

Assessment of Temporomandibular Joint Following Maxillomandibular Fixation in Mandibular Fracture Patients: A Case Series

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Abstract

Background and Objectives: Mandibular fractures are one of the most commonly encountered injuries in trauma clinics. The basic principles of the treatment of mandibular fractures include closed treatment and maxillomandibular fixation (MMF). This study assessed the temporomandibular joint (TMJ) functions in patients treated with MMF. **Methods:** This prospective case series included eight patients with a clinically and radiologically confirmed diagnosis of mandibular fracture who were treated with MMF in 2019. The range of mandibular motions, pain intensity, and body weight were followed up. Psychological distress and patients' ability to return to work were assessed with self-report questionnaires at the end of the 12th week. **Results:** The study included eight patients (six men and two women; mean age: 30.25 ± 4.80 years; range: 22–36 years) who sustained 10 fractures. Eight volunteers were the individuals of the control group (two men and six women, mean age of 26.00 ± 6.97). There was a significant decrease in the range of mandibular motion after the treatment. The patients had significantly lower maximum mouth opening and lateral and protrusive excursions than healthy controls at postoperative 12 weeks. They had a mean change of -7.34% of their initial body weight. Pain intensity was mild to moderate. Of the patients, 37.5% started a different job and 12.5% reported failure to work. The health questionnaire indicated mild depressive symptoms. **Conclusions:** MMF causes significant morbidity and leads to functional decline, pain in TMJ, weight loss, cooperation problems in the work life, and depression.

Keywords: Jaw fixation techniques, mandibular fractures, maxillomandibular fixation, temporomandibular joint dysfunction syndrome

INTRODUCTION

Mandibular fractures are one of the most commonly encountered injuries in trauma clinics. Mandibular fractures may be associated with acute complications, i.e., airway compromise, hemorrhage, malocclusion, and later complications such as infection, altered healing, and temporomandibular dysfunction. Therefore, timely repair of mandibular fractures is imperative.^[1]

The basic principles of the treatment of mandibular fractures include closed treatment and maxillomandibular fixation (MMF) or open reduction and fixation with screws, wires, or plates. MMF remains the mainstay of mandible fracture stabilization since it is a less complex approach and is as effective as more invasive methods.^[2] Conventionally, 4 weeks of immobility has been implemented for uncomplicated adult mandibular fractures.^[3] Various advantages of closed reduction

techniques have been reported, including obviation of the need for hospitalization, surgical morbidity, and the relatively high cost of open techniques.^[4] However, MMF has been criticized for pain, reduced masticatory efficiency, reduced mouth opening, inability to perform good oral hygiene, phonetic disturbance, loss of effective work time, and weight loss with the subsequent delay of rehabilitation.^[5,6]

The purpose of the present case series is to report the effect of MMF on temporomandibular joint (TMJ) functions. To

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address this research aim, patients treated with MMF due to mandibular fracture were evaluated in terms of the range of mandibular motion, Visual Analogue Scale (VAS) scores, body weight, and quality of life. The procedures adhered to the ethical guidelines of the Declaration of Helsinki, and the study was approved by the Institutional Review Board for Human Studies of the Dentistry Faculty of Istanbul University, Turkey (Study No: 2018/104).

