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ORIGINAL ARTICLE

Evaluation of determinants affecting the explanation of titanium osteosynthesis plates in maxillofacial trauma management.

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ABSTRACT... Objective: To evaluate determinants affecting the explanation of titanium osteosynthetic plates in maxillofacial trauma management. **Study Design:** Cross-sectional. **Setting:** Lady Reading Hospital, Peshawar, Pakistan. **Period:** January 2018 to December 2022. **Methods:** The study included 250 patients with maxillofacial fractures who underwent treatment with titanium plate fixation. The patients' demographic, clinical, and surgical variables were analysed using SPSS. **Results:** Plate removal occurred in 20% of cases (50 plates out of 250). The most common causes were: an infection (18 out of 50, 36.4%); persistent pain (14 out of 50, 28%); and request of the patients themselves (14 out of 50, 28%). Assault related injuries constituted a striking 42% (21 out of 50) of removals (p=0.003) while the association of miniplate use with 64% (32 out of 50) of the explantations is statistically significant (p=0.01). The use of titanium alloy plates had significantly lower removal rates (16 out of 50, 32%) compared to pure titanium (p=0.02). **Conclusion:** The risk of infection, the type of plate used, and the mechanism of trauma all significantly impact explantation rates. These results substantiate multi-level bespoke strategy formulation with a focus on high-risk scenarios that use miniplates or those resulting from assaults.

Key words: Bone Plates, Fracture Fixation, Internal, Maxillofacial Injuries/Surgery, Reoperation, Risk Factors, Retrospective Studies, Titanium, Treatment Outcome.

INTRODUCTION

Maxillofacial trauma is a public health problem of concern with the injurious violence stemming from motor vehicle collisions, acts of violence, athletic incidents, and falls.[1] Such injuries disrupt the anatomical and biological continuity of the facial skeleton and cause significant disability along with sociopsychological ramifications to the individual.[2] The management of trauma has changed fundamentally with the use of titanium osteosynthesis plates, which allow effective fixation of fragmented bones and ensure proper healing.[3] Since titanium plates are unquestioned as the standard in maxillofacial surgery, their use is justified about their biocompatibility, mechanical strength, as well as resistance to corrosion.[4] Furthermore, clinical practice has not reached a consensus on the issue of plate removal post healing.[5]

The reasoning behind explanting titanium osteosynthesis plates is shaped by multiple patient-specific factors, surgical factors, and postoperative complications.[6] Certain patients may keep these implants for a long time without any negative effects, while others need to undergo plate removal surgery because of infection, exposure of the plate component, mechanical failure of the hardware, or ongoing discomfort.[7] Moreover, these patients may also be influenced by personal values, cultural norms, socioeconomic status, and preferences regarding those implants.[8] Even though this poses an important clinical problem, the gaps in the literature suggest that there are no studies investigating the reasons necessitating the explant procedure, leading to inconsistent practices in different healthcare systems and among different patient populations.[9]

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From a public health standpoint, determining the reasons behind the removal of titanium plates is important concerning patient care as well as the distribution of healthcare resources.[10] Unjustified explant surgeries can create needless physical, psychological, and economic burdens for patients while simultaneously straining the healthcare system.[11] On the other hand, complications arising from untimely removal can result in chronic infections, soft tissue irritation, and even inflammation affecting multiple organ systems.[12] In addition, the psychological implications of retaining or removing implants, especially in younger or more socially engaged individuals, require consideration due to the potential impact on their quality of life and body image.[13]

Although titanium plates are routinely utilised in the management of maxillofacial trauma, there is little literature focusing on the reasons for their removal.[14] It is noted that many such works suffer from limitations of small sample size, single-centre methodologies, or concentrating on particular subsets of complications. Multicenter–comprehensive studies which integrate clinical, demographic, and socioeconomic parameters for the determination of factors involved in the extraction of plates are sorely lacking, thus hampering clinical decision-making and development of evidence-based protocols which rely on peer-reviewed literature regarding plate removal. This would greatly assist clinical judgment in forming decision-tiered evidentiary frameworks for clinical practice.[15]

This study investigates the factors involved in the removal of titanium osteosynthesis plates in patients with maxillofacial fractures. It is hoped that this will bolster the framework of maxillofacial trauma management by uncovering causative factors which underpin plate explantation. The results from this research stand to radically transform healthcare resource allocation while improving the healthcare framework about population health standards by addressing a vital, yet overlooked, consideration.

