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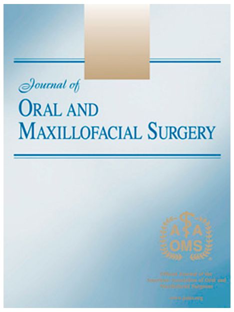

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Temporomandibular dysfunction after surgery of mandibular fractures not involving the mandibular condyle: a prospective follow-up study

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ABSTRACT

Purpose

Facial trauma may lead to temporomandibular dysfunction (TMD). The aim of this study was to clarify the occurrence and characteristics of TMD in patients surgically treated for mandibular fractures not involving mandibular condyle.

Methods

This prospective, single-center follow-up study was comprised of patients who underwent surgery for a non-condylar mandibular fracture. Patients were first evaluated at presentation, and again six months post-surgery to assess the function of the masticatory system, using the Helkimo index. Specifically, this index incorporates two complementary sub-indices: the subjective symptomatic (anamnestic) index (A_i), and the objective clinical dysfunction index (D_i). The A_i was recorded both at presentation and the six month follow-up. The D_i was recorded at the six month follow-up.

Results

Thirty-one patients completed the study. All patients were men (mean age 26.2, range 18–47 years). Four (12.9%) patients developed severe symptoms of dysfunction during the study period according to the A_i. Clinical findings (D_i) were observed in 25 (80.6%) patients, but these were not associated with symptoms of dysfunction.

Conclusions

TMD is common six months after surgery in patients with non-condylar mandibular fractures. Patients with such fractures should be evaluated for dysfunction during follow-ups, and referred for further treatment if necessary.

INTRODUCTION

Facial trauma such as mandibular fracture has been considered as a possible etiological factor in temporomandibular joint (TMJ) dysfunction (TMD)[1-6]. Direct or indirect trauma of the TMJ can cause mechanical changes within the joint, including effusion, hemarthrosis, dislocation, internal derangement, fibrous adhesion, ankylosis, fracture, and limitation or deviation of jaw opening[6]. Histologically, TMD effects have been presented as degeneration of the articular cartilage, synovitis, intra-articular adhesions, and production of inflammatory and pain mediators[4]. Other screening methods that have detected changes related to TMD include magnetic resonance imaging (MRI), arthroscopy, histomorphologic examination, and synovial fluid analysis[4,7,8]. Moreover, degenerative alterations in the mechanical properties of the articular disc have been documented[9]. Depending on the magnitude and direction of the impact, trauma may also cause inflammation of the adjacent muscles[10]. Malocclusion may disturb the balance of the TMJ and therefore cause TMD[11,12]. Cross-bite and TMJ displacement are proven risk factors in TMD development[11].

It is well known that condylar fracture of the mandible can cause TMD[8,13-15]. Direct trauma of the TMJ affects all structures of the joint, and treatment often requires immobilization. However, the effects of non-condylar mandibular fracture (caused by trauma) on the TMJ remain poorly studied. Indeed, when the trauma is severe enough to cause mandibular fracture, it could be hypothesized that the force of the trauma may directly or indirectly disturb the temporomandibular structures, hence causing TMD. Nevertheless, this has yet to be explored. Therefore, the aim of this study was to clarify the occurrence and characteristics of TMD in patients surgically treated for non-condylar mandibular fractures.

METHODS

Inclusion and exclusion criteria

The patients included in this study were drawn from a larger cohort of adult patients (aged 18 years or older), who had been surgically treated for facial fractures. Specifically, the selected patients had sustained a single or double non-comminuted, non-complicated mandibular fracture in the teeth-bearing region. The fracture types included were: 1) single fracture in the angle, 2) single fracture in the body, 3) single fracture in the symphysis/parasymphysis, and 4) double mandibular fracture (i.e., angle + body fracture, angle + symphysis/parasymphysis fracture). All patients underwent an open surgical reduction with intraoral fixation, using 2.0mm titanium miniplates and non-locking monocortical screws. Two miniplates were used in the symphysis/parasymphysis fractures, and one miniplate in the mandibular body and angle fractures, according to the technique presented by Champy and Lodde[16]. All patients were treated at the Helsinki University Hospital, Finland.

For the final analysis, patients with condylar fractures, infected fractures, or any other facial fractures that required surgical treatment were excluded. In addition, patients with any history of TMD were excluded.

