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EFFICIENCY OF OSTEOSYNTHESIS WITH TITANIUM PLATE IN MANDIBULAR FRACTURES

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Abstract

Trauma is an increasing global concern, with maxillofacial injuries making up a substantial portion of trauma cases. These injuries often result from road traffic accidents, interpersonal violence, falls, or contact sports. Among them, mandibular fractures are common and pose significant challenges in both functional and aesthetic restoration. The use of titanium plates for osteosynthesis has become the gold standard for managing mandibular fractures due to their superior mechanical properties and biocompatibility. This study aims to evaluate the efficacy of titanium plate osteosynthesis in the treatment of mandibular fractures.

Materials and Methods

This prospective study included 24 patients with mandibular fractures treated using titanium plates between May 15 and October 15, 2024. The patients were evaluated preoperatively, intraoperatively, and postoperatively at the 7th day, 3rd week, 6th week, and 12th week. The study assessed fracture healing, functional recovery, and the occurrence of postoperative complications.

Results:

The median age of the patients was 25.4 years, with a male-to-female ratio of 3:1. The most common cause of injury was assault (76.8%). The mean time from injury to surgical intervention was 8.6 days. The majority of fractures (88%) were comminuted. By the 12th postoperative week, 93.3% of patients achieved good occlusion. Postoperative complications included residual hypoaesthesia in four patients (16.7%) and wound dehiscence in one patient (4.2%).

Conclusion:

Titanium plate osteosynthesis proved to be an effective and reliable method for managing mandibular fractures. It provided excellent stabilization, particularly in complex, comminuted fractures, and allowed for early functional recovery. The procedure was quick and adaptable, making titanium plates a valuable tool in restoring both the form and function of the mandible in trauma patients.

Keywords: Mandibular fractures, Titanium plates, Comminuted fractures, Osteosynthesis, Functional recovery, Postoperative complications.

Introduction

Maxillofacial fractures, particularly mandibular fractures, are a prevalent concern in trauma care, accounting for a significant proportion of facial injuries. These fractures commonly result from various traumatic events, such as road traffic accidents, interpersonal violence, falls, and contact

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sports. The mandible, being both functionally and aesthetically important, plays a central role in speaking, mastication, and facial expression. Therefore, the treatment of mandibular fractures requires methods that not only restore its anatomical alignment but also ensure functional recovery and aesthetic restoration. Failure to adequately manage mandibular fractures can lead to long-term complications such as malocclusion, temporomandibular joint dysfunction, and facial deformities, making effective management crucial for patient outcomes.

The management of mandibular fractures has evolved significantly over the years, from early methods like bandages, splints, and circummandibular wiring to more advanced techniques such as rigid internal fixation. The introduction of titanium plate osteosynthesis marked a significant advancement in maxillofacial surgery. Titanium plates, known for their superior mechanical properties and biocompatibility, have become the standard in the treatment of mandibular fractures. Titanium's high tensile strength and resistance to corrosion provide the rigidity needed to stabilize fractures, particularly in challenging cases like comminuted fractures, where traditional methods may fall short [1].

Titanium plate fixation offers several advantages over older techniques such as intermaxillary fixation (IMF) and stainless steel wiring. Unlike IMF, which requires prolonged immobilization and can lead to muscle atrophy and joint stiffness, titanium plates allow for early mobilization and functional recovery [2]. Moreover, titanium plates can provide superior stability, preventing micromovements at the fracture site and promoting primary bone healing. The biomechanical properties of titanium also enable its use in complex fractures, such as those involving the angle or body of the mandible, where precise fixation is critical [3].

Despite its advantages, titanium plate osteosynthesis does have limitations, including the potential for postoperative complications such as infection, hardware failure, or nerve damage [4]. However, these complications are relatively rare, and with proper surgical technique and postoperative care, titanium plate fixation has been shown to yield favorable outcomes. In addition, advancements in plate design, such as pre-contoured and locking systems, have further enhanced the stability and ease of application of titanium plates, particularly in complex mandibular fractures [5].

The objective of this study is to evaluate the efficacy of titanium plate osteosynthesis in managing mandibular fractures, focusing on fracture healing, functional recovery, and postoperative complications. This investigation will provide valuable insights into the role of titanium plates in the treatment of mandibular fractures and their impact on clinical outcomes.