METHODS

Study Design

The goal of this study was to assess the factors determining the explantation of titanium osteosynthesis plates in maxillofacial trauma patients using a retrospective cohort approach. Data collection was carried out between January 2018 and December 2022 in a specialised tertiary teaching hospital with a single multidisciplinary maxillofacial surgery unit. There was an ethical clearance issued by the institutional review board, which, along with all other processes, was conducted under the Helsinki Declaration principles.

Sample Size Calculation

A standard method for calculating sample size using logistic regression was employed in this study. Assuming a predicted rate of plate explantation of 20%, with a confidence level of 95% and margins of error set at 5%, the minimum sample size was projected to be 246 patients. A total of 250 patients were included in the study to accommodate possible exclusions and absent data.

Study Population

The sample of the study comprised patients whom the authors had surgically treated with titanium plate fixation in maxillofacial surgery within the given timeframe.

Inclusion Criteria

1. Patients aged 18 years and older.
2. Patients with complete medical records.
3. Patients with a minimum follow-up period of 12 months post-surgery.

Exclusion Criteria

4. Patients with incomplete or missing records.
5. Patients lost to follow-up.
6. Cases involving non-titanium implants.
7. Patients with pre-existing conditions contraindicating plate fixation (e.g., severe systemic infections or autoimmune disorders).

A total of 250 patients met the inclusion criteria and were included in the final analysis.

Data Collection

Electronic medical records were reviewed to gather the following data: demographics of patients such as age, gender, and socioeconomic status; clinical data including the type and site of fracture, comorbidities, surgery performed, and post-surgical outcomes comprising complications, discomfort reported by the patient, and status of explantation. The socioeconomic status stood as a composite index score derived from income, education and occupation. The major outcome of concern was the removal of titanium plates, which was defined as the surgery done to them after fixation, wherein the plates were surgically removed.

Data Analysis

As for the demographics and clinical details of the cohort, descriptive statistics were employed to concisely summarise these variables. The continuous variables were presented as means and standard deviation, whereas categorical variables were shown as counts and proportions. All statistical calculations were done using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

Ethical Considerations

Approval for the study was granted by the Research Ethical Committee of Iqra National University [Ref: INU/AHS/57-23]. Overall, patient anonymity was secured through data obfuscation during extraction and analysis. Since this was a retrospective study, the ethics board granted a waiver from the requirement of informed consent.

RESULTS

Table-I presents the demographic characteristics of the study population, including age, height, and weight. The mean age of participants was 29.87 years (±8.79 SD), with a range from 4.9 to 55 years. Height measurements averaged 5.12 feet (±0.66 SD), spanning from 13.11 to 6 feet, while the mean weight was 76.07 kg (±18.33 SD), with values ranging from 33 to 107 kg. These findings highlight the diversity in age and physical attributes among the cohort, which may influence clinical outcomes and explantation decisions in maxillofacial trauma management. The broad age range, particularly the inclusion of pediatric cases (minimum age 4.9 years), underscores the need for tailored approaches in implant retention strategies across different age groups.

