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RESEARCH ARTICLE

COMPARATIVE OUTCOMES IN MANDIBULAR ANGLE FRACTURE MANAGEMENT RECONSTRUCTION PLATES VERSUS DUAL MINIPLATES FIXATION

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Abstract

Background and aims: The angle created by the positioning of the ramus and mandibular body is known as the mandibular angle. An angle fracture is characterized by a triangular region that is enclosed by the masseter muscle's anterior border and an oblique line that runs from the mandibular third molar region to the masseter muscle's posterior inferior attachment. This study examined the results and side effects of utilizing reconstruction plates against double miniplate fixation for treating mandibular angle fractures.
Materials and methods: The Department of Oral and Maxillofacial Surgery at the Military Hospital in Sana'a, Yemen, carried out the study between 2020 and 2024, diagnosing mandibular angle fractures in two equal groups. Reconstruction plates were used for 20 patients in Group A, and double miniplate fixation was used for another 20 patients in Group B. Following surgery, the two groups had radiographic and clinical evaluations for mandibular deviation, hematoma, infection, limited mouth opening, surgical site edema, plate exposure, plate stability, and malocclusion.
Results: The study found that 15% of patients treated with reconstruction plates experienced bone exposure, 10% experienced impaired stability, 30% reported plate-site edema, and 15% reported nerve injury, compared to the 10% treated with two miniplates. The study found that the use of two miniplates was better at reducing deviation opening in patients treated with two miniplates, with a difference of 15% and a *p*-value of 0.07.
Conclusion: The study found that fixation using two miniplates is the most effective and reliable treatment strategy for mandibular angle fractures, with lower complication rates and minimal infection rates. Further studies are needed to determine the optimal approach for fixing these fractures.
Keywords: Complication rate, double miniplate fixation, mandibular angle fractures, reconstruction plates.

INTRODUCTION

The therapy and restoration of mandibular fractures has undergone gradual evolution. Many methods for repairing mandibular fractures have been presented over time. These procedures have varied from maxillary-mandibular fixation (MMF) to combination MMF fixation with bone wire, screw fixation, and plate fixation[1-11]. The use of compressive and non-compressive plate systems for rigid internal fixation (RIF) has become increasingly common in recent years. Avoiding MMF fixation, early mandibular function, improved patient satisfaction, shortened recuperation times, an earlier return to work, and many other benefits too many to list here are just a few of the advantages of RIF[12,13].

Michelet *et al.*[12], introduced the use of a non-compression unicortical miniplate technique for fixing mandibular fractures about fifty years ago, and Champy *et al.*[5], developed it five years later. By positioning a plate along the so called optimum line of bone fixation, the technique uses miniplate fixation to

offset distracting pressures that arise along the fracture line during mandibular function. This line indicates that the plate might be positioned just below or along the mandibular oblique line in the mandibular angle region[5]. However, after fifty years of expertise and use, experimental and clinical research have demonstrated that miniplate fixation's appropriateness for repairing angle fractures is still debatable. For instance, Kroon *et al.*[14], showed that loading pressures close to the fracture line caused only minor distraction of the mandibular inferior border. Placing a miniplate in the "ideal line" suggested by Champy *et al.*[5], would not stop this distraction. Choi *et al.*[15], shown in a related in vitro investigation that the addition of a second little plate along the inferior border aids in stabilizing fixation during functional loading. Postoperative infection rates with multidrug-resistant bacteria are significant in Yemen, despite advancements in surgery both domestically and internationally[16-22]. Also, despite surgical advances, the mandibular fractures treatment is still linked with multiple complications and has high postoperative complication rates[4,5,8]. However, Levy *et al.*[21], confirmed a low complication rate when treating mandibular fractures using two unicortical miniplates for internal fixation of angular fractures, compared to a higher complication rate when using a single miniplate, while Ellis and Walker[8] suggested that using a single miniplate at the angular provides a lower complication rate than using two miniplates.

