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Comparison of Periodontium Reaction to Fixation of Mandibular Fractures with and Without Erich Arch Bars

Mohammad Ali Ghavimi [1], Milad Ghanizadeh [1] and Mahdieh Alipour [2, *]

[1] Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran
[2] Dental and Periodontal Research Center, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran

[*] *Corresponding author*: Research Assistant, Dental and Periodontal Research Center, Faculty of Dentistry, Tabriz University of Medical Sciences, Tabriz, Iran. Email: alipour.m@tbzmed.ac.ir

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Abstract

Background: There are two general types of fixation methods used in mandibular fractures and osteotomy: closed fixation method with Erich arch bars and the open fixation method (without Erich arch bars). Periodontium inflammation, following mandibular fixation methods, is a complication of the healing period.
Objectives: The current study aimed at evaluating and comparing periodontium reaction to fixation of mandibular fractures with and without Erich arch bars.
Methods: This cross-sectional study was carried out on 48 patients with mandibular fractures. Twenty-four patients were treated with close method and Erich arch bars and 24 patients with open method and without Erich arch bars. Periodontium clinical indices, including plaque index (PI), gingival index (GI), bleeding on probing (BOP), and probing pocket depth (PPD), were measured immediately before the surgery and four, six, and eight weeks later.
Results: After four, six, and eight weeks, subjects with arch bars had significantly greater PI, GI, and PPD (P value < 0.001). After four weeks, all subjects in the arch bar group had a positive BOP, which was significantly greater than that in the other group (P value < 0.001). In addition, after six weeks, the number of subjects with positive BOP was significantly more in the arch bar group than in the other group (P value < 0.001). Yet, after eight weeks, there was no significant difference between the two groups (P value > 0.001).
Conclusions: According to the results, the use of Erich arch bars more decreased periodontium status compared to the other group.

Keywords: Erich Arch Bar, Maxillofacial Trauma, Maxillomandibular Fixation, Mini-Plate, Periodontal Indices

1. Background

Studies predict that injuries will be the fourth cause of disability and mortality around the world by 2030 (1). Respecting injuries of different areas, the maxillofacial region should be considered as a critical area for injury because of its role in the function and esthetic (2). Second to nasal fractures, mandibular fractures are the most common fractures in the maxillofacial region with an estimated prevalence of 38% (3, 4). Mandibular fractures, which are common in young males, often occur due to interpersonal violence, road traffic accidents, falls, sports accidents, occupational accidents, or even iatrogenic traumas following tooth extraction (5). Like the treatment of bone fractures in other regions, repositioning and immobilization of the fractured fragments are the principles in treating mandibular fractures (5). Therefore, the post-surgical skeletal stability is an important part of treatment and healing procedure in maxillomandibular fixation (MMF). MMFs must be able to optimally restore the facial contour and masticatory function (6). The failure of mandibular fracture treatments leads to permanent functional and esthetic problems, which could affect the individuals' lives (7). There are two general types of MMF methods, including open reduction method with mini-plates (without Erich arch bars) and closed reduction with arch bars (8).

Closed reduction includes various methods. The standard Erich arch bar technique is a commonly used method in closed reduction (9, 10). Rapid bone healing, fewer expenses, and correct positioning of maxilla and mandible in relation to each other have been reported as advantages of the closed reduction method (8). The open reduction method, which is considered an anatomic reduction, was introduced in the 1970s. The advantages of this method include a shorter fixation period, less patient inconvenience,

and optimized repositioning (11, 12).

Bacterial plaque accumulation can cause inflammatory changes in the soft tissues, and fixation appliances act as plaque-retentive devices, which provoke gingival inflammation (13). Inflammation can lead to bleeding, color change, pocket formation, and bad odor in the periodontium (14).

Periodontal indices, including bleeding on probing (BOP), gingival index (GI), plaque index (PI), and probed pocket depth (PPD) are measured for the clinical examination of periodontium status (15).

2. Objectives

Although there are many papers on MMF methods, less attention has been paid to periodontium status during the fixation period. Fixation appliances are plaque-retentive and have adverse effects on periodontium health. Therefore, this study was conducted to evaluate and compare the effects of Erich arch bars on the periodontium status.

3. Methods

This cross-sectional study was conducted at the Maxillofacial Surgery Department of Imam Reza Teaching Hospital of Tabriz University of Medical Sciences (TUOMS) in Iran. The ethical approval of the study was obtained from the ethics committee of TUOMS, which complied with the Helsinki declaration (approval no. IR TBZMED.REC.1396.275).

