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Research Article

Evaluation of clinical features of mandibular fractures and associated injuries. A 10-year retrospective study

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Abstract. Introduction: The mandible is currently the most frequently fractured bone of the viscerocranium. Mandibular fractures are rarely isolated; they are usually accompanied by associated soft tissue injuries. The presence of associated injuries increases the morbidity of the case, makes diagnosis difficult, complicates treatment and favors the development of complications. Aim: The aim of this study is to determine the incidence of associated injuries in patients with mandibular fractures and to correlate them with the type of fracture in the population in our geographic area. Materials and methods: A 10-year retrospective study was conducted, which included patients diagnosed and treated at the Clinic of Oral and Maxillofacial Surgery I Cluj-Napoca. Results: Seven hundred and nine patients presenting 1099 fracture lines were included in the current study. The majority of the fracture lines were complete (97.45%), with displacement (87.35%), and without communication with the external environment (59.79%). Two hundred sixty-three patients (37.09%) had associated injuries. The most frequent associated injury was soft tissue contusion (38.29%), and the most rarely found injury was dental trauma (8.89%). Conclusions: Total mandibular fractures with bone fragment displacement most frequently present associated soft tissue injuries. The most frequent associated injury of mandibular fractures in our geographic area is soft tissue contusion. Partial or non-displaced fractures are rarely associated with other injuries.

Key Words: mandible, trauma, fracture, associated, injury, maxillofacial.

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Introduction

Traumatic pathology of the viscerocranium has an increasing incidence in the human population (Silveira 2000) and it is the most common cause of death and disability in young people, with an annual financial burden of over $50 billion per year in the United States (Zammit et al 2013). The mandible along with the zygomatic bone is the most fractured bone of the facial skeleton, which is currently the most frequently encountered pathology in the emergency service of maxillofacial surgery departments (Follmar et al 2007, Marchiori et al 2013). The particular position of the mandible in the viscerocranium, its structure and architecture, as well as its multiple insertions confer particular clinical features to mandibular fractures compared to other facial fractures (Bucur et al 2009, Burlibaşa et al 2005, Fonseca et al 1997). So far, there are no studies allowing to clearly define the clinical features of mandibular fractures, and even less, to standardize their main associated injuries (Grant et al 2012, Mendes et al 2013, Ramli et al 2011).

Although mandibular fractures are relatively easy to diagnose, they can be overlooked by less experienced clinicians. The main factors that can hide a mandibular fracture include injuries associated with these fractures as haematoma and swelling, that can mask the extent of the underlying injury (Lynham et al 2012, Marchiori et al 2013). Non-diagnosis of mandibular fractures at an early stage has serious consequences on the patients' quality of life, being followed by a range of infectious, mechanical, functional and particularly cosmetic complications that can seriously affect the patients' resumption of daily activities (Bucur et al 2009, Lynham et al 2012, Fonseca et al 2007, Warnke et al 2011). Although imaging examination is highly available in current modern medicine, knowing the clinical features of mandibular fractures, their potential associated injuries, as well as the interaction between these remains a fundamental goal for early diagnosis and the choice of optimal treatment (Bucur et al 2009, Lynham et al 2012, Burlibaşa et al 2005, Fonseca et al 1997, Mendes et al 2013, Muñante-Cárdenas et al 2011).

The aim of this study is to determine the clinical features of mandibular fractures, the incidence of their associated injuries, as well as to correlate clinical features with the type of associated injuries in the population.

Materials and methods

For the current study, patients diagnosed and treated at the Clinic of Oral and Maxillofacial Surgery Cluj-Napoca, in the period

1.01.2002 – 31.12.2011, were available. Data were collected from the patients' clinical observation charts. The protocol was approved by the Ethical Committee of University of Oradea, Romania and all the patients had signed the informed consent. The study inclusion criteria were as follows: presence of at least one fracture line in the mandible, a history of an acute trauma episode, paraclinical examination (X-ray or computed tomography) confirming the clinical diagnosis of mandibular fracture and evidencing its location and characteristics, patient treated in the study's host institution.

The exclusion criteria were: patient without mandibular fracture, mandibular fracture of other etiology than trauma, absence of complementary imaging investigations, treatment performed in another service, incomplete data.

