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Effectiveness of placement of second miniplates as tension band unit in mandibular parasymphysis fractures

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ABSTRACT

Background: The ideal position of the plates and the need for additional plates are discussed continuously. In mandible, the tensile forces at the fracture line should be neutralized with a tension band. This study evaluated the role of the mandibular arch bar as a tension band eliminating the need for an upper miniplate (tension band plate) in cases of parasymphysis fractures.

Materials and Methods: In this randomized control trial, a total of 90 patients with mandibular parasymphysis fractures underwent treatment in two groups. Group A was treated with one titanium miniplate along with Erich's arch bar. In Group B, two titanium miniplates were placed across the fracture site along with Erich's arch bar. Then, the complications and duration of the operation time were compared between two groups. The results were considered statistically significant when the $P < 0.05$.

Results: No significant difference was observed between the groups regarding postoperative complication rate. 1 month after surgery in Group A, number of patients with sensory impairment (17%) was significantly lower than Group B (37%) ($P = 0.029$). Furthermore, the operation time of Group A was significantly shorter than Group B ($P < 0.001$).

Conclusion: In the presence of arch bar, placing one miniplate instead of the routine technique of placing two, do not increase complication rates. Furthermore, it reduces the operation time and costs and results in a better neurosensory recovery outcome in short time.

Key Words: Mandibular fracture, open reduction, internal fixation

INTRODUCTION

In maxillofacial trauma, one of the first bones absorbing the force is mandible, due to its projected position, so it is one of the most frequently fractured ones.[1-3] Various methods have been used to treat mandibular fractures, and the concept of bone plating has been improved by the introduction of new technologies and different modifications.[4-6] Recently, the miniplate fixation has been the most popular method due to its procedural simplicity and good clinical outcomes.[7,8]

The ideal position of the plates and the need for additional plates has been discussed continuously. Champy *et al.* have shown that for ideal osteosynthesis of any fracture, fixation should be applied in the tension and compression areas. According to Champy, superior

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border of mandible is where tensile forces exist while compressive forces can be detected at its inferior border. The continuous functions of the stomatognathic system cause tensile forces at the fracture area, which must be prevented by tension bands.[9,10]

Function torsional forces appear in symphysis and parasymphysis regions.[10-12] Champy showed that re-establishing mechanical qualities of the fractured bone is the principle of osteosynthesis. In the anterior region, Champy used two miniplates, one at the inferior border and for further osteosynthesis and the second one is placed at the base of the alveolar process, which is known as the tension line. Surgeons are still following Champy's principle, but lots of questions have been arising about the need for two miniplates in the treatment of mandibular parasymphysis fractures.[9]

Rix *et al*. used one plate with a bridle wire fixed to teeth bilateral to the fracture serving as tension band.[13] Most surgeons when treating mandibular fractures place arch bars for intra- or postoperative maxillomandibular fixation (MMF).[14,15] In this situation, the tensile forces among the fracture line can be eliminated by the lower arch bar (as a tension band) which questions the need for a second plate (subapical plate). Placing only one miniplate for treatment will be more economical for the patient. Furthermore, it will reduce the incidence of infection, sensory impairment related to the mental nerve, wound dehiscence, and injury to the teeth adjacent to the fracture line.

In this study, the need for placing a second miniplate as a tension band in the presence of lower arch bar is evaluated. Two treatment modalities for parasymphysis fractures, one with placing a second plate as a tension band and one without it, are compared by assessing procedures intraoperative time, mental nerve sensory impairments, discrepancy in the occlusion, incidence of infection, exposure of miniplates, malalignment of the lower border, and improper reduction of fracture fragments.

MATERIALS AND METHODS

Study design and patients

This double-blind, randomized clinical trial was carried out during 24 months from December 2014 to December 2016 in the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Tabriz University of Medical Sciences.

In the present study, 90 patients aged 20–60 years with a history of trauma having isolated displaced parasymphysis fractures were selected and included in the study. All the patients were matched in relation to age and sex. The samples were selected randomly and were randomly assigned to two equal groups (n = 45) by one operator blinded to the aims of the study using the Randlist software (version 1.2). All the patients completed the study and none was excluded from the study [Figure 1].

Inclusion criteria: Patients with an isolated parasymphysis fracture with occlusal discrepancy who had sufficient teeth in both sides of the fracture were included.

Exclusion criteria: edentulous mandible, parasymphysis fractures along with other mandibular or facial bone fractures, no indication for or unwilling to undergo open reduction with internal fixation, comminuted fractures, and infected fractures were excluded from the study.

Study groups

The patients in the first group (Group A) who stand as an intervention group, were treated with placement of Erich's arch bar and one miniplate at the inferior border of the mandible. In the second group (Group B) which stands as active control group, two miniplates were used for internal fixation along with placement of Erich's arch bar.