Evaluation of temporomandibular function

The Helkimo anamnestic (A_i) and clinical (D_i) indices were used to identify the occurrence and severity of TMD[17]. During the pre-operative visits, patients' anamnestic subjective symptoms (A_i) were assessed using a questionnaire and an interview. At the six month follow-up, patients were evaluated again with the same questionnaire and interview. In addition, a comprehensive clinical examination of the masticatory system was performed according to the Helkimo clinical index (D_i). This index was only recorded at the six month follow-up; pre-operative TMD status could not be evaluated due to the effects of the primary trauma. All patients were examined by one person (JS), and only clinically demonstrable findings were included in the index.

For the Helkimo anamnestic index, the patients were divided into three groups (A_i0-A_iII) according to the severity of the TMD symptoms. Group A_i0 was the symptom-free category, which included patients that did not have any subjective symptoms. The patients in the A_iI group expressed mild symptoms, such as noises in the TMJ, jaw fatigue, and jaw stiffness upon awakening or during jaw movements. Group A_iII included patients with severe symptoms, such as difficulty opening the mouth, TMJ locking, luxation, and pain in the region of the TMJ or masticatory muscles.

For the Helkimo clinical index, the patients were divided into four groups (D_i0- D_iIII) according to the severity of the clinical findings. D_i0 indicated no findings, D_iI included mild findings, D_iII was moderate findings, and D_iIII was severe findings. See **Table 1 and 2** for more detailed criteria for A_i and D_i, respectively.

Data analysis

The primary outcome variables were A_i and D_i. The predictive variables were age, gender, cause of injury (assault, traffic, falling, sport, or other), site of the fracture, and malocclusion.

Ethical approval

The study protocol was approved by the Ethics Committee of the Department of Surgery and the Internal Review Board of the Division of Musculoskeletal Surgery, Helsinki University Hospital, Finland.

CONFLICT OF INTRESTS

The authors confirm that they do not have any conflict of interests.

RESULTS

A total of 49 patients met the inclusion criteria. Of these, four patients refused to participate in the survey. Of the remaining 45 patients, 14 patients were excluded for the following reasons: five patients had an additional condylar fracture, nine patients failed to attend the six month follow-up visit, and one patient reported a history of TMD. Thus, a total of 31 patients were included in the final analysis. **Table 3** lists the characteristics of the 31 patients.

All patients were treated within five days after the trauma (treatment delay average 2.2 days, range 0–5 days). Minor occlusal disharmony or mild malocclusion was found after operation in six (19.0%) patients, all of which were treated with occlusal equilibration by a specialist dentist during the study period.

Most of the patients (87.1%) were symptom-free (Ai0) six months after the trauma (and surgery). Nevertheless, four (12.9%) patients developed symptoms during the six month study period, which were ranked as severe (AiII) in all four of these patients.

A total of 25 (80.6%) patients had objective clinical findings of TMD (Di) six months after the trauma (and surgery). Mild findings (DiI) were the most common, reported in 19 (61.3%) patients. Six (19.4%) patients reported moderate TMD (DiII), whereas none of the patients had severe findings (DiIII). The majority of the patients (21 of 25; 84.0%) with clinical findings of dysfunction (DiI-II) did not have any TMD symptoms six months after the trauma (i.e. classified as Ai0).

All four patients with subjective symptoms (Ai) also had clinical findings (Di). Specifically, three of the patients with severe symptoms (AiII) had moderate (DiII) findings, and one reported mild (DiI) findings of TMD. **Table 4** lists the Helkimo anamnestic (Ai) and clinical (Di) indices of the 31 patients six months after the trauma. Impaired TMJ function was the most common finding among the patients with both symptoms (Ai) and clinical findings (Di). For a detailed list of the prevalence of different clinical findings, see **Table 5**. **Table 6** show the association between Ai and Di, as well as their association with other predictors, respectively.

All patients that developed TMD symptoms during the six month study period were men, aged 18–36 (mean 24.0). In all four patients that developed severe TMD symptoms during the study period, the trauma mechanism was assault, and the fracture site was in the angle of the mandible. Minor malocclusion after the operation was found in one patient, who then underwent an occlusal equilibration and was referred to a dentist for occlusal splint therapy after the study period.

DISCUSSION

This prospective, single-center study followed 31 patients with a surgically-operated, non-condylar mandibular fracture, for six months. Four patients (12.9%) developed severe symptoms of TMD during the study period, as determined with the Helkimo anamnestic index (A_i). Six months after the operation, 19.4% had moderate and 61.3% had mild clinical findings of TMD, as determined with the Helkimo clinical index (D_i).