From among the referring patients, 48 subjects with traumatic mandibular fractures were selected during the period from December 2017 to August 2018.

The inclusion criteria were:

1. An age of 18 to 55-years-old.

2. Being in the ASA1 and ASA2 categories and without any respiratory problems.

3. Being a patient with only favorable mandible fracture, which required open or closed reduction.

4. Having at least 10 maintainable teeth in the mouth.

5. Having a plaque index of less than 20% at baseline.

6. Not having more than 5 mm probing pocket depth at baseline.

Patients with crowded teeth, concomitant dentoalveolar or midface fractures, and smokers were excluded from the study. All the included subjects signed informed consent forms. The subjects were divided into two groups based on the post-operative fixation method. Group I contained 24 patients (n = 24), whose MMF was done with stainless steel (wire No. 0.5) Erich arch bars (IMEN IJAZ, Tehran, Iran). Erich arch bars were removed 4 weeks after placement. Group II comprised 24 patients (n = 24), who were treated with titanium mini-plates (IMEN IJAZ, Tehran, Iran) without any Erich arch bars. Closed and open reduction methods were performed by the same surgeon, who was not aware of the study objectives.

The periodontium status of the subjects was evaluated by periodontal indices. Some periodontal indices were determined immediately prior to the surgery and at four, six, and eight weeks after the placement of the appliances. They included:

1. Bleeding on probing (BOP)

2. Probing pocket depth (PPD)

3. Plaque index (PI)

4. Gingival index (GI)

During the study, all subjects in both groups were instructed to use normal saline solutions for mouth rinsing and tooth brushing (G.U.M Butler Sunstar Classic Soft Tooth Brush 411, USA), twice a day. In order to examine BOP and PPD, a Williams Periodontal Probe was used. Only were three surfaces (mesiobuccal, mid buccal, and distobuccal) of anterior teeth in maxilla and mandible probed. Bleeding 30 seconds after probing was considered as a positive BOP while the lack of bleeding after 30 seconds was considered as a negative BOP. Furthermore, PPD (the distance between free gingival margin and sulcus depth) was measured with a periodontal probe and the results were reported in millimeters. To determine PI (the O'Leary Index), the plaque disclosing gel (GC Tri Plaque ID Gel, Japan) was applied to all available dental surfaces over gingiva. After registering all teeth, the PI was calculated using the following equation:

PI = (number of colored surfaces/total number of dental surfaces) $\times$ 100

For measuring the gingival index, Loe and Sillness gingival index was used in the following teeth: 12, 16, 24, 32, 36, and 44. In this method, the soft tissue around the tooth was divided into four parts (mesial, buccal, distal, and lingual). As the lingual surface was not accessible in when using the closed fixation method, the researchers used three parts (mesial, buccal, and distal) in both groups. Accordingly, those parts were classified into zero (no inflammation), one (mild inflammation), two (moderate inflammation), three (severe inflammation), and four (tooth missing) classes. Finally, by summing the three values for each tooth and dividing it by three, the GI of the corresponding tooth was obtained. For calculating each patients' GI number, the sum of the GI of evaluated teeth was divided by six. All periodontal examinations were performed by two trained clinicians and the results were recorded in a relevant checklist. For inter-observer agreement, the Kappa agreement coefficient was used.

3.1. Statistical Analysis

Data were reported by frequencies and percentages for qualitative variables and means ± standard deviations for quantitative variables. The chi-square test was used to compare qualitative variables (BOP) based on the patients' gender, age group, and time of assessment. To compare the quantitative variables (PPD, PI, and GI) based on patients' gender, *t*-test for independent groups, One-way ANOVA for age groups, and repeated measures ANOVA for the time of assessment were used. In case of non-normal distribution of data, appropriate conversion or nonparametric equivalent tests were used. Data analysis was performed using the SPSS 17 software at a significance level of 0.05.

4. Results

In the closed reduction group, the number of males and females was equal (M: 12, W: 12). In the open reduction group, there were 11 males and 13 females. The mean ± standard deviation of age in groups I and II was 35.37 ± 6.67 and 38.54 ± 6.12, respectively.

The periodontium indices were measured at four time points: immediately before the surgery, and four, six, and eight weeks later.

The results of bleeding on probing are shown in Table 1.