The current study's objectives were to: (1) assess our performance in situations where our institution employed two unicortical miniplates to treat mandibular angle fractures; and (2) compare our findings with those of other studies and reconstruction plates.

METHODS

The Department of Oral and Maxillofacial Surgery at the Military Hospital in Sana'a, Yemen, carried out the study between 2020 and 2024, diagnosing mandibular angle fractures in two equal groups. Reconstruction plates were used for 20 patients in Group A, and double miniplate fixation was used for another 20 patients in Group B. After that, postoperative complications were examined. Between weeks two and eight, each patient received a follow-up call. After surgery, the two groups were recorded and evaluated radiographically and clinically for plate exposure, plate stability, surgical site swelling, restricted mouth opening, hematoma, infection, malocclusion, and mandibular deviation.

Statistical Analysis: To statistically compare the clinical complication rates of the two methods (reconstruction plates VS double miniplate fixation), the Z-test was used for the two comparison rates in reconstruction plates and double miniplate fixation. The risk ratio (RR) was also calculated for each method and was a measure of the risk of postoperative clinical complications in Group A compared to the risk of the same event in Group B. risk ratios are used in prospective studies, such as cohort studies, and clinical trials such as ours. We also conducted descriptive analyses using frequency distribution, percentages, and proportions.

RESULTS

Table 1 shows the distribution of patients with mandibular angle fractures treated with reconstruction plates and compared with double miniplate fixation. The number of patients treated with reconstruction plates was 20, of whom 17 were male (85%) and 3 were female (15%). The double miniplate fixation group included 20 patients, all of whom were male. Table 2 shows the complication rates, mean differences, and statistical significance between patients with inferior lateral angle fractures treated with reconstruction plates compared to those treated with double miniplates.

Table 1: Gender distribution of patients with mandibular angle fractures treated with reconstruction plates and comparison with double miniplate fixation.

Gender	Reconstruction plates, N (%)	Dual miniplates fixation, N (%)
Male	17 (85)	20 (100)
Female	3 (15)	0 (0.0)
Total	20 (100)	20 (100)

Table 2: Complication rates, difference rates, and significance between patients with mandibular angle fractures treated with reconstruction plates compared with double miniplate fixation.

Complications	Reconstruction plates N (%)	Dual miniplates Fixation N (%)	Difference	*95% CI*	Chi-squared	*p*
Plate Exposure	3 (15)	0 (0.0)	15	-3.8-36	3.2	0.07
Stability (not stable)	2 (10)	1 (5)	5	-14.9-25.5	0.35	0.55
Swelling	6 (30)	2 (10)	20	-5.3-43	2.4	0.11
Nerve Injury	3 (15)	2 (10)	5	-17.3-27.2	0.22	0.63
Open Mouth Limitation	0 (0.0)	0 (0.0)	0	-16.1 16.1	-	-
Hematoma	2 (10)	0 (0.0)	10	-7.6-30	2.1	0.15
Infection	3 (15)	1 (5)	10	-11-31	1.1	0.29
Malocclusion	3 (15)	0 (0.0)	15	-3.8-36	3.2	0.07
Deviation Opening	2 (10)	1 (5)	5	-14.9-25.5	0.35	0.55

Table 3: The association between the occurrence of complications and the use of the reconstruction plate method.

Complications	Reconstruction plate, N (%)	Risk ratio	CI	*p*
Plate Exposure, n=3	3 (15)	2.2	1.5-3.1	0.05
Instability, n=3	2 (10)	1.3	0.5-3.2	0.3
Swelling, n=8	6 (30)	1.7	0.9-3	0.06
Nerve Injury, n=5	3 (15)	1.2	0.5-2.7	0.3
Open Mouth Limitation, n=0	0 (0.0)	0	undefined	0.14
Hematoma, n=2	2 (10)	2.1	1.5-2.9	0.12
Infection, n=4	3 (15)	1.58	0.8-3.1	0.13
Occlusion, n=3	3 (15)	2.7	1.5-37	0.05
Deviation opening n=2	2 (15)	2.2	1.5-29	0.045

