jaw surgery was 2.20 ± 0.94 mm[4, 18].

Titanium has been acknowledged for its strong therapeutic usefulness as a material in bone repair since it possesses high strength and elasticity[19]. It is thought that titanium's porous structure may effectively correct the discrepancy between the elastic modulus and human bone. Most of the time, the patient is burdened with a disfigured face and an unattractive look for the rest of their lives. His/her social life is greatly impacted by this. Titanium is an inert, biocompatible substance that has a tendency to osseointegrate with bone. Since a few decades ago, titanium implants have also been employed as dental implants and for internal maxilla-mandibular fixations[20].

CONCLUSION

This research found that titanium implants work well to treat a variety of oral and maxillofacial abnormalities. Without causing any harm to the donor site, a titanium implant may be successfully utilized to replace autogenous bone in the repair of the zygoma and the jaws. The use of titanium implant for maxillofacial reconstruction claims outstanding patient satisfaction, predictable results and elimination of typical issues associated with implant surgeries such as infection initiation and rejection of the implant due to its non-biocompatibility.

Author's Contribution:

Concept & Design of Study:	Anam Tahir
Drafting:	Safi Ullah Khan
Data Analysis:	Hafiz Muhammad Abu Bakar Siddique, Mamoona Mujtaba, Asrar Ahmed
Revisiting Critically:	Anam Tahir
Final Approval of version:	By all above authors

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