SUBJECTS AND METHODS

Study design/sample

This study was designed and implemented as a prospective case series that involved one study group and one control group. The study population comprised eight patients presenting to the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Istanbul University, Istanbul, Turkey, for evaluation and management of mandibular fractures from January 2019 to June 2019. The selection was determined using the following criteria: (1) individuals between the ages of 21–40; (2) individuals being dentate and having sufficient occluding teeth present on either side of the fracture to allow MMF; (3) the presence of a mandibular fracture at the tooth-bearing area (e.g., body, symphysis and/or angle fractures); (4) a minimally displaced mandibular fracture, in which the displaced fracture was not more than 3–4 mm between the occlusal/incisal surfaces of the teeth of the fractured segments; (5) one or two fracture lines; (6) the absence of a concomitant maxillary or facial fracture; (7) no systemic disease; (8) no previous history of TMJ dysfunction; and (9) no condition that precluded 12-week follow-up. The exclusion criteria were nearly the same as those proposed by West *et al.*:^[7] (1) fracture(s) of the mandibular condyle; (2) presence of >1 cm displacement of segments in any direction; (3) presence of mixed dentition or unerupted permanent teeth (excluding third molars); (4) patients who were <18 years old; (5) concomitant maxillary or other facial fractures; (6) patients who presented partial edentulism; (7) general contraindications to MMF, including psychological disorder, seizure disorder, airway compromise, pregnancy, or breastfeeding. The control group comprised eight individuals who fulfilled the following criteria: (1) individuals between the ages of 21–40; (2) attending outpatient dental clinics of the Faculty of Dentistry, Istanbul University, Turkey, for routine oral healthcare; (3) sufficient bilateral dentition; (4) no skeletal or dental malocclusion; and (5) no dysfunction in the masticatory muscles or bilateral TMJ or previous jaw surgery. On initial presentation, selected participants with mandibular fractures were diagnosed both clinically and radiographically. The fracture site (symphysis, body, angle, and ramus), fracture pattern (confined and unconfined), continuity of the fracture (simple and comminuted), fate of the tooth in the line of fracture (extracted or not), paresthesia/neurosensory changes with light-touch sensation, occlusal discrepancies (scored as 1 – normal/functional occlusion, 2 – moderate derangement, and 3 – gross derangement), infection at the fracture site (erythema of the adjacent gingiva, swelling, pain, tenderness, wound

dehiscence, or pus discharge), and the presence of a dislocation/displacement were evaluated preoperatively by clinical examination and cone-beam computed tomography. The advantages and disadvantages of the treatment, surgical procedures, and expected complications, including those that pertained to malocclusion, masticatory problems, asymmetry of the mandible, and TMJ disorder, were fully explained to the patients willing to participate in the study.

Treatment

The closed treatment of mandibular fractures was carried out under local anesthesia. The mandibular fractures were manually reduced, fixed, and immobilized by MMF using arch bars and elastics. The teeth presented in the fracture line were not removed unless they were mobile or interfering with the reduction of the fractured segments. The intervention time was between 1 and 3 days. All patients received 600 mg of clindamycin intramuscularly every 12 h for 4 days, 75 mg of diclofenac sodium daily for 4 days, and chlorhexidine mouth spray three times daily. The patients had a liquid and pureed diet during the treatment period.

MMF was maintained for 4 weeks. The treatment was ended based on the following criteria: (1) the stability of the fractured segments was tested by bimanual manipulation; (2) normal occlusion was maintained; (3) no signs or symptoms of infection were recorded; and (4) good bony alignment of the fractured segments was confirmed by panoramic radiography.

Postoperative evaluation

The follow-up procedure for all patients consisted of standardized panoramic radiography and clinical examinations. Patients received follow-up examinations weekly for the 1st month, then once in 15 days for the next 2 months. The elastics were removed in each appointment, and passive jaw exercises were performed.

All cases were evaluated for the following parameters:

1. The maximum mouth opening was recorded by measuring the vertical interincisal distance (the distance between the incisal edges of the upper and lower central incisors)
2. The maximum lateral excursions (the displacement of the lower incisors' midline from the maxillary midline) on the right and left sides were measured
3. Protrusive movement (PM) was calculated by measuring the horizontal distance between the upper and lower incisors during full closure and adding the distance the lower incisors traveled beyond the upper incisors
4. Pain intensity was recorded subjectively using a VAS, on which "0" indicated no pain and "10" indicated the worst pain
5. Body weight was checked. The initial weight and each subsequent weight taken were recorded for each patient
6. At the end of the 12th week, the following additional follow-up procedures were performed:
 - A patient health questionnaire (PHQ-8) was used to measure current depression by asking the number of days in the past 2 weeks the respondent had experienced a particular depressive symptom. The

scores for each item were added to produce a total score between 0 and 24 points. A total score of 0–4 represented no significant depressive symptoms. A total score of 5–9 represented mild depressive symptoms; 10–14, moderate; 15–19, moderately severe; and 20–24, severe^[8]

- The patient’s ability to return to work was categorized as (1) return to the previous job position; (2) return to a different job position; (3) start a different job; or (4) unable to work.