The monitored variables were the following: degree of bone involvement (incomplete/complete fracture), degree of fracture displacement (with displacement/without displacement), relationship of the fracture focus with the external environment (closed/intraorally open/extraorally open fracture), presence or absence of associated injuries (hematoma, excoriation, wound, dental trauma), type of dental trauma (crown/root fracture, dental avulsion/dislocation).

Data were centralized in electronic format using the Microsoft Excel software. Descriptive statistics of the assessed cases was performed with a two-decimal percentage accuracy. The degree of bone fragment displacement was correlated with the type of associated injury. Statistical analysis was performed using MedCalc Statistical Software program version 16.8.4 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2016). The chi-square test was employed to assess the difference between groups. A p value of <0.05 was considered sta -tistically significant.

Results

The study included 709 patients presenting 1099 fracture lines. Of all fracture lines, 1071 were complete (97.45%) and only 28 were incomplete (2.55), a displacement of the fractured fragments occurring in the majority of the cases (Fig. 1).

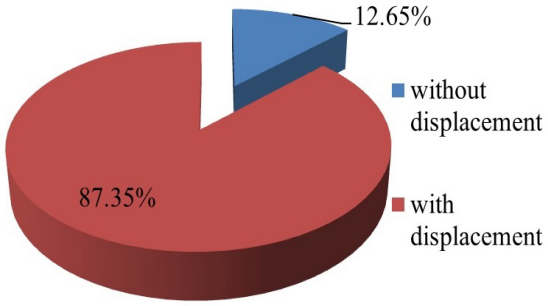

Fig. 1. Distribution of fracture lines depending on the degree of displacement

Most of the fracture foci were closed, without being contaminated from the septic environment of the oral cavity (Fig. 2). Associated injuries were present in 263 patients (37.09%), while in 446 patients (62.91%) these were absent. The most frequent associated injury was contusion, followed by abrasion (Fig. 3).

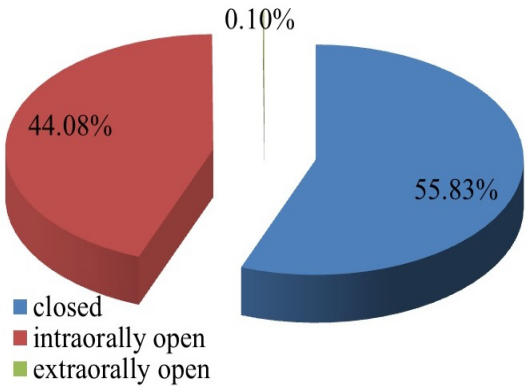

Fig. 2. Distribution of fracture lines depending on the relationship with the external environment

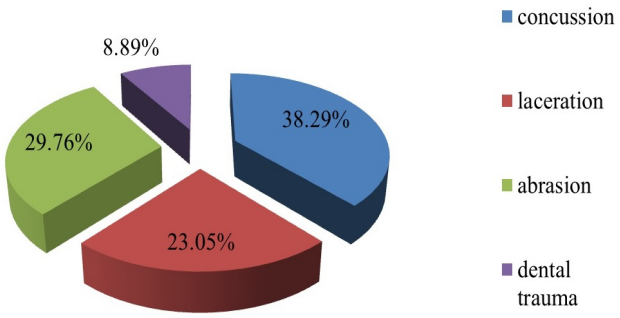

Fig. 3. Distribution of patients depending on associated injuries

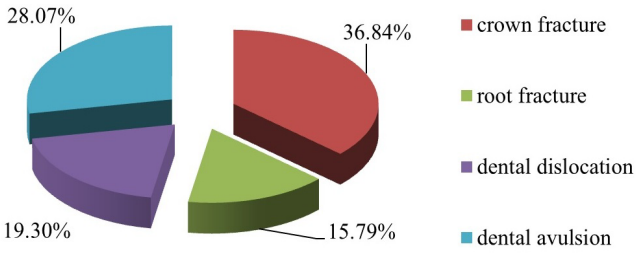

Fig. 4. Distribution of patients depending on the type of dental injury

The majority of non-displaced fractures were not accompanied by associated injuries, while most of the fractures with bone fragment displacement were intraorally open, very rarely extraorally open, and were accompanied by one or more associated injuries (Table 1).