Materials and Methods

This prospective study was conducted at the Maxillofacial Surgery Department of the Tashkent Medical Akademy from May 2024 to September 2024. A total of 24 patients with mandibular fractures who required open reduction and internal fixation (ORIF) using titanium plates were included in the study. The patients' ages ranged from 18 to 40 years, with a median age of 25.4 years. A detailed medical history, clinical examination, and radiographic evaluation were used to diagnose mandibular fractures. Radiographic investigations included orthopantomogram (OPG), postero-anterior view of the mandible (PA view), and occipitomental projections (Water's view). Additionally, preoperative haematological investigations such as complete blood count (CBC), liver and renal function tests, HIV testing (ELISA), and hepatitis screening (anti-HCV and Australian antigen tests) were performed based on the patient's medical history.

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The preoperative assessment also included the patient's age, gender, type of mandibular fracture (e.g., condylar, angle, body, etc.), fracture location, aetiology, and time between injury and treatment. The maximum interincisal opening (MIO) and occlusal status were assessed clinically. Surgical Procedure Patients were administered preoperative intravenous antibiotics (Augmentin 1.2g, GlaxoSmithKline Pharmaceuticals) for infection prophylaxis. The antibiotic regimen was continued postoperatively for 24 hours, followed by oral Augmentin 625 mg three times daily for one week. The surgery was performed under general anaesthesia, and intermaxillary fixation (IMF) was achieved using upper and lower Erich arch bars to stabilize the jaw during fracture reduction.

Internal fixation of the fractures was accomplished using titanium plates. For mandibular fractures, 1.5–2.0 mm titanium plates were used, depending on the location, complexity, and size of the fracture. Titanium mesh was used for cases with comminuted fractures, with a mesh thickness of 0.6 mm selected for mandibular fractures. The titanium mesh was cut from a 8 × 8 hole square sheet, and its size was adjusted to fit the fracture site (Fig. 1, 2). The mesh was shaped using bending pliers, ensuring that vital neurovascular structures were not compromised. The plate and mesh was fixed to the bone using 1.5 mm or 2.0 mm titanium screws, with a minimum of two screws on either side of the fracture site to ensure proper stabilization.

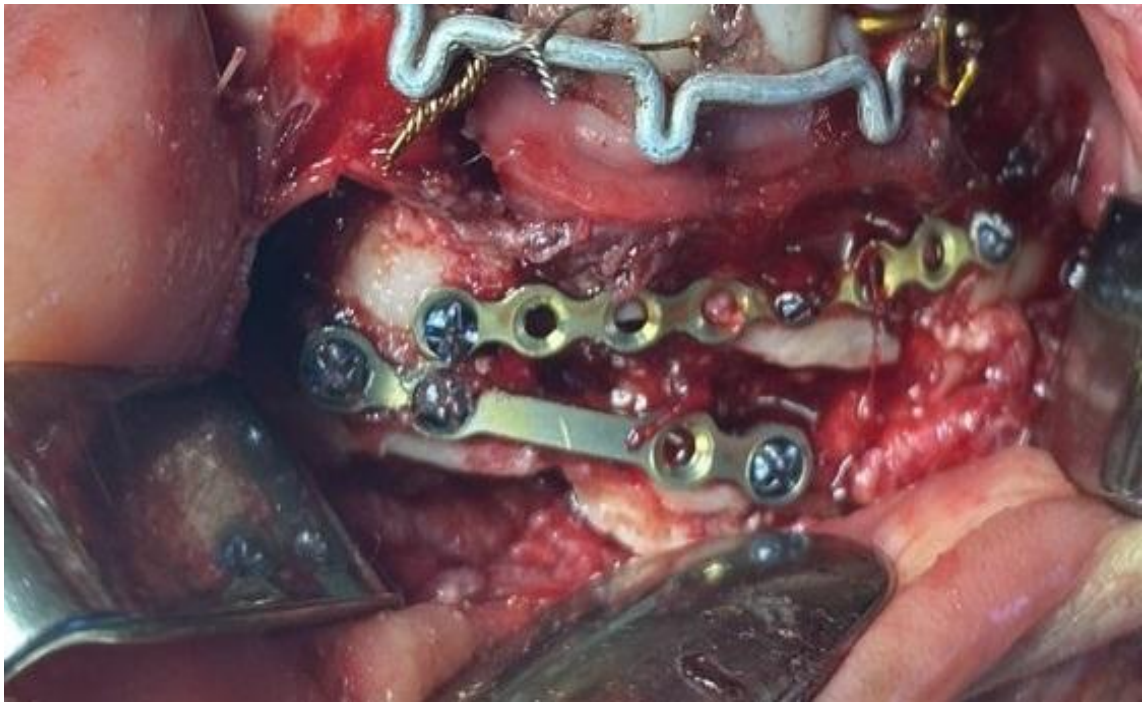

Fig1. Fixation of fracture site (symphysis)