Controls underwent testing of maximum interincisal distance (MID) and lateral and protrusive excursions only once.

Statistical analysis was performed using IBM SPSS Statistics V22.0 (Armonk, NY, USA). The data are presented as mean and standard deviation. To compare the differences between the control and study groups, the Mann–Whitney *U*-test was used. The changes in parameters in terms of study periods were compared with the Wilcoxon-signed rank test. Statistical significance was established at *P* < 0.05.

RESULTS

The study included eight patients (six men and two women; mean age 30.25 ± 4.80 years; range 22–36 years) who sustained 10 fractures. Eight volunteers were the individuals of the control group (two men, and six women; mean age of 26.00 ± 6.97). The cases of mandibular fracture were most often due to road traffic crashes, followed by interpersonal violence and falls. The intervention time ranged between 1 and 3 days. The average body mass index at presentation for patients included in the study was 26.27 ± 2.90 kg/m². Significant differences in sex and mean age were not found between the study and control groups. The demographic data of the patients are enumerated in Table 1.

Regarding the site distribution of fractures, the angle of the mandible was the most frequently fractured site (75%), followed by the body (25%), symphysis (25%), and ramus (12.5%). Of all the fractures, 62.5% had a confined pattern, and 37.5% were classified as unconfined. Simple fractures comprised 75% of all fractures, and the remainder were comminuted. Seventy-five percent of the cases had a tooth in the line of the fracture, and of those, 50% were extracted due to mobility. No paresthesia/neurosensory changes with light-touch sensation were recorded. Occlusal changes were seen in seven of the eight patients at the first visit. The percentage of normal/functional occlusion was 12.5%, moderate derangement, which was defined as reasonable but not exact contact bilaterally, was 50%, and gross derangement, which showed no contact, contact in one or two teeth, or open bite, was 37.5%. All cases (100%) presented mild infection at the fracture site, which was managed with postoperative antibiotic therapy. There was no dislocation/displacement of the fractured segments in any case. All patients completed the follow-up examinations. A satisfactory healing outcome was observed in all cases. No case of infection, nonunion,

Table 1: Demographic data of the selected patients, as well as the descriptive features of the fractures

Patient number	Age (years)	Gender	Fracture etiology	Fracture site	Fracture pattern	Continuity	Tooth in the line of fracture	Paresthesia	Occlusion	Infection at the fracture site	Presence of dislocation/displacement
1	22	Male	Interpersonal violence	Symphysis, left angulus	Confined	Simple	+ /not extracted	-	3	Mild	-
2	31	Male	Road traffic crash	Left ramus	Unconfined	Comminuted	-	-	2	Mild	-
3	36	Male	Road traffic crash	Left angulus	Confined	Comminuted	+ /extracted	-	2	Mild	-
4	31	Male	Road traffic crash	Left body	Confined	Simple	+ /not extracted	-	1	Mild	-
5	35	Female	Fall	Right angulus	Confined	Simple	+ /not extracted	-	2	Mild	-
6	25	Female	Fall	Symphysis, left angulus	Unconfined	Simple	+ /extracted	-	3	Mild	-
7	29	Male	Road traffic crash	Left body	Unconfined	Simple	+ /extracted	-	3	Mild	-
8	33	Male	Interpersonal violence	Left angulus	Confined	Simple	-	-	2	Mild	-

(+): An intact tooth involved in the fracture line, (-): no teeth were present within the fracture line

malunion, paresthesia, or occlusal discrepancy was recorded. The results of the statistical analysis of the mean interincisal distance and lateral and PMs of the study and control groups are contained in Table 2. All measurements of the healthy controls were significantly greater than those of the patients ($P < 0.05$). This difference occurred throughout the periods of observation.

