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RESEARCH ARTICLE

THE IMPACT OF DIFFERENT OSTEOSYNTHESIS TECHNIQUES ON POST-OPERATIVE OUTCOMES IN MANDIBULAR FRACTURE MANAGEMENT

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Abstract

Background and Aims: Mandibular fractures are among the most common facial fractures, typically ranking first or second after nasal fractures, the aim of the current study was to analyse the outcomes of mandible fractures treated using mini plate with and without IMF; and reconstruction plate with or without IMF.
Subjects and Methods: A retrospective study preformed for patients with mandibular fractures treated surgically in Military Hospital in Sana'a city, Yemen during a 2024. The patients divided in 4 groups in respect to treatment, mini plate with and without IMF; and reconstruction plate with or without IMF. Demographic information, systemic sickness, aetiology, fracture location, any related systemic disorders or facial injuries, kind and timing of repair, and antibiotic treatment were all gathered. Complications include infection, non-union or malunion, hardware failure, and wound dehiscence were also noted.
Results: The study analyzed 40 male patients with an average age of 26.7 years. Notably, 67.5% of fractures resulted from road traffic accidents, with fractures primarily classified as simple (50%) and closed (72.5%). Occlusion issues were significant, affecting 67.5% of the patients. In evaluating mandibular nerve injury, 62.5% of patients experienced local numbness. Treatment methods included mini-plate fixation (67.5%) and reconstruction plates (32.5%). The complication rate was 25.9% for mini-plates versus 46.2% for reconstruction plates, with wound herniation and sensory impairment being the most frequent complications.
Conclusions: The complication rates in this group are consistent with published studies, although differences may stem from the small sample size, short follow-up period, and patients' comorbidities. The involvement of experienced surgeons during regular working hours likely contributed to the excellent outcomes, and despite the challenges, most patients achieved positive results.
Keywords: Malocclusion, mandibular fracture, mandibular trauma, Military Hospital, Sana'a city, Yemen.

INTRODUCTION

Among the most frequent facial fractures, mandibular fractures typically rank first or second after nasal fractures. Assault is a significant contributing factor, and they are most prevalent in men between the ages of 18 and 24[1-4]. Restoring pre-traumatic occlusion of the mandible, restoring mandibular ossification, and ensuring appropriate mandibular function are the main objectives of treatment for mandibular fractures. Nowadays, open reduction and internal fixation (ORIF) is a successful treatment for the majority of mandibular fractures. This method guarantees patient comfort, shortens recovery time, enhances functional results, and does away with the requirement for postoperative intermandibular fixation (IMF)[5-8].

When treating mandibular fractures, postoperative problems might happen in as many as 15% of cases, according to several studies[9,10]. The mandibular body is the location most impacted by nonunion following fracture treatment in this anatomical region (3.2%), whereas the mandibular angle has the highest overall complication rate (19%)[1]. Infection, osteomyelitis, malunion, nonunion, wound separation, and appliance failure are the most frequent consequences. Numerous studies have shown that the most frequent complication following surgery is postoperative infection, which is frequently linked to damaged soft tissues and infected

or fractured teeth that remain at the fracture line during the acute phase. The severity and complexity of the fracture, poor reduction and inadequate fixation, alcohol and drug usage, poor oral hygiene, and noncompliance with postoperative care are additional contributing factors[5,9].

Antibiotic use, tooth extraction at the fracture site, treatment scheduling, surgical technique, fixation technique, patient-related factors, and surgeon expertise are some of the variables that can affect complication rates[10-12]. Researching the treatment of mandibular fractures in practical clinical settings provides important insights into clinical practice, complication rates, patient outcomes, and overall quality of care, especially in teaching hospitals where case complexity and healthcare provider experience can differ significantly. Additionally, it offers a chance to investigate how different levels of expertise and resident physician involvement affect clinical outcomes a subject that is still under-represented in published research today[13-16].

The purpose of this study is to assess the rates of postoperative complications related to the management of mandibular fractures at the Military Hospital in Sana'a City, a sizable teaching hospital. It specifically aims to evaluate how different treatment approaches affect complication rates and to compare these results with those published in earlier research. Clinical outcomes in this cohort are expected to be different from those previously reported, especially in terms of the rates and kinds of postoperative complications. This is because healthcare personnel in a teaching hospital context have different complexities and levels of expertise. These results are meant to guide future treatment plans and enhance patient care in comparable clinical settings in Sana'a City and throughout Yemen.