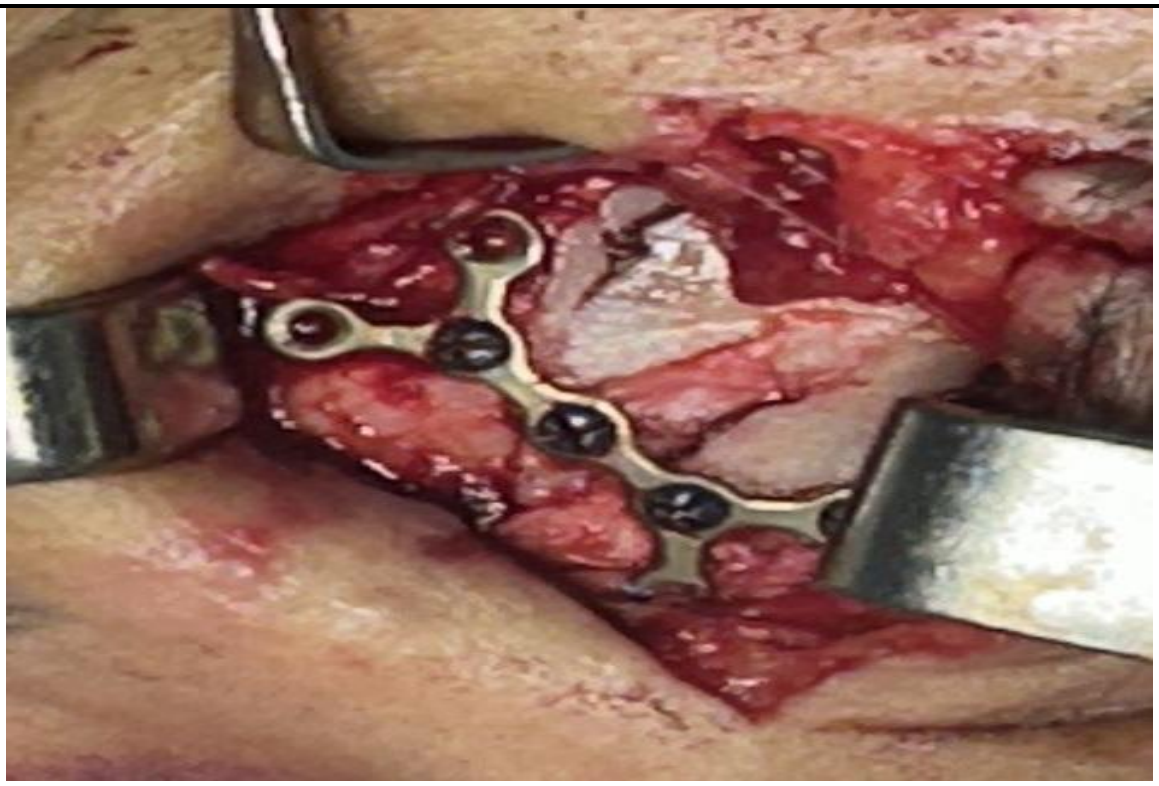

Fig2.Fixation of fracture site (right body)

Postoperative Care

Postoperatively, patients were assessed clinically and radiographically at the 7th day, 3rd week, 6th week, and 12th week. The clinical evaluation focused on occlusal outcomes and the maximum interincisal opening (MIO). Occlusal outcomes were classified as *good*-equivalent to premorbid occlusion, *fair*-minor occlusal discrepancies requiring adjustment or no treatment, *poor*-requiring reoperation to achieve acceptable occlusion

Radiographic evaluation was performed to assess fracture reduction, with the following grading system:

- Good: anatomic reduction
- Fair: minor radiographic spacing
- Poor: significant discrepancies in fracture alignment

Patients who required further stabilization were provided with intermaxillary fixation (IMF) or elastic traction postoperatively to assist with occlusion, particularly in patients with more complex fractures or when initial reduction did not provide satisfactory results.

Data Collection and Statistical Analysis

Data were collected and recorded using Microsoft Excel and analyzed using SPSS (version 15.0). The paired t-test was used to assess changes in maximum interincisal distance. Results were considered statistically significant when the p-value was < 0.05.

This study aimed to evaluate the efficiency of titanium plate osteosynthesis in mandibular fractures by analyzing clinical and radiographic outcomes, postoperative complications, and functional recovery.

Results

A total of 24 patients with mandibular fractures were included in this prospective study. The age of the patients ranged from 18 to 40 years, with a median age of 25.4 years. The male-to-female ratio was 3:1, with the majority of patients being male. The most common aetiology for mandibular fractures was assault, which accounted for 76.8% of the cases (Fig. 3). The mean time between injury and surgical intervention was 8.6 days (range 3–22 days). The fractures in the study cohort were predominantly comminuted, with 88% of the fracture sites classified as such.

