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Article

Assessment of Complications Associated with Metallic Plate Removal in Maxillofacial Surgical Patients

Javeria Saeed[1], Mehwish Gul[1], Fawad Ahmad[2], Wasif Khan[3], Hareera Ahmad Khan[1], Muhammad Adil[4]

1 Dental Department, College of Medical Technology, Bacha Khan Medical College, Mardan, Pakistan
2 Institute of Health Sciences, Hazara, Khyber Medical University, Pakistan
3 Dental Department, The Professional Institute of Health Sciences, Mardan, Pakistan
4 Sarhad University of Science and Information Technology, Pakistan

Correspondence
fawadkmu781@gmail.com

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ABSTRACT

Background: Metallic hardware is widely used in oral and maxillofacial surgery for skeletal stabilization, yet its long-term retention can lead to complications such as infection, discomfort, and plate exposure. Despite the clinical significance, there is limited consensus on the indications and timing for plate removal, particularly in relation to demographic and surgical variables. **Objective**: This study aimed to evaluate the complications associated with metallic plate removal in maxillofacial surgical patients and to analyze the associations between patient demographics, surgical characteristics, comorbidities, and the causes, sites, and timing of hardware removal. **Methods**: A cross-sectional observational study was conducted on 70 patients who underwent metallic plate removal following oral and maxillofacial surgery at Bacha Khan College of Dentistry, Mardan, between March and August 2024. Patients aged ≥18 years were included based on clinical indication for plate removal; those with incomplete data or who declined consent were excluded. Data on demographics, comorbidities, surgical type, and removal characteristics were collected using standardized forms. Ethical approval was obtained in accordance with the Declaration of Helsinki. Statistical analysis was conducted using SPSS v26, employing descriptive statistics and Chi-square tests to assess associations at a significance threshold of $p < 0.05$. **Results**: Mandibular ORIF was the most frequent procedure (35.7%), with infection (31.4%), pain (21.4%), and plate exposure (17.1%) as leading causes of removal. The majority of plates were removed after >24 months (31.4%). Significant associations were observed between age and cause ($p = 0.035$), site ($p = 0.041$), and duration ($p = 0.028$) of removal. Surgery type and comorbidities also significantly impacted removal patterns ($p < 0.05$). **Conclusion**: Plate removal following maxillofacial surgery is primarily driven by infection and discomfort, particularly in younger patients and those undergoing mandibular fixation. Patient-specific factors should inform follow-up protocols and surgical decision-making to enhance postoperative outcomes and reduce secondary intervention rates.

Keywords: Maxillofacial Surgery, Titanium Plate Removal, ORIF, Postoperative Complications, Infection, Mandible, Oral Surgical Procedures

INTRODUCTION

The field of oral and maxillofacial surgery has undergone significant evolution with the advancement of internal fixation techniques, particularly the use of metallic plates for skeletal stabilization. Titanium plates have become a standard due to their biocompatibility and mechanical strength, allowing for precise anatomical reduction and early functional recovery following trauma or corrective surgeries. However, despite their advantages, the long-term presence of metallic hardware in the craniofacial skeleton can lead to complications such as infection, plate exposure, discomfort, and allergic reactions (1,2). These issues may necessitate a second surgical intervention for plate removal, posing additional risks and costs to patients. While some clinicians advocate for the prophylactic removal of asymptomatic hardware to prevent potential complications, others prefer retention due to the risk-benefit ratio and economic concerns (3,4). This divergence in clinical practice has given rise to an ongoing debate in the surgical community regarding the optimal management of retained hardware.

The need to address this issue is underscored by studies reporting plate removal rates ranging from 2.3% to as high as 28.1% among maxillofacial trauma patients, often driven by

postoperative infections or hardware-related discomfort (5,6). Specific anatomical sites, particularly the mandible, have been identified as more susceptible to complications due to factors such as thin overlying soft tissues and frequent functional loading during mastication (7). Additionally, patient-specific variables such as age, systemic comorbidities (e.g., diabetes, smoking, osteoporosis), and the type of surgical intervention significantly influence both the likelihood and timing of hardware-related complications (8,9). Despite these insights, there remains a lack of consensus and standardized guidelines regarding the indications and timing for plate removal, especially in the absence of overt clinical symptoms. Most existing literature is retrospective in nature, limited to single-institution reviews, and lacks comprehensive stratification by demographic and surgical variables.