A comparison of the study intervals with respect to both means and changes over time generally revealed significant differences. The results showed that the range of mandibular movements (i.e., maximal mouth opening and lateral and PMs) in the study group was significantly lower than in the control group over a period of time ($P < 0.05$) [Table 2]. There was a significant decrease in maximal mouth opening and lateral movements from the pretreatment measurement to the 6th postoperative week. MID was significantly reduced by the end of the 1st postoperative week and was greater in the 2nd week. At the 3rd postoperative week, MID was the lowest. It steadily recovered to the preoperative level between the 3rd and 8th postoperative weeks, and it subsequently increased at each measurement time to above the preoperative level. Patients seemed to achieve a greater degree of mouth opening and lateral and PMs from the 6th to 12th postoperative weeks. However, the final measurements in the 12th week appeared to be significantly lower than those of the control group [Figure 1].

Twelve weeks after the fracture, the study group had maximum interincisal openings that were 11.97 mm less than the controls.

Regarding the function of the TMJ, persistent mandibular deviation on the opening pathway was noted in four patients (patient numbers 1, 2, 3, and 4). Postoperative joint clicking was registered in 25% of the patients (patient numbers 1 and 4). The study group showed a significant improvement regarding the pain score. Postoperative pain was mild to moderate (mean preoperative VAS score: 5.75, 1st week postoperative: 4.00), which was managed with analgesics at the early stage of treatment. The incidence of joint pain decreased with time from pretreatment to weeks 1, 2, 3, 4, and

6. The mean sum of the VAS scores of all patients was 0 after the 6th posttreatment week [Table 2 and Figure 2].

Body weight, on average, was 79.60 ± 6.24 preoperatively, which decreased significantly to 74.04 ± 5.29 at the end of treatment. The net loss of weight observed was 2.4 kg at the 1st week postoperatively and 5.5 kg at the 4th week postoperatively when compared with their weights before surgery [Table 2]. Patients had a mean change of -7.34% of their initial body weight and started to regain weight after MMF release [Figure 2]. Of the patients, 50% were able to

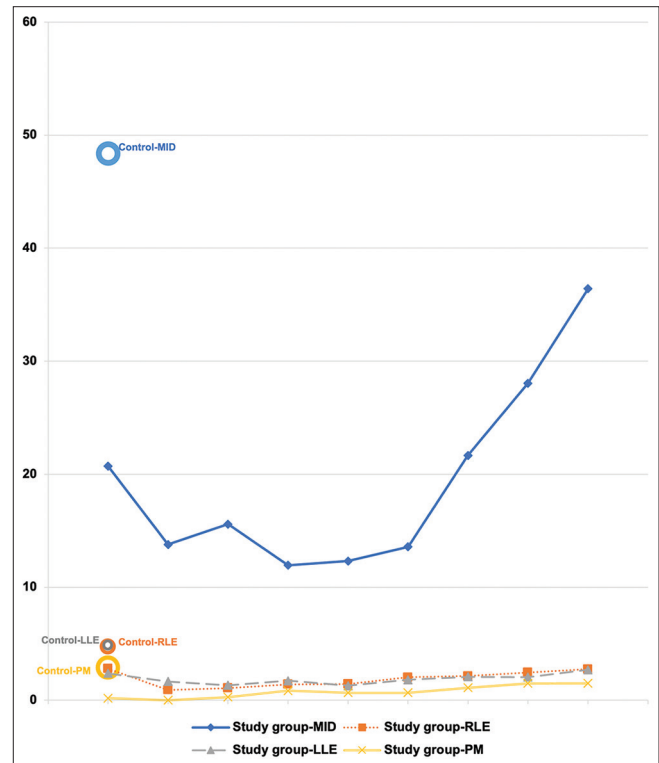


Figure 1: Changes in the range of mandibular motion in the study group. MID: Maximum interincisal distance, LLE: Left lateral excursion, RLE: Right lateral excursion, PM: Protrusive movement