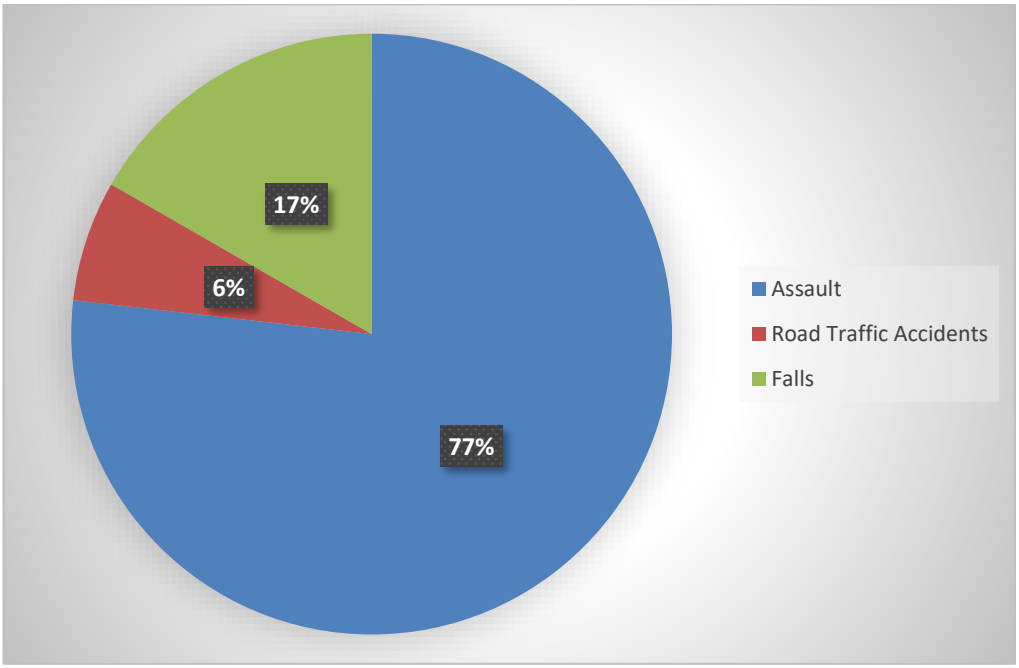

Figure3. *The aetiology of mandibular fractures in the study cohort.*

A total of 30 fracture sites were observed across the 24 patients, with the following distribution: 14 patients (18 fracture sites) had body and angle fractures, 6 patients (6 fracture sites) had condylar and coronoid process fractures and 4 patients (6 fracture sites) presented with symphysis and parasymphysis fractures (Table 1; Fig. 4). The mandibular fracture sites included parasymphysis, body, and angle fractures, as well as combined fractures involving the mandibular body, angle, and condyles.

Table 1. Anatomic location of fracture and distribution of fracture sites

Types of fracture	No. of patients (N)	No. of fractures	Side involved		%
			Right	Left	
Body fracture	6	6	4	2	20.0
Angle fracture	4	4	3	1	13.3
Body + angle fracture	4	8	4	4	26.7
Coronoid process fracture	2	2	-	2	6.7
Condylar process fracture	3	3	2	1	10.0
Symphysis +condylar fractures	3	4	1	3	13.3
Parasymphysis fracture	2	3	1	2	10.0