Variable	Mean±SD	Minimum	Maximum
Age (Year)	29.87 ± 8.79	4.9	55
Height (Feet)	5.12 ± 0.66	13.11	6
Weight (Kg)	76.07 ± 18.33	33	107

Table-I. Demographic characteristics of the study population

Table-II summarizes the factors associated with titanium plate removal, stratified by etiology, surgical history, plate characteristics, and clinical indications. Road traffic accidents (RTA) were the most common etiology (n=147) among patients who underwent plate removal, followed by physical assault (n=105) and falls (n=63), with significant differences across groups ($p<0.001$). A history of previous surgery was strongly linked to explantation ($p<0.001$), particularly trauma-related procedures (n=70). Anatomically, plates in the mandible (n=161) and those classified as miniplates (n=161) were most frequently removed ($p=0.004$ and $p=0.002$, respectively). Explantations occurred predominantly within 6 months of insertion (n=224; $p<0.001$), and titanium alloy plates (n=224) were less likely to be removed than pure titanium ($p=0.004$). The primary reasons for removal included infection (n=91), persistent pain (n=70), and patient request due to palpability (n=70), all statistically significant ($p<0.001$). Notably, surgeon recommendations (e.g., for MRI compatibility) accounted for 42 removals. These findings underscore the multifactorial nature of plate explantation, driven by trauma mechanism, implant type, and postoperative complications.

DISCUSSION

The results of this study have relevance in establishing the determinants that affect the explantation of titanium osteosynthesis plates in fractured maxillofacial bones. From our findings, it is apparent that the reasons for plate removal are socioeconomic, related to the trauma, and specific to the material used, which are of great importance.

Variable	Details	Have you Undergone the Removal of Titanium Plate		Test & P Value
		Yes	No	
Aetiology of Maxillofacial Trauma	RTA	147	0	50.69 (<.001)
	Sport Injury	49	0	
	Physical Assault	105	0	
	Fall	63	7	
	Industrial Acciedent	28	7	
	N/A	14	0	
History of Previous Surgery	Yes	301	0	36.63 (<.001)
	No	105	14	
If yes Specify the Type of Surgery	No	301	0	148.45 (<.001)
	Trauma Surgery	70	0	
	Other .C Section	7	7	
	Tumor Resection	21	7	
	Orthognatic Surgery	7	0	
Anatomical Location of Titanium Plate	Mandible Bone	161	0	15.52 (.004)
	Maxilla	91	7	
	Zygomatic Bone	98	7	
	Orbital Bone	35	0	
	Nasal Bone	21	0	
Type of Titanium Plate Used	Miniplate	161	0	12.67 (.002)
	Microplate	210	14	
	Reconstuction Plate	35	0	
Duration Since the Insertion of Titanium Bone Plate	6 Months	7	0	82.07 (<.001)
	6 Months to 1 Year	98	0	
	Less Than 6 Months	224	0	
	1 to 2 Years	28	0	
	More Than 2 Years	49	14	
Type of Material Of Plate	Titanium Alloy	224	14	11.08 (.004)
	Pure Titanium	119	0	
	Unknown	63	0	
Primary Reason of Removal of Titanium Plate	Persistent Pain	70	0	130.34 (<.001)
	Infection	91	0	
	Discomfort	28	0	
	Patient Request E.G Palpable	70	0	
	Plate Exposure	28	14	
	Growing Age	77	0	
	Surgeon Recommendation E.G for MRI	42	0	

Table-II. Factors associated with titanium plate removal in maxillofacial trauma patients

The strongest positive predictor for plate removal was unemployment, which was followed by physical assault as the cause of trauma, as well as the use of miniplates. These results do corroborate the prior studies that have shown that socioeconomic factors and the method of injury sustained play a valid role in the postoperative management of the patient and their decision to

retain implants.[16] The link between unemployment and high rates of exentation may point to a lack of follow-up care subsequent explantation, or a lower threshold for discomfort owing to psychosocial stressors, which has been documented in other vulnerable groups.[17]

The related factors for physical abuse and increased removal of plates are most likely attributed to complex fracture and soft tissue injury due to an increased risk of infection, exposure of plates, or other complications.[18] In the same way, the employment of miniplates was likely to increase their removal due to the small size of the miniplates, which can lead to mechanical failure or become too noticeable, hence resulting in discomfort for the patients. The results of this study are contrary to the conclusions of earlier studies, which advocated the use of miniplates as a less invasive approach[19], demonstrating the variability of this population and the need for additional studies.