Furthermore, many previous studies have either focused narrowly on specific fracture types or failed to analyze associations between hardware removal and patient characteristics such as comorbidities, surgical type, or anatomical site (10,11). This results in an incomplete understanding of the patterns and predictors of plate removal, which limits the development of evidence-based clinical protocols. Notably, the British Association of Oral and Maxillofacial Surgeons recommends symptomatic plate removal, but the criteria for symptomatology and timing vary widely across institutions (12). The ambiguity surrounding hardware retention versus removal is further complicated by the emergence of biodegradable alternatives, which although promising, have not yet replaced titanium as the gold standard in most settings (13).

Given these gaps, this study was designed to systematically assess the complications associated with metallic plate removal in patients undergoing oral and maxillofacial surgery, with particular emphasis on the influence of age, gender, surgical site, type of procedure, and presence of comorbidities. By identifying statistically significant associations between these variables and the reasons, sites, and durations of plate removal, the study aims to contribute to a more structured clinical decision-making framework. The central research question guiding this investigation is: What are the demographic, surgical, and clinical predictors of complications leading to metallic plate removal in maxillofacial surgery patients, and how can these inform patient selection and postoperative care strategies?

MATERIALS AND METHODS

This cross-sectional observational study was conducted to assess the complications associated with metallic plate removal in patients who had previously undergone oral and maxillofacial surgical interventions. The study was carried out at the Department of Dentistry, Bacha Khan College of Dentistry, Mardan, from March 2024 to August 2024. A total of seventy patients were enrolled through purposive sampling based on their presentation for plate removal following previous oral and maxillofacial surgery. Eligible participants included individuals aged 18 years or older who had received metallic hardware (plates or screws) as part of their maxillofacial treatment and were subsequently indicated for device removal due to various clinical or personal reasons. Patients were excluded if they were under 18 years of age, provided incomplete medical records, or declined to give informed consent. All participants gave written informed consent, and the study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Confidentiality of patient information was ensured by assigning anonymous identification codes and restricting access to identifiable data to the core research team only.

Data collection was performed using a standardized, researcher-designed questionnaire and review of medical records. Demographic variables such as age and gender were recorded, along with relevant clinical details including the type of surgical procedure performed, anatomical site of hardware placement, presence of systemic comorbidities (e.g., diabetes mellitus, smoking history, osteoporosis), and time elapsed between original surgery and plate removal. The primary outcome was the cause of hardware removal, which included infection, pain or discomfort, plate exposure, patient preference, failure of osteosynthesis, metal allergy or reaction, and others such as loosening or recurrence of trauma. Secondary outcomes included the site of plate removal (mandible, maxilla, zygomatic complex, nasal bone, orbital rim, or other) and the duration between initial surgery and removal (categorized as <6 months, 6–12 months, 13–24 months, and >24 months). Where the reason for removal was unclear in the medical record, patients or operating surgeons were contacted to clarify the indication.

All data were analyzed using SPSS version 26. Descriptive statistics including frequency and percentages were used to summarize demographic and clinical characteristics. The Chi-square test was applied to assess associations between categorical variables such as age group, gender, type of surgery, comorbidities, and the outcomes of interest including cause, site, and duration of plate removal. Statistical significance was established at a p-value of less than 0.05. Data entry was double-checked for consistency, and no imputation was performed for missing values, as complete records were available for all included participants. Confounding variables were minimized by stratified analysis within age groups and surgical categories to ensure robustness of associations identified.

RESULTS

A total of 70 patients who had undergone oral and maxillofacial surgery followed by metallic plate removal were included in the study. The mean age of participants was distributed predominantly across the 18–30 (28.6%) and 31–40 (25.7%) age brackets, with a smaller proportion above 60 years (10%). Males comprised a higher proportion of the sample (60%) compared to females (40%). The most commonly performed procedure preceding plate removal was Open Reduction and Internal Fixation (ORIF) of the mandible, accounting for 35.7% of all surgeries. Other common surgical procedures included ORIF of the maxilla (17.1%) and zygomatic complex (14.3%). Approximately half of the patients (50%) reported no comorbidities, while the remainder reported diabetes (14.3%), smoking (17.1%), osteoporosis (7.1%), or other conditions (11.4%) (Table 1). Regarding the timing of plate removal, 31.4% of patients underwent removal more than 24 months postoperatively, while 28.6% had removal between 13 and 24 months. Fewer removals

occurred between 6 and 12 months (25.7%) or within 6 months (14.3%). This distribution indicates a trend toward delayed hardware removal in the majority of cases (Table 2). Infection was the most common cause of hardware removal (31.4%), followed by pain or discomfort (21.4%) and plate exposure (17.1%). A subset of patients requested removal for non-clinical reasons (11.4%). Other causes included failure of osteosynthesis (10%), metal allergy or reaction (5.7%), and trauma recurrence or loosening (2.9%) (Table 3).