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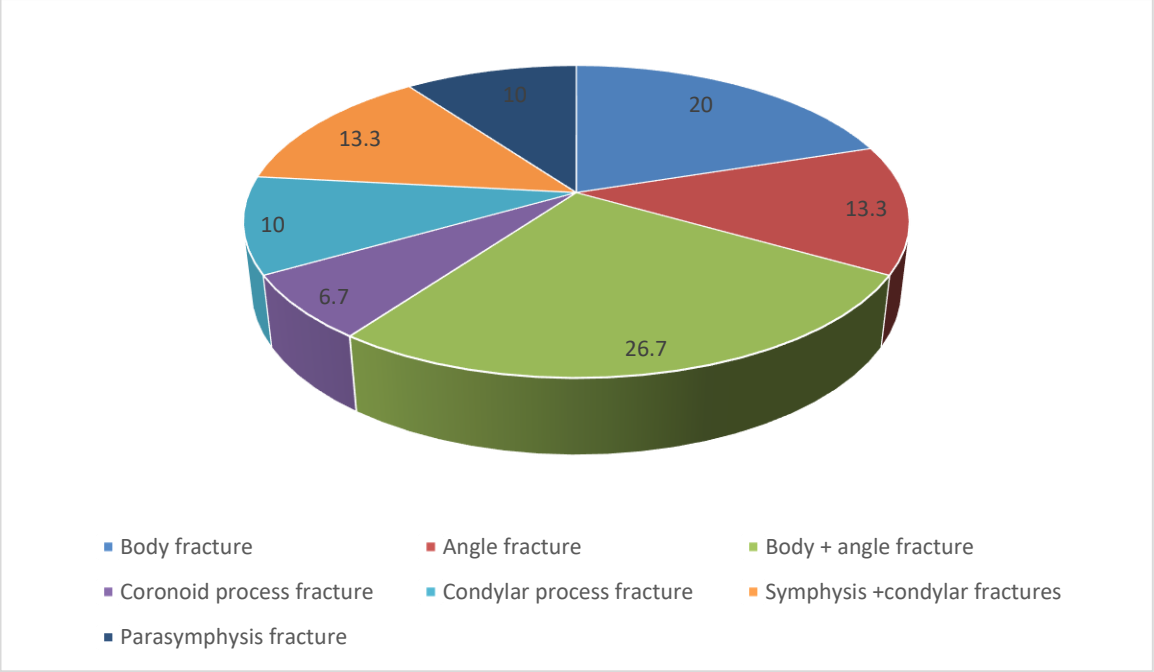

Figure4. *Distribution of fracture sites in the study cohort.*

Preoperative Occlusion and Postoperative Outcomes:

Out of the 24 patients, 83.3% had disturbed preoperative occlusion (Fig. 5). Following open reduction and internal fixation, 91.3% of patients achieved good occlusion by the 12th week, while 8.7% of patients had fair occlusion. Notably, six patients with fair occlusion achieved good occlusion by the 6th week following occlusal adjustment and intermaxillary elastic traction (Fig. 6). Occlusion remained fair in the remaining three patients, who had combined body and condylar process fractures.