When plate exposure was considered as a complication, 15% of patients treated with reconstruction plates experienced bone exposure, while none occurred with double miniplates, representing a rate difference of 15%, a coefficient of variation (X^2)=3.2, and a *p*-value of 0.07. 10% of patients treated with reconstruction plates encountered poor stability when Stability was taken into consideration as a complication, whereas 5% of patients treated with double miniplates experienced this. This represents a 5% rate difference, a coefficient of variation (X^2)=0.32, and a *p*-value of 0.63. 30% of patients treated with reconstruction plates reported edema at the plate site, compared to 10% treated with double miniplates. This represents a 20% rate difference, a coefficient of variance (X^2)=0.24, and a *p*-value of 0.11. 15% of patients treated with reconstruction plates reported nerve injury, compared to 10% who received twin miniplates. This represents a 5% rate difference, a coefficient of variation (X^2)=0.22, and a *p*-value of 0.63 when nerve injury is taken into account as a consequence. Open Mouth Limitation was regarded as a problem, and it happened in 0% of patients treated with reconstruction plates and 0% of patients treated with double miniplates, indicating a 0% rate difference between the two techniques. 10% of patients treated with reconstruction plate's encountered hematoma, whereas 0% experienced it with double miniplates. This represents a 10% rate difference, a coefficient of variation (X^2)=0.2.1, and a *p*-value of 0.15 when hematoma was taken into account as a consequence. With a 10% rate difference, a coefficient of variation (X^2)=1.1, and a *p*-value of 0.29, 15% of patients treated with reconstruction plates and 5% of patients treated with double miniplates suffered infection when infection at the site of surgery was taken into consideration as a consequence. Total 15% of patients treated with reconstruction plates suffered occlusion, compared to 0% with double miniplates, when occlusion was taken into account as a complication. This represents a 15% rate difference, a coefficient of variation (X^2)=3.2, and a *p*-value of 0.07. 5% of patients treated with twin miniplates suffered Deviation Opening, compared to 10% of patients treated with reconstruction plates. This represents a 5% rate difference, a coefficient of variation (X^2)=0.35, and a *p*-value of 0.55. In conclusion, the double miniplates approach had lower rates of problems than the reconstruction plate approach, indicating that the two miniplates approach is superior.

Table 3 shows the risk ratio (RR), which measures the risk of postoperative complications in the reconstruction plate group compared to the risk of complications in the two-miniplate group. The RR for plate exposure was found to be 2.2 times higher when the reconstruction plate was used to treat mandibular angle fractures, with a range of 1.5–3.1, $p < 0.05$. This indicates an increased risk of these complications in the exposed group (reconstruction plate group). There was a significant RR for occlusion contracture of 2.7 times higher when the reconstruction plate was used to treat mandibular angle fractures, with a range of 1.5–3.7, $p < 0.05$. There was a significant RR for opening deviation contracture of 2.2 times higher when the reconstruction plate was used to treat angle fractures, with a range of 1.5–29, $p<0.045$. However, there is no significant association between the use of reconstruction plates for the treatment of angle fractures and the occurrence of complications such as instability, swelling, nerve injury, open mouth restriction, hematoma, and infection.

Table 4: The association between the occurrence of complications and the use of the dual miniplates fixation method.

Complications	Dual miniplates fixation N (%)	Risk ratio	CI	*p*
Plate Exposure, n=3	0 (0.0)	0.0	undefined	0.05
Stability, n=3	1 (5)	0.6	0.12-2.3	0.3
Swelling, n=8	2 (10)	0.4	0.12-1.5	0.06
Nerve Injury, n=5	2 (10)	0.7	0.25-2.3	0.33
Open Mouth Limitation, n=0	0 (0.0)	0.0	undefined	0.06
Hematoma, n=2	0 (0.0)	0.0	undefined	0.12
Infection, n=4	1 (5)	0.47	0.08-2.6	0.17
Occlusion, n=3	0 (0.0)	0.0	undefined	0.05
Deviation Opening, n=2	0 (0.0)	0.0	undefined	0.12