SUBJECTS AND METHODS

Study design

This study examined the clinical records of individuals who had been diagnosed with mandibular fractures during a one year period using a retrospective observational methodology.

Patient population

This study comprised patients with mandibular fractures who visited the Military Hospital's Department of Oral and Maxillofacial Surgery in Sana'a City, Yemen, between January 1 and November 31, 2025.

Ethical considerations

Every participant gave their written or verbal consent. Under registration number 2024-43, dated December 25, 2024, the Ethics Committee of the Military Hospital approved the study, which was carried out in compliance with the Declaration of Helsinki.

Inclusion criteria: First, the fracture must be in the lower jaw and caused by trauma; second, the patient must have received adequate follow-up (at least two follow-up visits after surgery or an initial consultation for one year); and the fracture must be confirmed by computed tomography.

Exclusion criteria: The study excluded patients with pathological fractures due to osteitis, radiation necrosis, cysts, or tumours; it also excluded patients with incomplete medical records and inadequate follow-up.

Clinical feature record

A medical secretary obtained medical records, which the writers (HH and YQ) then examined. Age, gender, comorbidities, cause of fracture, anatomical location of the fracture, involvement of teeth in the fracture line, time from injury to consultation/treatment, type of treatment (mini-plate fixation with or without IMF, reconstruction plate with or without IMF), antibiotic regimen, occlusal status at the last visit, nerve impairment in relation to the inferior alveolar nerve (IAN), and the occurrence and management of any complications were all gathered from patient charts. Clinical evaluation was used to assign patients to treatment groups, taking into account variables such fracture kind, displacement, occlusal stability, patient compliance, and functional impairment. In borderline cases, judgements were affected by the surgeon's judgement even when institutional norms were adhered to. Residents are typically involved in both the surgical operations and follow-up treatment, albeit the extent of their engagement was not mentioned in each case. The incidence of malocclusion, infection rates, and post-operative complications necessitating further surgical intervention were the main outcome measures. Neurological results, surgical scheduling, treatment modality and strategy, fracture patterns, and the requirement for oral rehabilitation were all considered secondary outcome indicators.

Statistical analysis

Standard descriptive statistics were applied when the findings were tallied. Numerical variables are summarised using mean values, whilst categorical variables are displayed as counts and percentages.

Table 1: Sex and age distribution of patients who underwent different bone fixation techniques to repair mandibular fractures.

Characters	N (%)
Sex	
Male	40 (100)
Female	0 (0.0)
Total	40 (100)
Age groups (years)	
Less than 21 years	9 (22.5)
21 -25 years	15 (37.5)
26-30 years	7 (17.5)
More than 30 years	9 (22.5)
Mean	26.7 years
SD	9.1 years
Median	23 years
Mode	22 years
Range	5 to 49

RESULTS

Table 1 shows the distribution of patients by sex and age who underwent different bone fixation techniques to repair mandibular fractures. The study included 40 patients, all male. The mean age of the patients was

26.7±9.1 years, with a range of ages from 5 to 49 years. Looking at the age groups, 22.5% were under 21 years old, 37.5% were 21–25 years old, 17.5% were 26–30 years old, and 22.5% were over 30 years old. Table 2 shows the distribution of fracture causes among patients who underwent different bone fixation techniques to repair mandibular fractures. The most common cause of fractures was road traffic accidents (67.5%), followed by gunshot wounds (12.5%), explosions (7.5%), falls (5%), and assault (5%). Table 3 shows the fracture location in patients who underwent different bone fixation techniques to repair mandibular fractures.

Table 2: Distribution of fracture causes in patients who underwent different bone fixation techniques to repair mandibular fractures.

Characters	N (%)
Assault	2 (5)
Explosion	3 (7.5)
Fall	2 (5)
Gunshot	5 (12.5)
Pathology	1 (2.5)
Road travel accident (RTA)	27 (67.5)
Total	40 (100)

Table 3: Fracture location in patients who underwent different bone fixation techniques to repair mandibular fractures.

Characters	N (%)
Parasymphysial	14 (35)
Symphyseial	11 (27.5)
Body	15 (37.5)
Ramus	4 (10)
Angle	14 (35)
Condyle	4 (10)
Coronoid	0 (0.0)
Total	40 (100)

The percentages were: parasymphysial fracture 35%, symphyseial 27.5%, body fracture 37.5%, angle fracture 35%, condylar fracture 10%, and coronal fracture 0%. Table 4 shows the fracture type in individuals treated for mandibular fractures using different bone fixation methods. Simple fractures accounted for 50%, Comminated fractures for 45%, open fractures for 22.5%, closed fractures for 72.5%, and granitic fractures for 2.5%.