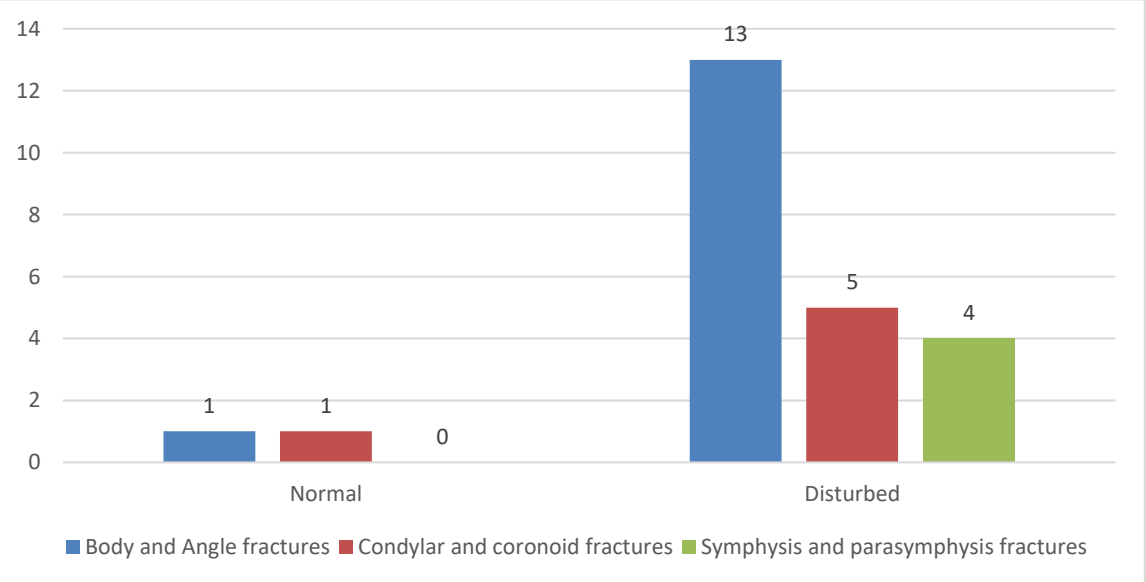

Figure5. *Preoperative occlusion status of patients.*

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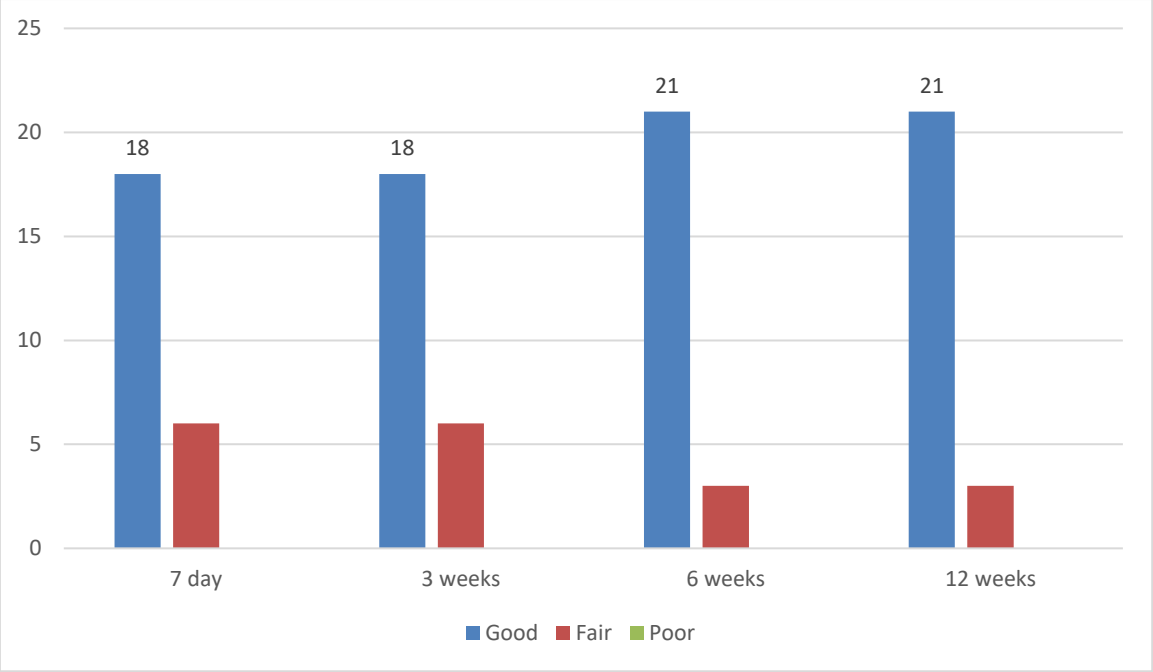

Figure6. *Postoperative occlusion status of patients*

Radiographic Evaluation:

Radiographic assessment was performed at 7 days, 3 weeks, 6 weeks, and 12 weeks postoperatively. At the 12th week, 87.5% of fractures were classified as having good anatomic reduction, while 12.5% were classified as fair reduction (Fig. 6). Condylar fractures (n = 2) and coronoid fractures (n = 1) were excluded from the radiographic reduction evaluation, as these fractures were managed conservatively.

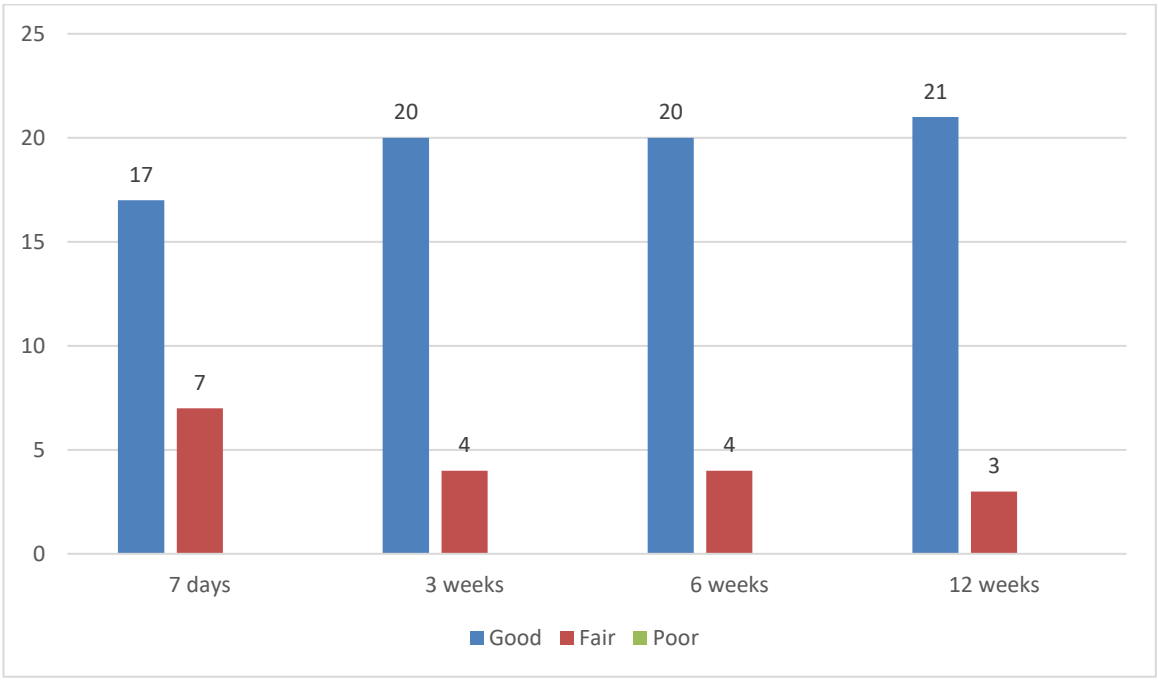

Figure6. *Radiographic evaluation of fracture reduction.*

Maximum Interincisal Distance (MIO):