Table 2: Maximum excursions, Visual Analog Scale, and body weight comparisons between the study and control groups

Time	Mean interincisal distance (mm)	RLE (mm)	LLE (mm)	PM (mm)	Visual Analog Score	Body weight (kg)
Control group	48.38±11.17 ^a	4.75±1.28 ^b	4.88±1.46 ^c	2.88±1.25 ^d		
Study group (MMF)						
Preoperative	20.71±13.01 ^a	2.79±2.68 ^b	2.38±2.39 ^c	0.18±0.36 ^d	5.75±4.06 ^e	79.60±6.24 ^f
1 st week	13.79±7.38 ^a	0.91±0.90 ^b	1.66±1.91 ^c	0.00±0.00 ^d	4.00±3.46 ^e	77.19±5.62 ^f
2 nd week	15.58±6.10 ^a	1.08±1.09 ^b	1.33±1.54 ^c	0.28±0.51 ^d	3.00±3.02 ^e	76.16±5.23 ^f
3 rd week	11.95±7.56 ^a	1.41±1.56 ^b	1.73±1.42 ^c	0.85±0.41 ^d	1.25±1.83 ^e	74.48±5.18 ^f
4 th week	12.31±7.52 ^a	1.44±1.45 ^b	1.29±1.42 ^c	0.66±0.65 ^d	0.38±0.52 ^e	74.04±5.29 ^f
6 th week	13.58±8.21 ^a	2.03±1.53 ^b	1.81±1.65 ^c	0.66±0.83 ^d	0.13±0.35 ^e	74.63±4.83 ^f
8 th week	21.66±7.40 ^a	2.15±1.58 ^b	2.08±2.01 ^c	1.11±1.12 ^d	0.00±0.00 ^e	75.51±4.97 ^f
10 th week	28.04±6.17 ^a	2.46±2.01 ^b	2.05±1.90 ^c	1.49±0.96 ^d	0.00±0.00 ^e	75.38±4.73 ^f
12 th week	36.41±3.15 ^a	2.75±1.98 ^b	2.70±1.75 ^c	1.50±1.20 ^d	0.00±0.00 ^e	76.28±4.43 ^f

^{a,b,c,d} $P < 0.05$ between controls and each postoperative line of patients, ^{e,f} $P < 0.05$ between preoperative values and each postoperative line.

MMF: Maxillomandibular fixation, VAS: Visual Analog Scale, LLE: Left lateral excursion, RLE: Right lateral excursion, PM: Protrusive movement

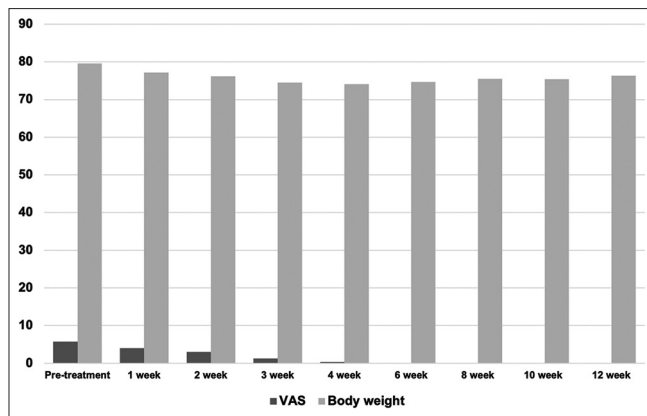


Figure 2: Changes in the incidence of joint pain and body weight. VAS: Visual Analog Scale

return to their previous work, 37.5% started a different job, and 12.5% reported failure to work. The mean PHQ-8 score was 8, ranging from 7 to 9, which indicated mild depressive symptoms.