The patients in the Group A were treated with placement of arch bar and a 6-hole miniplate with 2.3 mm diameter at the inferior border of the mandible. In the Group B, among placing an Erich's arch bar, two miniplates were used. One miniplate is placed as described in Group A, in addition to that, a 4-hole miniplate with 2.3 mm diameter was placed 5 mm above the first miniplate. For all patients, 2.3 mm × 8 mm monocortical titanium screws were used.

First head injury and cervical spine injury were ruled out in all patients. After all patients were treated for any concomitant injury and their complete stabilization was ensured, surgery was undertaken. Under general anesthesia, arch bars were applied. Then, an intraoral approach was used. A vestibular incision 4–5 mm below the level of attached gingival was made in the alveolar mucosa. Periosteal dissection was performed. The fracture was detected and dissection extended to the inferior border. The fractured segments were reduced and using arch bars a temporary MMF was

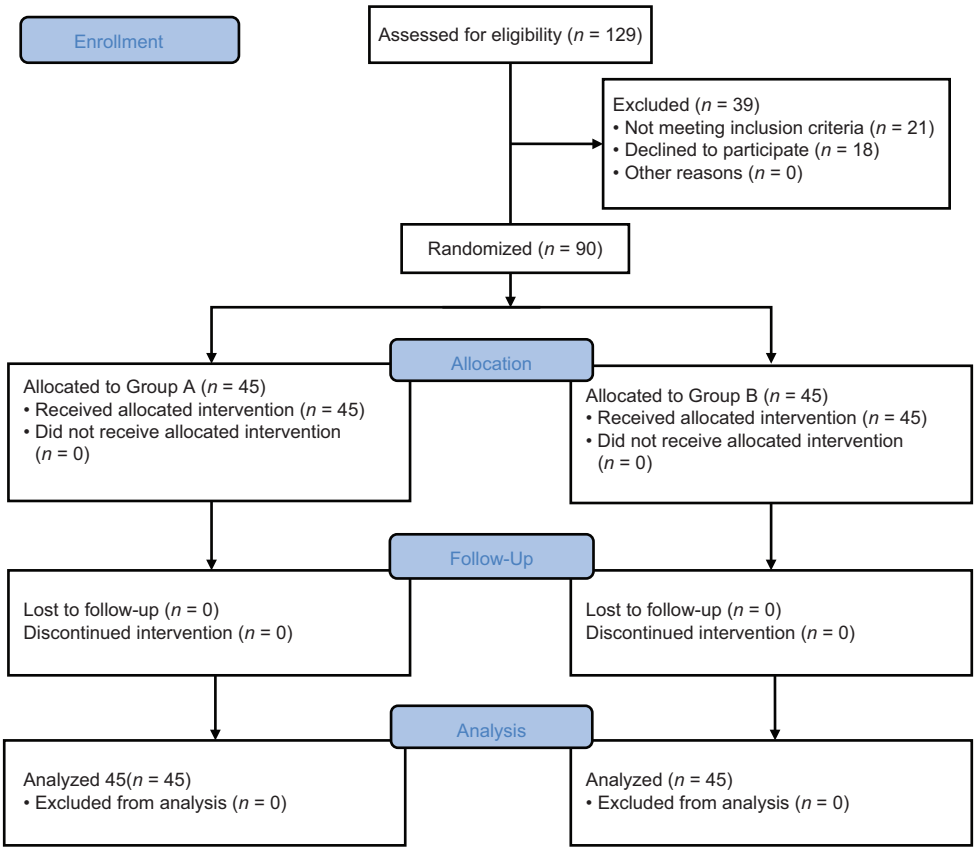

Figure 1: Flow diagram of the study patients.

done in this position. In Group A, for osteosynthesis, a 6-hole miniplate with 2.3 mm diameter was placed at the inferior border of the mandible. In Group B, in addition to the miniplate placed in Group A, a 4-hole miniplate was placed 5 mm above the first one. In all cases, 2.3 mm × 8 mm monocortical titanium screws were used. After plate fixation, the operation field was irrigated copiously and the wound was closed with polyglactin 3-0 sutures. For all patients, MMF was applied postoperatively for 2 weeks. The length of hospital stay for patients in both groups was 3 days after surgery. Intravenous antibiotics were administered during the stay. For all patients, the Erich's arch bars were removed after 6 weeks [Figures 2 and 3].

Patients were visited on the immediate postoperative day and after 15 days. The assessment was repeated after 1 month, 3 months, and 6 months. For all patients, panoramic radiography was obtained and evaluated at the first and last follow-up session. All patients were followed up for 6 months and clinical and radiographic criteria were assessed by an oral and maxillofacial surgeon who was blinded to the study (double-blinded study).