The maximum interincisal distance (MIO) preoperatively was 19.13 ± 3.94 mm. Postoperative MIO improved progressively at each follow-up, reaching 38.87 ± 4.40 mm at the 12th week. The difference in MIO between preoperative and postoperative measurements was statistically significant at 3 weeks (p = 0.019), 6 weeks (p = 0.000), and 12 weeks (p = 0.000) (Fig. 7).

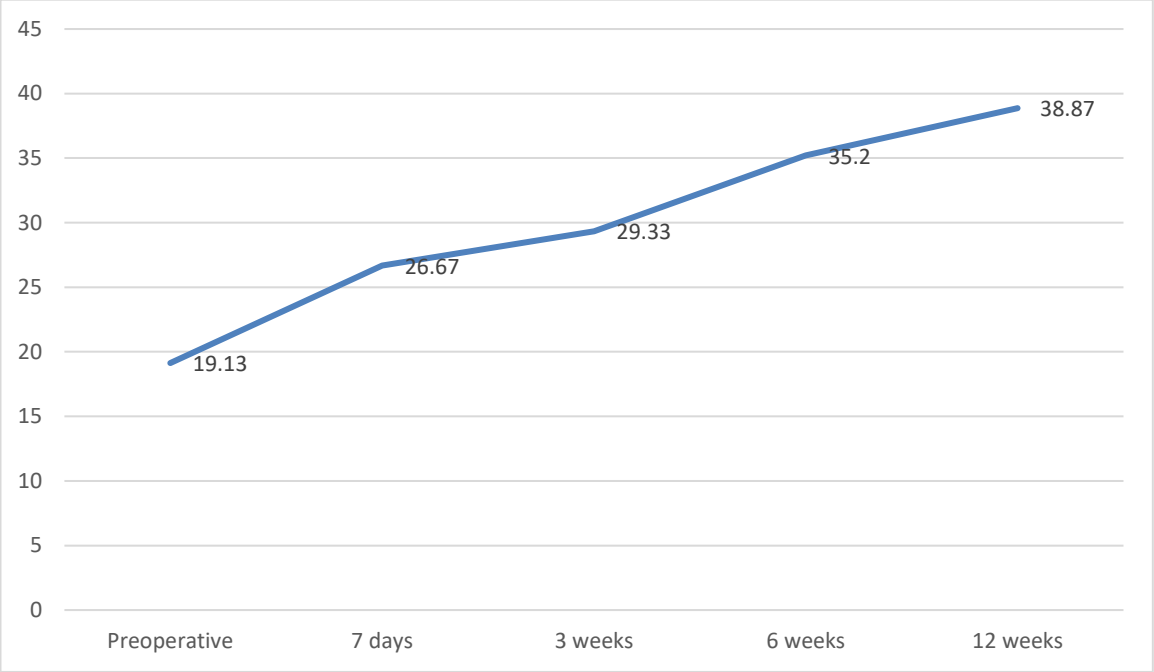

Figure7. *Changes in maximum interincisal distance (MIO) postoperatively.*

Complications:

Preoperative sensory disturbances were present in 73.3% of patients, with 33.3% experiencing hypoaesthesia and 40% experiencing anaesthesia. At 12 weeks postoperatively, residual sensory nerve impairment persisted in 4 patients (15.1%). Intraoral wound dehiscence, with exposure of the titanium plate, was observed in one patient (4.2%) at the 7th postoperative day. This complication was managed with secondary suturing, and no further issues were reported.

Discussion

The use of titanium plate osteosynthesis in mandibular fractures has become the preferred treatment due to its superior biomechanical properties and versatility in managing complex fractures. Titanium plates, known for their malleable and semi-rigid nature, allow for precise fracture stabilization without the risk of elastic memory, which can lead to subsequent stress shielding at the fracture site. The semi-rigid nature of titanium plates is particularly advantageous in the treatment of comminuted fractures, atrophic mandibles, and discontinuity defects where other methods, such as miniplates, may fail to provide adequate stabilization [3]. Titanium plates are especially effective in achieving functional and aesthetic restoration, as they are adaptable to various fracture configurations, ensuring the continuity of the mandible regardless of fracture location or complexity.