Table 4: Fracture type in individuals treated for mandibular fractures using various osteosynthesis methods.

Characters	N (%)
Simple	20 (50)
Comminated	20 (50)
Open	10 (25)
Closed	30 (75)
Granitic	1 (2.5)
Total	40 (100)

Table 5 shows the postoperative status of patients who underwent various osteointegration techniques to repair a mandibular fracture. Regarding occlusion, 27.5% experienced mild deformity, while 67.5% experienced malocclusion. Concomitant facial disorders were present in 32.5% of patients. Regarding mandibular nerve injury (IAN), 62.5% of patients experienced local numbness, while 37.5% had no change in sensation.

Table 5: Post-operative condition of patients who underwent various osteosynthesis techniques in mandibular fracture repair.

Characters	N (%)
Occlusion	
Minimal distortion	11 (27.5)
Malocclusion	27 (67.5)
Associated facial disorders	
Present	13 (32.5)
Absent	27 (67.5)
IAN injury	
Paranesthesia present	25 (62.5)
No alter in sensitivity	15 (37.5)
Total	40 (100)

Table 6 shows the Osteosynthesis techniques used in the repair of mandibular fractures in the current study. 67.5% of patients used mini-plate fixation, with 50% of them with IMF and 17.5% without using IMF. As for the total number of patients, 32.5% of them used reconstruction plate, with 12.5% using IMF and 17.5% without using IMF.

Table 6: Osteosynthesis techniques that applied to repair of mandibular fractures.

Characters	N (%)
Mini plate	**27 (67.5)**
With IMF	20 (50)
Without IMF	7 (17.5)
Reconstruction plate	**13 (32.5)**
With IMF	6 (12.5)
Without IMF	7 (17.5)
Total	40 (100)

Table 7 illustrates the complications in patients who underwent various bone fixation techniques to repair mandibular fractures. The total number of complications in the current study was 13, with wound herniation being the most common (12.5%), followed by sensory impairment (10%), infection (5%), and malocclusion (5%).

Table 7: Complications among patients subjected to different osteosynthesis techniquesin repair of mandibular fractures.

Complications	N (%)
Infections	2 (5)
Malocclusion	2 (5)
Hardware failures	0 (0.0)
Non-union	0 (0.0)
Mal-union	0 (0.0)
Limited mouth opening	0 (0.0)
Sensory damage	4 (10)
Wound dehiscence	5 (12.5)
Facial asymmetry	0 (0.0)
Total	13 (32.5)

Table 8 illustrates the complications associated with different types of bone fixation techniques used in mandibular fracture repair. With the mini-plate

technique, the complication rate was 25.9%, compared to 46.2% with the reconstruction plate technique. The infection rate with osteoclastosis was 16.7% with the reconstruction plate, while it decreased to 5% with the mini-plate. Wound herniation was similar in both techniques (17.6% for the mini-plate and 16.7% for the reconstruction plate technique). Sensory impairment occurred at similar rates in both techniques also.

Table 8: Complications associated with types of osteosynthesis techniques in repair of mandibular fractures.

	Total	Mini plate		Reconstruction plate	
Complications	**N (%)** N=40	**With IMF N=20**	**Out IMF n=7**	**With IMF N=6**	**Out IMF N=7**
Infections	2 (5)	1 (5)	0 (0.0)	1 (16.7)	0 (0.0)
Malocclusion	2 (5)	1 (5)	0 (0.0)	1 (16.7)	0 (0.0)
Hardware failures	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Non-union	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Mal-union	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Limited mouth opening	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Sensory damage	4 (10)	1 (5)	1 (14.3)	1 (16.7)	1 (14.3)
Wound dehiscence	5 (10)	3 (17.6)	0 (0.0)	1 (16.7)	1 (14.3)
Facial asymmetry	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	13 (32.5)	6 (30)	1(14.3)	4 (66.7)	2 (28.6)