At baseline, two patients (8.3%) in group I and three patients (12.5%) in group II had a positive BOP. The statistical analysis showed no significant difference between the two groups (P value = 0.637). After four weeks, all patients (n = 24) with Erich arch bars showed positive BOP whereas only eight patients (33.5%) in the other group showed positive BOP. These results demonstrated a significant difference between the two groups after four weeks (P value < 0.001). After six weeks, 18 patients (75%) in group I and seven patients (29.2%) in group II had a positive BOP. The statistical analysis showed a significant difference between the groups (P value < 0.001). After eight weeks, 11 subjects (45.8%) had positive BOP in the Erich arch bar group and six subjects (25%) had positive BOP in the other group. The results after eight weeks did not show any significant between-group difference (P value = 0.131).

To compare BOP at different intervals, considering the qualitative nature of this variable, the Friedman test was used (Table 1). There was a significant difference between BOP levels at different time points in group I (P value < 0.001). In addition, there was a significant difference between these values at different time points in the group II (P value = 0.025).

Figure 1 shows the linear variation in BOP values at different time points and in both groups.

It is noticeable that at baseline, BOP values of the groups were approximately similar. The number of subjects with positive BOP after four and six weeks was significantly greater in the arch bar group, whereas after eight weeks, the difference was not significant.

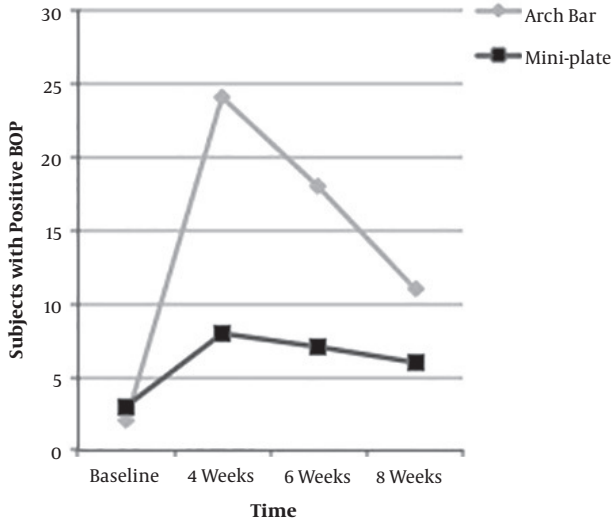

Figure 1. Comparison of Subjects with Positive Bleeding on Probing Between the Two Groups

The results of PPD, PI, and GI are presented in Table 2.

The PPD at baseline did not show a significant difference between the groups (P value = 0.951). After four weeks, PPD in the Erich arch bar group was significantly (8.33 mm) greater than that in the other group (P value < 0.001). Moreover, after six and eight weeks, PPD was significantly greater in the Erich arch bar group (P value < 0.001).

As shown in Table 2, the comparison of PI levels between the two groups by Mann Whitney U test (Table 2) did not show any significant difference at baseline (P value = 0.513). After four, six, and eight weeks, the PI was significantly greater in the Erich arch bar group than in the other group (P value < 0.001).

The pairwise comparison of GI levels between groups by Mann Whitney U test (Table 2) showed a 0.41-unit difference between GI values immediately after the appliance placement, which was greater in group II; however, it was not statistically significant (P value = 0.842). After four, six, and eight weeks, the GI results were significantly greater in the Erich arch bar group (P value < 0.001).

5. Discussion

One of the main objectives of treating bone fractures is to restrict or hinder the movement of fractured bone

Table 1. Descriptive Statistics of Subjects with and Without Bleeding on Probing (BOP)[a]

	Positive BOP, No. (%)	Negative BOP, No. (%)	P Value (Friedman)
Group I			< 0.001
Baseline	2 (8.3)	22 (91.7)	
4 weeks after fixation	24 (100)	0	
6 weeks after fixation	18 (75)	6 (25)	
8 weeks after fixation	11 (45.8)	13 (54.2)	
Group II			0.025
Baseline	3 (12.5)	21 (87.5)	
4 weeks after fixation	8 (33.3)	16 (66.7)	
6 weeks after fixation	7 (29.2)	17 (70.8)	
8 weeks after fixation	6 (25)	18 (75)	

[a] P value (Friedman) < 0.01.