The results of this study are similar to those of Görgu et al[1], who concluded that trauma of the mandible was a major factor causing TMD after comparing patients with a non-condylar mandibular fracture to healthy adult patients. On the contrary, Al-Hashmi et al[18] did not find any clinically significant TMD in patients with a mandibular fracture. However, they did suggest that assault and bilateral mandibular fractures might be important risk factors in TMD development. Similarly, the present study also found that TMD symptoms were associated with assault (trauma mechanism). Several other associations were also made with TMD symptoms, including male gender, and angle of the mandible (site of the fracture). However, it should be noted that all patients were male, and most had an angle fracture. Male gender is typically predominant among trauma patients[19]. Tabrizi et al[5] compared the frequencies of TMD in different types of mandibular fractures, and concluded that patients with a condylar fracture and a contralateral angle/body fracture were more likely to develop TMD than those with a unilateral fracture. These authors suggest that a transmitted force from the contralateral side of the mandible, such as angle or body, is the most common mechanism for TMJ damage. Hence, if the force is strong enough to cause a fracture of the angle or the body, it can also be transmitted to the TMJ with or without a condylar fracture.

Malocclusion has also been considered a causative factor for TMD[11]. In this study, however, there was no clear association between post-operative malocclusion and TMD symptoms. Only one patient who developed TMD symptoms during the study period had mild occlusal disharmony post-operatively, and was treated with occlusal equilibration. That patient was referred to a specialist for occlusal splint therapy after six months. Thus, the main causative factor for TMD would therefore be the trauma itself.

The modern classification of TMD differs from the Helkimo index that was used in the present study. Although the Helkimo index is not suitable for modern diagnostic criteria, it has nevertheless been widely used for research purposes. The main limitation of the Helkimo index is that it does not differentiate between joint and muscle-related symptoms. In addition, it does not account for intensity or frequency of the symptoms. When used alone, neither the clinical index D_i

nor the anamnestic index A_i are sufficient, considering the modern definition of TMD. Nevertheless, when combined, these two indices offer useful information for research purposes. Hence, the patients with dysfunction can be recognized and referred to a specialist dentist for stomatognathic examination and treatment, which often includes physiotherapy and occlusal splint therapy.

It is important to note that the occurrence of TMD among adults varies among different studies according to the definition and criteria of TMD, as well as the age and gender of the patients screened[20,21]. Similar to this study, the prevalence of clinical findings of TMD is often higher than the symptoms[20]. Therefore, the majority of patients are symptom-free even though some clinical findings of dysfunction are present, suggesting that all patients recovered relatively well. The indication for treatment is based on the symptoms, which tend to vary over time and are multifactorial[22]. Thus, a longer follow-up period could offer more definitive conclusions. The signs and symptoms of TMD do not often interfere with the patients' quality of life, but for some patients, TMD can be severe. Nevertheless, Kaukola et al.[23] have concluded that the overall health related quality of life (HRQoL) in patients with an operated mandibular fracture is significantly lower shortly after the operation, but improves until normal levels in three months.

Earlier studies have shown that TMD is common in patients with a fracture of the zygomatic complex[24]. Overall, the possibility of TMD after an operated facial trauma should be addressed, and the need for treatment should be evaluated.

CONCLUSION

This study concludes that postoperative TMD is a relatively common disorder in patients with non-condylar fractures of the mandible. It is hence advised that the clinician should be aware of possible TMD when treating patients with facial trauma. Patients with TMD should be referred to a specialist for evaluation and treatment.

TABLES

Table 1. Anamnestic Index (A_i)

Symptom-free	A_i0	Patients reported no symptoms of the masticatory system.
Mild symptoms	A_iI	Patients reported one or more of the following mild symptoms: temporomandibular joint sounds, jaw fatigue, stiffness of the jaws upon awakening or when moving the lower jaw.
Severe symptoms	A_iII	Patients reported one or more of the following severe symptoms: difficulty opening the mouth wide, jaw locking, luxations, pain when moving the mandible, pain in the region of the temporomandibular joint or the masticatory musculature.