Table 1. Demographic and Clinical Characteristics of the Study Participants (N = 70)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–30	20	28.6
	31–40	18	25.7
	41–50	15	21.4
	51–60	10	14.3
	>60	7	10.0
Gender	Male	42	60.0
	Female	28	40.0
Type of Surgery	ORIF Mandible	25	35.7
	ORIF Maxilla	12	17.1
	ORIF Zygomatic Complex	10	14.3
	Orthognathic Surgery	8	11.4
	Other (TMJ, Reconstruction)	15	21.4
Comorbidities	None	35	50.0
	Diabetes	10	14.3
	Smoking	12	17.1
	Osteoporosis	5	7.1
	Other	8	11.4

Table 2. Duration Between Surgery and Plate Removal

Duration Post-Surgery (Months)	Frequency (n)	Percentage (%)
<6 months	10	14.3
6–12 months	18	25.7
13–24 months	20	28.6
>24 months	22	31.4

Table 3. Reported Causes of Metallic Plate Removal

Cause of Removal	Frequency (n)	Percentage (%)
Infection	22	31.4
Pain/Discomfort	15	21.4
Plate Exposure	12	17.1
Patient Request	8	11.4
Failure of Osteosynthesis	7	10.0
Metal Allergy/Reaction	4	5.7
Other (e.g., trauma, loosening)	2	2.9

The anatomical site most frequently involved in plate removal was the mandible (42.9%), followed by the maxilla (17.1%) and zygomatic complex (14.3%). Less frequently involved sites included the nasal bone (7.1%), orbital rim/orbit (8.6%), and other craniofacial regions such as the frontal bone or TMJ (10%) (Table 4).

Table 4. Anatomical Site of Plate Removal

Site of Plate Removal	Frequency (n)	Percentage (%)
Mandible	30	**42.9**
Maxilla	12	17.1
Zygomatic Complex	10	14.3
Nasal Bone	5	7.1
Orbital Rim/Orbit	6	8.6
Other (e.g., TMJ, Frontal)	7	10.0

Chi-square analysis revealed statistically significant associations between age and the cause ($p = 0.035$), site ($p = 0.041$), and timing ($p = 0.028$) of plate removal. Patients aged 18–30 were significantly more likely to undergo earlier and

symptom-driven removals compared to older cohorts. Gender showed a significant association only with the duration of removal (p = 0.045), indicating a longer retention period among males. The type of surgery significantly influenced the cause (p = 0.021), site (p = 0.033), and duration (p = 0.015) of removal, with ORIF of the mandible showing the highest complication and removal frequency. Additionally, comorbidities were significantly associated with both the cause (p = 0.048) and duration (p = 0.039) of hardware removal, suggesting systemic conditions may influence the clinical course and removal timeline (Table 5).

Table 5. Association of Demographic and Clinical Variables with Cause, Site, and Duration of Plate Removal (Chi-Square Test)

Demographic Variable	Categories	Cause (p-value)	Site (p-value)	Duration (p-value)
Age	18–30	0.035*	0.041*	0.028*
	31–40, 41–50, >50	—	—	—
Gender	Male vs. Female	0.089	0.076	0.045*
Surgical Type	ORIF Mandible	0.021*	0.033*	0.015*
	ORIF Maxilla, Zygomatic, etc.	—	—	—
Comorbidities	Yes vs. No	0.048*	0.062	0.039*

These findings support the clinical relevance of age, surgical technique, anatomical site, and systemic health in influencing the timing and indication for hardware removal. Although no effect sizes were calculated, the p-values indicate moderate to strong statistical associations, warranting consideration in clinical decision-making. The consistent patterns of complications among younger patients and those undergoing mandibular ORIF suggest that targeted postoperative surveillance in these subgroups may be warranted.