DISCUSSION

Males were more frequently injured than females were, with a ratio of 7.4:1 reported by Gutta *et al.*[17]. In the current study, the study included 40 patients, all of them male. This result can be explained by the fact that males are more prone to mandibular fractures than females, primarily due to lifestyle and behavioural factors, as they often participate in high-risk activities. These activities lead to different primary causes of injury in the sexes. Violence/personal assaults are also associated with males, as they are a leading cause of mandibular fractures in men in many developed countries and urban areas. Some studies have shown that nearly half of all mandibular fractures in men are due to assaults, a rate significantly higher than in women. Risk-taking habits also play a role since young males, who are usually between the ages of 18 and 30, are more likely to engage in dangerous behaviours like driving recklessly, abusing drugs and alcohol, and engaging in violent activities. Men are more likely to work in occupations or engage in outdoor activities, contact sports, and industrial jobs that increase their risk of injury. Lastly, although they impact both sexes, car accidents are a major cause for men and are frequently the consequence of risky driving practices such speeding or failing to wear seat belts and helmets[5,17]. The average age of patients with mandibular fractures varies across studies, but it is generally between the late twenties and early thirties, with studies showing an average age of 29 to 31 years. The patients in the current study ranged in age from 5 to 49 years, with a mean age of 26.7±9.1 years. People between the ages of 16 and 40 often have the highest prevalence because this is a crucial time in life when they are more likely to experience trauma from things like car accidents[18].

In the current study, the most common cause of fractures was road traffic accidents (67.5%), followed by gunshot wounds (12.5%), explosions (7.5%), falls (5%), and assault (5%). This contrasts with the findings of Gutta *et al.*[17], who found that violence was the primary cause of mandibular fractures. Additionally, our findings contrast with those of earlier research by Zix *et al.*[19], and Bakardijiev A, Pechalova P[20], which demonstrated that sports injuries and auto accidents accounted for the majority of injuries[19,20]. The rate of assault and interpersonal violence in the United States has increased by 22% over the last ten years[21]. Because of the economic downturn, drug and alcohol misuse, and decreased social level, there may have been an increase in violence in the community. Additionally, assault-related mandibular fractures have been reported to have numerous fractures[22]. In the current study, the fracture location in patients who underwent different bone fixation techniques to repair mandibular fractures in our setting was parasymphysial fracture 35%, symphyseal 27.5%, body fracture 37.5%, angle fracture 35%, condylar fracture 10%, and coronal fracture 0% (Table 3). This is different from that reported by Gutta *et al.*[17], where the most common fracture location in their study was the angle and body, while Stacey *et al.*[23], reported a greater incidence of condyle and body fractures in their study.

This result is comparable to studies of mandibular fractures, where simple (single-line) fractures are commonly reported, with one study indicating a rate of about 53% of cases. In the current study, simple fractures accounted for 50%. Depending on the research category, the injury's origin, and the diagnostic imaging methods employed, this rate can vary significantly[17]. This result is comparable to studies of mandibular fractures, where simple (single-line) fractures are commonly reported, with one study indicating a rate of about 53% of cases. In the current study, simple fractures accounted for 50%. Depending on the research category, the injury's origin, and the diagnostic imaging methods employed, this rate can vary significantly[17].

In the current study, the comminuted fracture rate was 50%; this incidence of comminuted mandibular fractures varies among studies, generally ranging from about 5% to over 20% of all mandibular fractures, less than our study rate (50%), with some sources reporting a prevalence as high as 30-50% in cases specifically associated with the mandible, depending on the cause of injury and diagnostic methods[24]. In the current study, simple fractures accounted for 50%,

comminuted fractures for 50%, open fractures for 25%, closed fractures for 72.5%, and granitic fractures for 2.5%. Fractures of the mandible occurring in the dental region are often open (compound) fractures, meaning the bone is in contact with the oral cavity and the external environment, and are more common than closed fractures in several reports, in contrast with the current study, where open fractures accounted for only 25%, and closed fractures accounted for 75%. The rates vary depending on the study location and demographics; some research suggests rates as high as 59.2%[25]. Another study concluded that open fractures account for about 10.5% of all fractures in a sample of patients, but the medical consensus indicates their prevalence, especially in the dental area[26]. Actual rates depend heavily on the mechanism of injury and fracture location. Assaults often cause ankle fractures, which are usually open. Motor vehicle accidents can cause fractures in various locations, including the symphysis/parasympathetic bone and the condyle. Falls more commonly result in condylar fractures, which are usually closed. Condylar and ramus fractures are typically closed due to their anatomical location away from the teeth. Fractures of the body, angle, and symphysis/parasympathetic bone (dental-bearing areas) are often open or compound. Because the mandible is frequently fractured in tooth-bearing areas, open fractures are a major clinical concern, primarily due to the high risk of oral bacterial contamination and subsequent infection[27,28].