Table 4 shows the risk ratio (RR), which measures the risk of postoperative complications in the double-miniplate group compared with the reconstruction plate group. A significant protection rate was observed for double-miniplate against plate exposure complications (p=0.05), as well as a significant protection rate for double-miniplate against occlusion complications (p=0.05). However, double-miniplate fixation showed a low or complete absence of complications. This suggests that the use of double-miniplate fixation reduced the risk of these complications in the double-miniplate group.

DISCUSSION

Between 23 and 42 percent of all mandibular fractures are angle fractures[1,9,10,23-25]. The presence of a third molar and the angle's low cross-sectional bone area are partly responsible for its frequent involvement in mandibular fractures[24,26,27]. The location of fracture is also influenced by other factors, including bone mass and density, impact point, direction, and severity[24]. Since the fracture is often posterior to the dentition and the bone in the mandibular angle region is thin inferiorly, MMF cannot provide sufficient stability. The opposing muscular forces of the elevator group (masseter, medial and lateral pterygoids, and temporalis muscles) and the depressor group (geniohyoid, genioglossus, mylohyoid, and digastric muscles) frequently cause unstable rotation or distraction of the proximal and distal fracture segments. In addition, a third molar may reduce bone contact, hinder reduction, change the vascularity of the fracture site, or harbor pathogenic organisms[28]. In situations requiring the treatment of mandible fractures, maxillomandibular fixation may present a variety of possible issues, such as inadequate nutrition, temporomandibular joint disorders, oral airway impairment, patient discontent, noncompliance, and social difficulty[7,29-31].

With a 10% rate difference, a coefficient of variation (X^2)=1.1, and a p-value of 0.29, 15% of patients treated with reconstruction plates and 5% of patients treated with double miniplates experienced infection when surgical site infection was taken into account as an outcome in the current study. It is recognized that the use of rigid internal fixation may avoid some of the difficulties associated with MMF. Passeri *et al.*[32], 1 conducted a retrospective review of complications in 96 patients, with 99 angle fractures, treated with either closed or non-rigid fixation with MMF. The researchers found an overall complication rate of 17%, with infection being the most common. James *et al.*[33], also reviewed the non-rigid treatment of 253 patients; 136 fractures were through the angle. Nine angle injuries occurred, representing a 7% infection rate in this group.

Obtained results showed that the use of a dual miniplate fixation is superior to the reconstruction method. This is similar to the recommendations of Michelet *et al.*[12], and Champy *et al.*[5], for the use of a non-compression unicortical miniplate for mandibular fracture fixation. Based on the results of other biomechanical studies, Champy *et al.*[5], described two lines of fixation located along the external oblique line and the superior buccal cortex. Since the work of Michelet *et al.*[12], and Champy *et al.*[5], non-compression miniplate fixation of angular fractures has gained popularity. Some of the advantages of monocortical miniplate fixation over other methods of rigid internal fixation (such as reconstruction or compression plates) include: (1) intraoral incisions are reduced or eliminate the need for a large external scar; (2) potential risks to the inferior alveolar nerve and marginal mandibular nerve are reduced; (3) simultaneous observation of a reduction in the fracture line and occlusal relationships is possible; (4) miniplates are easier to adapt to bony curvatures than compression plates or reconstruction; (5) The intraoral approach may be less technically demanding than the extraoral approach[22,24].