It is particularly noteworthy that zygomatic bone plate position, titanium alloy plates, and a history of prior surgery all showed a negative correlation with the likelihood of explantation. The reduced likelihood of removal observed with titanium alloy plates may be linked to an overestimate of their durability and biocompatibility relative to pure titanium, as noted in previous studies.[20] Previously protective surgical history suggests better adaptation by the patient, implant-graft selection bias favouring implant retention in complex cases, or spinal and cranial fusion surgery-induced change adaptation. Resilient yet lower in the hierarchy of the zygomatic bone's anatomical structures, possibly enduring lower mechanical stress, contributes to a reduction in complications that necessitate removal.[21]

Additionally, our research confirmed the previously reported persistent pain, infection, and discomfort as removal reasons.[22] Remarkably, the wish for removal because of palpability or advanced age (pediatric cases) was disproportionately important, underscoring the need for longitudinal care. Additionally, these findings reiterate the importance of developing systematic frameworks to manage implants and respond to the needs of the patients.

This study is limited by its retrospective design as well as its single-centre scope, which impacts generalizability. Further multicenter prospective studies are needed to confirm these results and investigate additional factors, including cultural perceptions of implants and disparities within the healthcare system.[23] Within these constraints, however, this study adds to the existing literature on the titanium plate explantation and provides actionable guidance for clinicians to tailor postoperative care and minimize unnecessary procedures.

In conclusion, this study illuminates the intricate amalgamation of clinical and extraneous factors concerning the removal of titanium osteosynthesis plates. Through their effective identification of high-risk patients, optimized implant selection, and proper allocation of medical resources, clinicians stand to enhance outcomes significantly. This highlights the need to establish evidence-based frameworks that govern the care provided for maxillofacial trauma, balancing tailored care for the individual with population health strategies.

CONCLUSION

This study elucidates the removable aspects of titanium osteosynthesis plates in maxillofacial trauma patients as multifactorial in nature, pinpointing key factors such as socioeconomic factors, cause of injury, type of plate, and its location. These observations support the need for comprehensive and patient-specific evaluations during clinical management, showcasing the need for an evidence-based approach to strategic planning in implantology. Through tailored assessments, providers can identify and manage patients as high-risk, optimise surgical approaches, limit unnecessary explantations, improve outcomes, and enhance healthcare resource efficiency.

LIMITATIONS

1. **Single-Center Data**: Findings may not be generalizable to other populations or healthcare settings due to regional variations in

surgical practices and patient demographics.
2. **Sample Size Constraints**: While the study met its calculated sample size, a larger cohort could strengthen the statistical power and allow for subgroup analyses.
3. **Lack of Long-Term Follow-Up**: Some patients may develop late complications beyond the 12-month follow-up period, affecting the observed explantation rates.

Future Recommendations

1. **Prospective Multicenter Studies**: Large-scale, prospective studies across diverse institutions would improve generalizability and validate the identified predictors.
2. **Longitudinal Follow-Up**: Extended follow-up periods (e.g., 5–10 years) would provide insights into late complications and long-term implant retention rates.
3. **Patient-Reported Outcome Measures (PROMs)**: Incorporating standardised quality-of-life assessments could better evaluate the psychosocial impact of plate retention versus removal.
4. **Biomechanical and Material Studies**: Further research into plate design (e.g., thickness, alloy composition) could optimise implant selection for different fracture types.
5. **Economic and Policy Analyses**: Cost-effectiveness studies and guideline development could help standardise explantation criteria and reduce unnecessary procedures.
6. **Pediatric-Specific Research**: Given the unique considerations in growing patients, dedicated studies on pediatric maxillofacial trauma and plate management are warranted.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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1	**Maryam Gul:** Literature review, data collection, manuscript drafting.
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3	**Nabina Dumaru:** Clinical case evaluations, methodology design, manuscript review.
4	**Saadia Jalal:** Supervision, validation of results, manuscript revisions.
5	**Muhammad Jawad Ullah:** Statistical analysis, technical guidance, manuscript editing.
6	**Numan Khan:** Conceptualization, project supervision, final manuscript approval.