Table 2. Descriptive Statistics for Probing Pocket Depth (PPD), Plaque Index (PI), and Gingival Index (GI) Indices

	PPD, mm[a]	P Value (Repeated Measures)	PI[a]	P Value (Friedman)	GI[a]	P Value (Friedman)
Group I		< 0.001		< 0.001		< 0.001
Baseline	25.29 ± 2.25		18.87 ± 1.36		0.45 ± 0.65	
4 weeks after fixation	34.25 ± 2.41		65.45 ± 9.66		3.21 ± 0.77	
6 weeks after fixation	33.08 ± 2.26		59.62 ± 7.16		2.16 ± 0.76	
8 weeks after fixation	31.95 ± 2.89		57.21 ± 5.86		1.66 ± 0.7	
Group II		0.002		< 0.001		0.002
Baseline	25.33 ± 2.42		18.41 ± 1.83		0.5 ± 0.78	
4 weeks after fixation	26.12 ± 2.45		25.33 ± 7.72		0.87 ± 0.99	
6 weeks after fixation	26.04 ± 2.47		22.08 ± 4.84		0.66 ± 0.86	
8 weeks after fixation	25.95 ± 2.51		21.37 ± 5.03		0.58 ± 0.77	

[a] Values are expressed as Mean ± SD.

segments in order to prevent complications like inadequate healing, infection, or life-threatening abscesses. The mandible area is the most susceptible site for these complications, and this area is the only moving bone in the maxillofacial region. Therefore, fixing the fractured segments of this bone has a considerable importance (6, 16). One of the main objectives of the treatment procedures for mandibular fractures is to create proper occlusion and more stable movements of temporomandibular joints (TMJ) through the appropriate and accurate placement of the fracture fragments (17). In most cases, the Erich arch bar treatment method is used, which causes undesirable movements of the teeth and periodontal problems due to attachment to the teeth; it ultimately complicates the observance of hygienic issues by the patient. In addition, although the Erich arch bar method is capable of maintaining dental stability, it cannot lead to skeletal stability. Therefore, the application of this method in most toothless areas is difficult and sometimes impossible (17, 18). The results of the present study revealed that the highest rate of complications, including BOP, PPD, PI, and GI, were observed four weeks after fixation in both groups with higher complications in the Erich arch bars group at all the time points compared to the other group.

A clinical study compared PI in open reduction with screws and closed reduction with Erich arch bars. The results revealed that the mean PI was 1.88 and 2.69 among the mini-plate (open reduction) and arch bar groups (closed reduction), respectively, which indicated a statistically significant difference (19). The results of the current study also showed a significant increase in plaque index in the Erich arch bar group compared to the other group.

In a study by Stone et al., open surgical treatment was the most important factor in the increased risk of infection among patients (20). In a meta-analysis study by Andreasen et al., the periodontal status of patients with

mandibular fractures was compared based on the type of treatment, according to previous studies. The results indicated that the rate of complications was significantly greater in the open reduction method than in the closed reduction method. The infection rate was higher in the open treatment method than in the closed treatment; yet, this difference was not significant. In general, the infection rate was about 5% in the closed therapy group while in the plate-type open treatment and wire methods, the infection rate was 10.6% and 14.6%, respectively (8). Another study by Oikarinen and Nieminen examined the effects of periodontium among patients under treatment with IMF due to orthognathic surgery or mandibular fracture. In that study, the CPITN index and Periotest method were used to evaluate the periodontal condition and tooth mobility, respectively. The periodontal condition (CPITN index) became worse following the splint but returned and improved to the normal state in the control group after five months. However, the mean Periotest did not differ between the control and orthognathic surgery groups. In addition, the short-root teeth showed a higher Periotest value compared to the long-root teeth. Therefore, their results also indicated that fixation with arch bars causes changes in periodontium and dental movements (21).

In another study, PI, papillary bleeding, and probing pocket depth were evaluated and the rate of dental movement was measured in the treated patients. It was found that changes resulting from open and closed therapies were all reversible (22). Moreover, a clinical study by Harle et al. indicated that six weeks after arch bar splint, the dental movements, PD, and BOP increased, but these variables returned to the normal state six weeks after splint removal (23).

Treatment of maxillofacial fractures usually depends on the experience and tendency of the physician, the internal fixation equipment, and other factors including the type of fracture, patient's age, and the extent of fracture (involvement of other areas of the face) (24, 25). In the open reduction treatment, the mini-plate method is one of the preferred methods of fixation due to its relatively small size, compatibility, and easy oral insertion in the craniomaxillofacial surgeries (26).

5.1. Conclusions

Based on the findings, it can generally be concluded that changes in the periodontium are temporary and fixation complications will disappear completely over time. Furthermore, the results of the study indicated that the open treatment method without Erich arch bars results in the improvement and disappearance of the fixation complications faster than the closed treatment method.

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Footnotes

Authors' Contribution: Mohammad Ali Ghavimi and Mahdieh Alipour planned the study and performed the literature review. Milad Ghanizadeh and Mahdieh Alipour performed the experiments the manuscript and experimental procedures. Milad Ghanizadeh carried out the statistical analyses and interpretation of data. All the authors critically revised the manuscript for intellectual content. All the authors have read and approved the final manuscript.

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