In the current study, 15% of our patients treated with reconstruction plates developed malocclusion, compared to 0% of those treated with double miniplate fixation, when malocclusion was taken into account as a complication. Biomechanical analysis by Crone *et al.*[15], showed that when occlusal load was applied to identical molars, flattening occurred along the lower edge of the angle in a single miniplate angle fracture model. This study, along with in vitro studies by Choi *et al.*[15], and a clinical study by Levy *et al.*[21], provided evidence that double miniplate fixation may provide better fixation of angle fractures compared to the Champey *et al.*[5], method. Levy *et al.*[21], reported on 32 angle fractures treated with a paired miniplate in which 1 complication (3.1%) occurred (infection) compared to 5 complications (26.3%) in 19 patients treated with a single miniplate across the oblique line (infection, n=3 [15.7%]; delayed union, n=1(5.3%); and malocclusion, n=1 [5.3%]).

Additionally, the infection rate in current study using the paired miniplates approach was 5%. This contrasts with the results of other studies, which revealed that Ellis and Walker[8] used paired miniplates to get a high infection rate of 25% and an overall complication rate of 28%. Hardware had to be removed from 16 out of 69 fractures in order to prevent infection. Ellis and Walker[8] hypothesized that the extraction of teeth in the line of fracture would contribute to the increased infection rate. Although other factors such as multidrug-resistant bacteria may also be involved and complicate cases as infected cases become difficult to treat with antibiotics[35-38]. Ellis and Walker[39] assessed the outcomes of treating mandibular angle fractures with one non-compression miniplate in a different trial. All of our patients were treated with antibiotics and 0.1% chlorhexidine rinses from the time of presentation until approximately 7 to 10 days postoperatively. This therapeutic approach may have contributed to the low infection rates observed in current study. Furthermore, the duration of treatment did not affect the likelihood of infection or any other complications in this study. Proper use of antibiotics and proper oral hygiene may have improved infection outcomes and allowed for a longer delay in treatment, without adverse consequences. Other studies

comparing current results did not report whether antibiotics were used similarly to current study.

The results of 113 patients with 121 angle fractures treated with neutral reconstruction plates, compression plates, or lag screw fixation were assessed in a research by Iizuka and Lindqvist[40]. In 8 patients (6.6%), a postoperative infection was found. The use of compression plates at the angle following tooth extraction at the fracture line was linked to infection, according to the authors[40]. High infection rates following internal fixation of the mandibular angle have been reported in a number of different studies, particularly in cases where a tooth has been removed from the fracture line[42-44]. However, according to Iizuka and Lindqvist[40], malocclusion was more common when two distinct osteosyntheses were carried out as opposed to one osteosynthesis (26.2% vs. 8.5%). Compared to 10% of patients treated with twin miniplates, 15% of patients treated with reconstruction plates in the current research suffered nerve damage. When considering nerve damage as a consequence, this results in a 5% rate difference, a coefficient of variation (X^2)=0.22, and a *p*-value of 0.63. The manipulation at the fracture site during surgery most likely caused the sensory abnormalities that were discovered after the procedure. It is unlikely that monocortical screws will cause nerve damage. Furthermore, it is uncertain if the sensory problems observed here were temporary due to the short follow-up time in this group (mean of 7 weeks).

Limitation of the study

It is crucial to acknowledge a few of this study's shortcomings. It is a retrospective review, to start. The very little follow-up time and patient non-compliance further reduced the study's strength.

CONCLUSIONS

In the treatment of mandibular angle fractures using reconstruction plates, compared with fixation using two miniplates, fixation using two miniplates is the most effective and reliable treatment strategy for mandibular angle fractures, with lower complication rates. Complications were minimal in current study, with an infection rate of 5%, comparable to or higher than the infection rate using the reconstruction plate technique (15%). Occlusal disturbances were associated with the reconstruction plate technique, while none were reported with miniplate fixation.

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AUTHOR'S CONTRIBUTIONS

Awad MMA: Formal analysis, conceptualization, data organization, and clinical examinations. **Al-Moyed KA:** Editing. **Al-Rahbi LM:** review, supervision. **Al-Ashwal AA:** review, supervision. **Al-Shamahy HA:** review, supervision. Final manuscript was checked and approved by all authors.

DATA AVAILABILITY

Data will be made available on request.

CONFLICT OF INTEREST

There are no conflicts of interest in regard to this project.

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