In our study, the patient cohort consisted of 24 individuals with a median age of 25.4 years, which aligns with findings from previous studies where mandibular fractures were most commonly observed in younger adults [6]. The male-to-female ratio was heavily skewed toward males

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(93.3%), which is consistent with other reports on trauma-induced fractures where male patients are more commonly affected by road traffic accidents and violence [8]. In our study, the most common mode of injury was road traffic accidents (56.8%), which mirrors the findings of other studies where road traffic incidents are the leading cause of mandibular fractures [6].

Titanium plates have shown a superior ability to restore anatomical alignment and improve fracture stability, especially in comminuted fractures, which constitute 88% of the cases in our study. The rigid fixation provided by titanium plates prevents micromovement and facilitates early healing, which is crucial for reducing the risk of malunion or nonunion, especially in complex fractures where conventional fixation methods may fail [1]. This is consistent with the findings of [5], who reported excellent occlusal outcomes in patients with comminuted mandibular fractures treated with titanium mesh.

One of the key advantages of titanium plate osteosynthesis is its ability to provide functional recovery in a shorter time frame compared to traditional methods such as IMF. In this study, 93.3% of patients achieved good occlusion by the 12th postoperative week, reflecting the efficiency of titanium plates in achieving stable fracture fixation and promoting rapid functional recovery. This finding is in line with studies by [2] and [10], who noted that titanium plate fixation allows for early mobilization, reduces the need for prolonged jaw immobilization, and restores normal function more quickly than IMF, which typically requires weeks of jaw wiring and limited mouth opening.

Despite the favorable outcomes, some complications were observed in this study, including residual hypoaesthesia in four patients (16.7%) and wound dehiscence in one patient (4.2%). These complications, although rare, are consistent with the findings of previous studies on titanium plate osteosynthesis. Residual hypoaesthesia is a common consequence of mandibular fractures due to the involvement of the inferior alveolar nerve or other sensory nerves, particularly in fractures of the body, angle, or condylar regions [11, 5]. In this study, hypoaesthesia resolved in most cases within 6-8 weeks, similar to the outcomes reported by [12]. Wound dehiscence, though uncommon, has been observed in other studies on titanium fixation and is typically associated with poor soft tissue healing or patient-specific factors such as smoking or diabetes [2]. It was successfully managed with secondary suturing and did not result in further complications.

The postoperative management of malocclusion remains a challenge in some cases, particularly in patients with complex fractures or concomitant injuries, such as those with bilateral condylar fractures. In this study, three patients with condylar fractures required intermaxillary elastic traction to guide occlusion, which is consistent with the recommendations by [12]. In cases of condylar fractures, postoperative elastic traction helps mitigate malocclusion caused by muscular guarding or joint stiffness, and its use in our study contributed to achieving favorable functional outcomes in the majority of these patients.

The results from this study confirm the findings of [5], who reported that titanium mesh used for comminuted mandibular fractures resulted in good occlusal relationships postoperatively in 100% of the cases. Similarly, the 93.3% rate of good occlusion achieved in our cohort by the 12th week demonstrates the high efficacy of titanium plate osteosynthesis in restoring both functional and aesthetic outcomes, even in the presence of complex fracture patterns.

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Conclusion

In this study, titanium plate osteosynthesis was found to be an effective and reliable method for managing mandibular fractures. As a fixation technique, it demonstrated excellent physical and biomechanical properties, providing rigid stabilization to the fracture site. Titanium plates were particularly beneficial in stabilizing comminuted fractures due to their strength, adaptability, and ease of contouring to the anatomical structure of the mandible. They allowed for optimal fixation with a minimal number of screws, enhancing fracture stabilization while reducing the risk of micromovements that can impair bone healing.

Titanium plates also offer significant advantages in terms of early functional recovery, as they allow for early mobilization and reduced reliance on intermaxillary fixation, which is typically associated with longer recovery times and functional limitations. Furthermore, the semi-rigid nature of titanium plates helps in preventing stress shielding, promoting functional bone healing and reducing the risk of non-union. The cost of titanium plates in our study was comparable to other fixation methods, making it a cost-effective choice for most patients, particularly for those with complex or comminuted fractures.

Although some complications, such as residual sensory disturbances and wound dehiscence, were observed, these were relatively infrequent and manageable. Overall, the complication rate was acceptable, and the use of titanium plates proved to be highly beneficial in restoring both the form and function of the mandible. This study supports the continued use of titanium plates in mandibular fracture treatment, demonstrating that they provide a reliable, efficient, and effective solution without causing significant functional disability or morbidity to the patient.

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