DISCUSSION

The findings of this study provide important insights into the complications associated with metallic plate removal following oral and maxillofacial surgery, reaffirming the relevance of infection, discomfort, and plate exposure as predominant clinical indications for hardware removal. Consistent with prior research, infection emerged as the most frequently cited cause, affecting approximately one-third of the patient cohort. This aligns with earlier reports by Murthy and Lehman, who noted that infections were the primary reason for symptomatic plate removal in maxillofacial trauma cases (7). The mandible was identified as the most common anatomical site of plate removal, a finding corroborated by previous literature suggesting that the thin mucoperiosteum and functional load-bearing nature of the mandibular region predispose it to complications such as exposure and infection (6,14). The statistically significant associations between age, surgical site, and presence of comorbidities further emphasize the multifactorial nature of hardware-related complications.

The observed tendency for younger patients, particularly those aged 18–30, to undergo earlier plate removal may reflect a combination of higher physical activity levels, heightened symptom sensitivity, or increased healthcare-seeking behavior in this demographic. Previous studies by Bhatt et al. and Chaushu et al. similarly found higher removal rates in younger populations, attributing this to more frequent traumatic etiologies and greater expectations for postoperative comfort (12,9). Additionally, the predominance of ORIF mandible procedures among those requiring hardware removal suggests that fracture site and surgical approach significantly influence postoperative outcomes. These findings support Kent et al.'s retrospective review, which demonstrated that mandible plates, particularly in the angle region, exhibit higher complication rates due to mechanical stress and thinner soft tissue coverage (5).

Interestingly, the duration between initial surgery and plate removal varied widely, with most cases clustered between 13 months and beyond 24 months. This pattern is partially consistent with data from Rallis et al., who reported a peak in removals between 6 and 12 months, though the longer removal timelines observed here may reflect institutional practices or delayed recognition of symptoms (14). The clinical decision to retain or remove asymptomatic plates remains contentious, with some surgeons advocating for retention based on titanium's biocompatibility and low reactivity, while others argue for proactive removal to preempt late-onset complications (20). Our findings lend support to a selective removal approach, particularly in symptomatic patients or those with risk factors such as diabetes, smoking, or compromised bone healing capacity.

Mechanistically, the pathophysiology underlying hardware-related infections and discomfort may involve biofilm formation, soft tissue irritation, or metal hypersensitivity reactions, especially in patients with underlying systemic conditions. The statistically significant link between comorbidities and both the cause and duration of removal underscores the importance of comprehensive patient evaluation prior to surgical hardware placement. Moreover, the association between gender and removal timing, with men showing delayed removal trends, suggests possible differences in symptom reporting, pain threshold, or social determinants influencing healthcare utilization—although this warrants further investigation.

This study contributes to the growing body of evidence advocating for individualized postoperative monitoring and hardware management strategies based on patient-specific factors. From a clinical standpoint, identifying high-risk subgroups—such as those undergoing mandibular ORIF or those with systemic comorbidities—can inform early intervention protocols and targeted follow-up schedules, potentially improving outcomes and reducing the need for secondary surgeries. The integration of risk stratification models and decision-making algorithms into clinical workflows may help standardize care and optimize resource utilization.

Despite its strengths, including a well-defined patient cohort and use of standardized statistical analyses, the study is limited by its single-center design and relatively small sample size, which may constrain generalizability. Additionally, the cross-sectional nature of the study precludes causal inferences, and potential confounding factors such as surgical technique variation, operator experience, and socioeconomic factors were not explored. Future multicenter prospective studies with larger and more diverse populations are recommended to validate these findings and explore long-term outcomes associated with different plate types, anatomical locations, and patient demographics.

This study reinforces the clinical significance of infection, pain, and plate exposure as leading causes of metallic hardware removal in maxillofacial surgery, with mandibular sites and patient-specific factors playing a pivotal role. The results underscore the necessity of tailored follow-up protocols and judicious surgical planning. Further research focusing on long-term functional outcomes and the efficacy of emerging biodegradable alternatives could enhance evidence-based decision-making in maxillofacial hardware management.

CONCLUSION

This study highlights that complications such as infection, pain, and plate exposure are the most prevalent reasons for metallic plate removal in patients undergoing oral and maxillofacial surgery, with the mandible being the most commonly affected site. Statistically significant associations between age, surgical type, comorbidities, and hardware removal characteristics underscore the importance of individualized risk assessment and postoperative planning. These findings emphasize the need for refined clinical protocols that consider patient-specific factors to optimize outcomes and reduce the morbidity associated with secondary surgical interventions. Clinically, the study supports a selective approach to hardware removal based on symptomatic presentation and risk profiles, while future research should aim to establish standardized guidelines and investigate long-term outcomes associated with different plate materials and anatomical placements.

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