Table 2. Clinical Index (D_i)

A	**Impaired range of movement, mobility index*:**	
	Normal range of movement	0
	Slightly impaired mobility	1
	Severely impaired mobility	5
B	**Impaired temporomandibular joint (TMJ) function**	
	Smooth movement without TMJ sounds or deviations upon opening and closing of the mouth	0
	TMJ sounds in one or both joints and/or deviations ≥2 mm	1
	Locking and/or luxations of the TMJ	5
C	**Muscle pain**	
	No tenderness on palpation	0
	Tenderness upon palpation in 1-3 palpation sites	1
	Tenderness upon palpation in 4 or more palpation sites	5
D	**Temporomandibular joint (TMJ) pain**	
	No tenderness upon palpation	0
	Tenderness upon lateral palpation	1
	Tenderness upon posterior palpation	5

E	**Pain upon movement of the mandible**	
	No pain upon movement	0
	Pain in 1 movement	1
	Pain in 2 or more movements	5
F	**Sum A+B+C+D+E Dysfunction score**	**0-25**
G	**Dysfunction group 0-5**	**0-5**
H	**Clinical index D_i according to the code**	**D_i I-III**

The Code:

0 points	Dysfunction group 0	clinically symptom-free	D_i0
1-4 points	1	mild findings	D_iI
5-9 points	2	moderate findings	D_iII
10-13 points	3	severe findings	D_iIII
15-17 points	4	severe findings	D_iIII
20-25 points	5	severe findings	D_iIII

* For more details, see Helkimo[17].

Table 3. Characteristics of the 31 patients with an operated non-condylar mandibular fracture

Predictor	**Average**	**Range**
Age (years)	26.2	18–47
	Number of patients	**Percentage of all patients %**
Gender		
men	31	100
women	0	0
Cause of injury		
assault	26	85
falling	2	6
sport	1	3
traffic	1	3
other	1	3
Fracture site		
angulus	13	42

angulus + symphysis/parasymphysis	9	30
angulus + corpus	2	6
corpus	1	3
symphysis/parasymphysis	6	19
Malocclusion after operation	6	19

Table 4. Subjective symptoms (A_i) and objective clinical findings (D_i) of dysfunction in 31 patients six months after the surgery of a non-condylar mandibular fracture

Anamnestic index (A_i)		**Number of patients**	**% of all**
A_i0	no symptoms	27	87
A_iI-A_iII	symptoms present	4	12.9
A_iI	mild symptoms	0	0
A_iII	severe symptoms	4	12.9
Clinical index (D_i)			
D_i0	no clinical findings	6	19.4
D_iI-D_iIII	clinical findings present	25	80.6
D_iI	mild clinical findings	19	61.3
D_iII	moderate clinical findings	6	19.4
D_iIII	severe clinical findings	0	0

Table 5. Association between subjective symptoms (A_i) and objective clinical findings (D_i) six months after surgery

Clinical findings	**All patients with clinical findings (n=25)**	**Patients with TMD symptoms (n=4)**
Impaired range of movement	10	1
Impaired TMJ function	17	4
Muscle pain	9	3
TMJ pain	7	3
Pain on movement	2	1

Table 6. Association between subjective symptoms (A_i), objective clinical findings (D_i), age, gender, cause of injury, fracture site, and malocclusion after operation

Predictor	A_iI-A_iII (symptoms present)		A_i0 (no symptoms)		D_iI-D_iIII (clinical findings present)		D_i0 (no clinical findings)	
Age (years)								
range	18–36		18–47		18–47		19–40	
mean	24.0		26.5		25.8		27.7	
	Number of patients	**% of 4**	**Number of patients**	**% of 27**	**Number of patients**	**% of 25**	**Number of patients**	**% of 6**
Gender								
male (n=31)	4	100	27	100	25	100	6	100
Cause of injury								
assault (n=26)	4	100	22	81.4	20	80.0	6	100
falling (n=2)	0	0	2	7.4	2	8.0	0	0
traffic (n=1)	0	0	1	3.7	1	4.0	0	0
sport (n=1)	0	0	1	3.7	1	4.0	0	0
other (n=1)	0	0	1	3.7	1	4.0	0	0
Fracture site								
angulus (n=13)	4	100	9	33.3	12	48.0	1	16.7
angulus + corpus (n=2)	0	0	2	7.4	2	8.0	0	0
angulus + symphysis/parasymphysis (n=9)	0	0	9	33.3	6	24.0	3	50.0
corpus (n=1)	0	0	1	3.7	1	4.0	0	0
symphysis/parasymphysis (n=6)	0	0	6	19.4	4	16.0	2	33.3
Malocclusion after operation	1	25	5	18.5	5	20.0	1	16.7

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