In this study the following criteria were evaluated: procedure intraoperative time, any symptom or sign of mental nerve sensory impairment, any discrepancy in the occlusion, incidence of infection and wound dehiscence, exposure of implant, malalignment of the lower border, and improper reduction of fractured fragments, any sign or symptom of nonunion or malunion, and loosening or fracture of fixation devices. Sensory impairment of the mental nerve was evaluated clinically using static light touch, brush directional discrimination, two-point discrimination, and pin pressure methods.

Ethical approvals

All the ethical and the humanity considerations were considered and performed according to the Helsinki Declaration of 1975, as reviewed in 2000 and 2008. This study was accepted by the Ethics Committee of Tabriz University of Medical Sciences in Iran (Grant No.: IR.TBZMED.REC.1396.96) and Iranian Registry of Clinical Trials (IRCT2014122920480N1). Informed consent was obtained from all the patients before including in the study.

Statistical analyses

Statistical analyses were performed by SPSS version 16.0 for Windows software package

Figure 2: Radiography image of the patient in the first group, a6-hole miniplate with 2.3 mm diameter was placed at the inferior border of mandible.

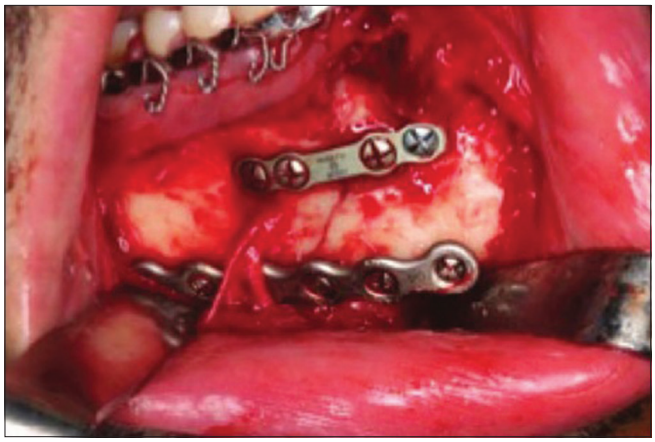

Figure 3: Clinical image of the patient in the second group, a 6-hole miniplate with 2.3 mm diameter was placed at the inferior border of mandible and a 4-hole miniplate was placed 5 mm above the first one.

(SPSS Ins., Chicago, USA). Quantitative data were presented as mean ± standard deviation, while qualitative data were demonstrated as frequency and percent (%). After determining the distribution of continuous variables by Kolmogorov–Smirnov test, data were analyzed using *t*-test and Fisher's exact test. The results were considered statistically significant when the $P < 0.05$.

RESULTS

A total of 90 patients with mandibular parasymphysis fractures were evaluated, which included 71 male (78.8%) and 19 female patients (21.1%). After surgery, wound dehiscence occurred in 2 patients in Group A (treated with one miniplate) and 3 patients in Group B (treated with two miniplates), and the wounds healed properly until the 4th follow-up session. Infection was detected in 3 patients in Group A and 2 in Group B, which all responded to administration of antibiotics and resolved during several weeks. In Group A, 8 of 45 patients had occlusal discrepancy, which was more than Group B (5 out of 45 patients) but was statistically non-significant [Table 1]. Three of them in Group A and one in Group B showed signs of malunion. Additional MMF was applied for these patients and one of the patients in Group A improved and the problem was resolved. Implant loosening was seen only in one patient in Group A who undergone another surgery and the implant was replaced. Radiographically, 5 patients in Group A and 3 in Group B showed inferior border discrepancies and fracture segments were not reduced properly. The comparison of these complications showed no statistically significant difference. In this study, paresthesia and anesthesia were evaluated according to neurosensory tests and the results are shown in Table 2. After surgery, 18 patients in Group A and 20 patients in Group B had different levels of sensory impairments which were resolved in most of them during the next follow-ups. After 1 month, the number of patients with sensory impairments reduces to 8 patients (17%) in Group A and 17 patients (37%) in Group B and the difference between two groups were statistically significant with $P = 0.029$.

The average intraoperative time was 27.04 ± 3.90 min for Group A and 34.93 ± 3.47 min for Group B. Intraoperative time had a significant difference between the two groups ($P < 0.001$).