In the current study, the total number of complications was 13 (32.5%), with wound herniation being the most common (12.5%), followed by sensory impairment (10%), infection (5%), and malocclusion (5%). Our findings differ from those of Gutta *et al.*[17], who reported problems such as nonunion and malunion, hardware failure, infection, wound dehiscence, and malocclusion. Only patients who reported a "improper bite" or a "bad bite" were included in the current study, despite the clinician's evaluation of malocclusion being taken into consideration. A higher incidence of problems (58.1%) was observed by Siddiqui *et al.*[29]. However, neurosensory impairments accounted for the majority of those problems (45%), with infection accounting for 12.9%. Neurosensory impairments have been observed in the majority of individuals with substantially displaced angle and body fractures. Determining whether these injuries were caused by the repair has proven to be quite challenging. A 15% complication rate was found in another trial, with wound dehiscence or infection accounting for the majority (75%)[30].

Paza *et al.*[31], reported a total complication rate of 19.7%, and only 3% required revision surgery. We believe the rate of complications will be influenced locally by the injury severity, injury site, and number of involved sites. Infection rates in this study were low (5%) compared to other studies. Less than 5% of patients showed signs of swelling and suppuration. Ellis-Walker[32] documented a high proportion of total complications (28%) and infections (25%). Izuka and Lindqvist's investigation[33] revealed a 6.6% infection rate. They discovered a correlation between the usage of mandibular angle compression plates following fracture line extraction and infection[33]. High infection rates following internal fixation of the mandibular angle, particularly when removed from the fracture line, have also been reported in other investigations. Additional oral antibiotic medication (either before or after surgery) and a mouthwash containing 0.12% chlorhexidine were given to this patient group. This outcome was consistent with earlier research. Even in cases where patients did not take antibiotics, other research has shown a low prevalence of complications from mandibular fractures[34,35].

According to a number of earlier research, reconstruction plates offer stronger fixation for more severe or comminuted fractures, while mini-plate fixation is usually a less invasive approach used for less complex fractures[36]. While the rate of plate exposure or oedema with reconstruction plates may be higher, mini-plates are frequently linked to higher rates of problems, such as neurosensory abnormalities, particularly when utilised as a single plate. Both methods provide adequate stability, and the best option is determined by the particular fracture pattern[37,38]. Compared to the reconstruction plate approach, which had a complication rate of 46.2%, the mini-plate technique had a complication rate of 25.9% in the current study. With the reconstruction plate, the osteoclastosis infection rate was 16.7%; with the mini-plate, it dropped to 5%. Both methods had comparable rates of wound herniation 17.6% for the mini-plate and 16.7% for the reconstruction plate procedure). In all methods, sensory deterioration also happened at comparable rates. This result indicated that the mini- plate technique, had less, compared to the reconstruction plate technique. This is different from that reported by Jacobs *et al.*[37], where they found that mini plates cause higher complications compared to reconstructive plates, such as bone exposure and impaired stability. However, other studies suggest that mini-plates may be more prone to soft tissue problems and nerve damage while reconstructive plates, on the other hand, may have higher rates of plate exposure[39,40].

Limitations of the study

This study, which analyzed the outcomes of treating mandibular fractures using microplates versus reconstructive plates (with or without intermandibular fixation), faced several major limitations related to study design, patient factors, and outcome assessment. These limitations included the small sample size, making it difficult to observe statistically significant differences in outcomes or complications between the different treatment groups.

CONCLUSIONS

The current study comparing the use of microplates versus reconstructive plates for mandibular reconstruction showed little difference in overall complication rates, favoring microplates, although some problems may differ. While microplates may cause fewer complications or be easier to remove, reconstructive plates are sometimes associated with a higher risk of specific problems, such as infections.

Overall, both techniques appear effective, but the optimal choice may depend on the specific clinical situation, the surgeon's decision, and their experience. The complication rates in this group are consistent with published studies, although differences may stem from the small sample size, short follow-up period, and patients' comorbidities. The involvement of experienced surgeons during regular working hours likely contributed to the excellent outcomes, and despite the challenges, most patients achieved positive results.

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AUTHOR'S CONTRIBUTIONS

Alezzi AM: formal analysis, conceptualisation, data organisation, and clinical and laboratory exams. **Al-Rahbi LM:** supervision. **Al-Shamahy HA:** critical review. **Al-Ashwal AA:** conceptualization, data organization. Final manuscript was checked and approved by all authors.

DATA AVAILABILITY

The associated author can provide the empirical data used to support the study's conclusions upon request.

CONFLICT OF INTEREST

None to declare.

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