DISCUSSION

The present report specifically highlighted the outcomes of intermaxillary fixation in the treatment of mandibular fractures. The main finding of the present report was that MMF significantly decreased the range of mandibular movements in patients with fractures, and the values remained significantly less than controls for up to 12 weeks after treatment.

Several studies have evaluated maximum mouth opening in patients with mandibular fractures before and after MMF. These studies clearly indicate that mouth opening is significantly reduced in patients treated with 4 weeks or more of immobilization.^[6,9,10] In the current series, the patients had a significant reduction in their maximum mouth opening, lateral excursion, and protrusion measurements until 6 weeks postoperative. This may be attributed to the effect of immobilization on the joint structures.^[11] Notably, it seems that a period longer than 12 weeks after MMF may be required for postoperative masticatory function to reach the level of healthy controls.

In the study group, mean MID and lateral and protrusive excursions significantly decreased at 1 week after treatment. An improvement in jaw function was observed at 2 weeks. It may be presumed that the quick improvement of jaw movement resulted from the posttraumatic edema observed at the initial presentation, which began to resolve by the 1st postoperative week and completely resolved by the end of the 2nd postoperative week. After that, the maximum mouth opening, which had the lowest level, was limited due to MMF.

The overall weight loss in this study was 5.5 kg at the postoperative 4th week, which is in comparison with previous studies.^[12] Bearing in mind that patients can only be on soft or liquid diets during the MMF period, the severity of weight

loss may increase. Therefore, supplements should be added in liquid form to overcome patients' difficulty in maintaining nutrition intake.

The PHQ-8 score indicating mild depression and patients' inability to return to their work may show that more attention is needed to treat the psychological effects of traumatic facial injury and MMF treatment.^[8] Researchers have noted that immobilization of the jaws with MMF may lead to psychosocial and physical problems and affect patients' overall treatment-related quality of life.^[13,14] Patients in the present series presented depressive symptoms following jaw fracture, and these symptoms were associated with trauma and MMF that limits both functions related to eating, speech, and swallowing as well as social interactions. Patients who sustained mandibular fractures may have concerns and dissatisfaction regarding their oral health and appearance and avoid social contacts, both due to the effect of trauma and the immobilization provided by the arch bars and wires. With that being said, health professionals should become aware of detecting depressive symptoms during follow-up visits and refer patients to behavioural health services.

The mean time required for fracture healing was reported as 4.67 ± 0.72 weeks in the mandibular tooth-bearing area.^[5] Considering the outcomes of this report, an approach to protect the joint during and after the 4-week healing process of mandibular fractures should be advocated. Researchers reported that active, isometric, and passive exercises; patient education; electrotherapy; ultrasound; and low-level laser therapy may contribute to the improvement of jaw function, which may be adopted in patients with mandibular fractures both during and after MMF.^[15,16]

The limitations of this report were related to the small population size. Relatively few patients met the strict exclusion criteria, and this is to refrain from introducing confounding variables that might negatively affect treatment. An additional possible limitation is that fractures in the left and right sides were not evenly distributed in the study group, and because the sample size was small, the patients' excursions toward the fractured and nonfractured sides cannot be compared. Last, the enrollment of further participants in a prospective fashion is needed to ascertain the effectiveness of different treatment protocols on the recovery of jaw function and the reduction of the symptoms associated with mandibular fractures.

CONCLUSIONS

This study investigated the outcomes of the MMF technique in mandibular fracture. The findings are as follows:

1. The fractured patients were shown to have significantly lower maximum mouth opening, lateral excursion, and PM than healthy controls at 12 weeks postoperative.
2. Patients experienced mild-to-moderate postoperative pain and had a mean change of -7.34% of their initial body weight.
3. The treatment may affect the patient's well-being. Patients

sustained work-related problems and showed mild depressive symptoms due to immobilization treatment.

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Conflicts of interest

There are no conflicts of interest.

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