DISCUSSION

Treatment of mandibular fractures has been developed through years. Restoring the preinjury function and appearance within the shortest possible time and with the least disability is the main goal in treatment of maxillofacial fractures.[7,16,17] The principles of re-establishing preinjury occlusion, reduction of the fracture segments, and adequate internal fixation are the key to successful treatment.[18,19] To this purpose, different types of fixation devices have been introduced. Michelet *et al.* introduced treatment of maxillofacial fractures with miniplates for the first time in the 1970s and miniplates were applied to the mandible by Champy *et al*.[20] He described an ideal osteosynthesis line considering multiple factors such as clinical, biomechanical, and anatomical factors. According to them, placing the osteosynthesis implants along these ideal lines is mandatory to

Table 1: Occlusal discrepancy in study groups during time period

Time period	Study group		
	Group A (%)	Group B (%)	Statistical analysis (*P*)
Immediate postoperative period	7 (15.5)	5 (11.1)	0.37
15 days after surgery	7 (15.5)	5 (11.1)	0.37
1 month after surgery	8 (17.7)	5 (11.1)	0.27
3 months after surgery	8 (17.7)	5 (11.1)	0.27
6 months after surgery	8 (17.7)	5 (11.1)	0.27

Table 2: Signs and symptoms of anesthesia and paresthesia in the study groups during time period

Time period	Study group		
	Group A (%)	Group B (%)	Statistical analysis (*P*)
Immediate postoperative period	18 (40)	20 (44.4)	0.41
15 days after surgery	11 (24.4)	19 (42.2)	0.058
1 month after surgery	8 (17.7)	17 (37.7)	0.029
3 months after surgery	6 (13.3)	11 (24.4)	0.141
6 months after surgery	5 (11.1)	8 (17.7)	0.275

achieve the best results.[9] Compressive forces exist at the inferior border of mandible while tensile at the superior border which should be neutralized by osteosynthesis methods. The torsional forces increase by moving forward from posterior to symphysis region. By placing a strong solid plate on the lower border adequate rigidity is provided among the fracture line, but while using this technique, the fracture segments could adapt to the shape of the plate if the plate is not formed anatomical. Therefore, two adaptable miniplates can be placed anterior to mental foramina instead of one strong solid plate. By placing the second miniplate 4–5 mm above the first one, compressive and torsional forces will be neutralized.[21]

Lots of surgeons use intraoperative MMF to simplify internal fixation. Placing arch bars is the most commonly used method for this purpose.[13] It has been reported that many authors faced problems recreating patients' occlusion when not using MMF during the surgery.[22-25] Many patients would benefit from a short period of MMF after surgery.[14] Hence, in this study, Erich's arch bar is placed intraoperatively for all patients and they were treated with 2 weeks of MMF after surgery.

Determining the amount of fixation in different regions of mandible has always been of great importance.[19,26] Al-Moraissi in a meta-analysis showed that in mandibular angle fractures, the incidence of wound dehiscence and infection, failure of hardware, and overall complications was reduced by placing only one miniplate on the external oblique ridge compared to placing two. The second miniplates were put on to the ventral surface of mandible.[18,27] In the present study, there was no increase in any of the complications or failures by omitting the second miniplate placement from the treatment plan. Similar to Al-Moraissi's findings, this study also showed that patients will benefit from treatment with only one plate placement, instead of two, in the presence of arch bar.

Schenkel *et al*. evaluated the function of inferior alveolar nerve after surgical treatment of mandibular fractures. They reported that after open reduction and internal fixation of their fractures, 73% of the patients had nerve hypoesthesia and recovery occurred in 45% of these patients. The recovery period was between 6 and 12 months.[28] In the present study, hypoesthesia rate was 44% and 40% in Group A and B, respectively. Schenkel *et al.* reported a higher rate of hypoesthesia than the present study, because they evaluated all mandibular fractures specially fractures in more posterior regions, like angle of mandible which are more likely to cause hypoesthesia, while the present study included only fractures in the parasymphysis region.

In the present study, it is shown that although there is no significant difference between two groups of the study in the rate of hypoesthesia after surgery and after 6 months, however, the rate of hypoesthesia between Group A (n = 17, 37%) and B (n = 8, 17%) in the 1st month follow-up is significantly different. This difference reveals that the recovery in the group with placing one miniplate (Group A) happens faster which

could be due to less operating time and less retraction of the mental nerve needed in this technique.

In this study, by placing an extra plate, the procedure took about 8 (in average) min longer than the other group which could be one of the reasons of later improvement in sensory impairment in Group B, while in a previous study, the average difference of these two techniques was reported about 14 min.[21]

CONCLUSION

Many surgeons place arch bars for its intraoperative and postoperative benefits, so in the presence of mandibular arch bar, parasymphysis fractures can be treated with placing only one miniplate at the inferior border while the arch bar acts as a tension band. The present study revealed that placing one miniplate instead of the routine technique of placing two does not increase complication rates. Furthermore, it reduces the operation time and costs and results in a better neurosensory recovery outcome in short time.

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Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

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