Discussions

The aim of this study was attained, and the clinical features of mandibular fractures as well as the type and incidence of their associated injuries can be determined in a large group of patients. Literature data referring to the correlation between soft tissue injuries and underlying mandibular fractures differ considerably. Knowing the frequency of association of a particular type of soft tissue injury with a certain type of mandibular fracture

Table 1. Distribution of associated injuries depending on the degree of fracture displacement

Displacement degree	Associated injuries: Contusion	Laceration	Abrasion	Dental trauma	p	Type of fracture site: closed fracture	open fracture	p
with displacement 623 patients	202 patients (32.42%)	120 patients (19.26%)	155 patients (24.87%)	45 patients (7.22%)		530 lines of fracture (55.78%)	420 lines of fracture (44.21%)	
without displacement 62 patients	9 patients (14.51%)	7 patients (11.29%)	9 patients (14.51%)	4 patients (6.45%)	0.7	45 lines of fracture (57.69%)	33 lines of fracture (42.30%)	0.7

is useful in making rapid complete diagnosis, because in this way, the clinician will know when to suspect the presence of a mandibular fracture that can be masked by other clinical signs. In the current study, the majority of fractures were complete, with the involvement of both cortical bones. This result is described by other authors (Kraft et al 2012, Batista et al 2012, Lynham et al 2012, Burlibaşa et al 2005, Businger et al 2012, Gandhi et al 2011, Nonato et al 2011, Ramli et al 2011, Roccia et al 2013, Warnke et al 2011). Incomplete fractures are rarely found in clinical practice, as they only occur in the case of the action of traumatic agents with low kinetic energy (Burlibaşa et al 2005, Fonseca et al 1997). In addition, these fractures have much more reduced clinical signs and almost absent functional disorders, which is why the patient does not consider imperative to present to a specialized service. Many incomplete mandibular fractures remain undiagnosed. In contrast, in case of loss of bone continuity, severe functional and cosmetic disorders develop, which lead the patient to present to the doctor in emergency (Bucur et al 2009, Lynham et al 2012, Burlibaşa et al 2005, Fonseca et al 1997).

Displaced fractures are the most frequent in our study, while non-displaced fractures represent a minority; these results are similar to those reported by other authors (Kraft et al 2012, Batista et al 2012, Lynham et al 2012, Burlibaşa et al 2005, Businger et al 2012, Gandhi et al 2011, Nonato et al 2011, Ramli et al 2011, Roccia et al 2011, Warnke et al 2011). This increased incidence can be explained on the one hand by the fact that most of the traumas causing mandibular fractures have a high kinetic energy and lead to primary displacement, and on the other hand, by the action of important muscle groups on the mandible, which causes significant secondary displacement (Bucur et al 2009, Alvi et al 2003, Burlibaşa et al 2005, Businger et al 2012, Fonseca et al 1997, Gandhi et al 2011, Natu et al 2012, Warnke et al 2011).

In the current study, closed fracture foci are predominant. This is supported by the results of Gassner et al (2004), Kapoor et al (2012) and Işik et al (2012), but is contradicted by the findings of other authors, who report open fractures to be prevalent (Mesgarzadeh et al 2011, Hashim et al 2011, Hitosugi et al 2011, Roccia et al 2011). The fact that literature data are contradictory is not surprising, given the multitude of injuring agents that may cause mandibular fractures. Thus, studies carried out in military conflict areas or those in which road traffic accidents are the predominant cause indicate a higher incidence of open fractures. On the other hand, interhuman aggression in areas without major conflicts is not associated with injuries of the same severity as those occurring during armed conflicts, so that the incidence of open fractures reported by these authors decreases. The lower incidence of open fractures in the current study can be best explained when taking into consideration the social and political context of the region where the study was performed. However, open fractures are not rare in our results either; more than one third of all patients are affected, which can be rather explained by the anatomical factors that favor the opening of the fracture focus, such as the bone-adherent alveolar mucosa, than by external factors causing the fracture (Lynham et al 2004, Marchiori et al 2013, Martins et al 2011, Mendes et al 2013, Qing-Bin et al 2013, Wang et al 2011).

Most of the patients in the current study had no comorbidities, patients with injuries associated with mandibular fractures representing a minority. This result is similar to those published by Natu et al (2012), Businger et al (2012), Thoren et al (2012) and Martins et al (2011), but is in contradiction with the results of other studies, where the majority of patients diagnosed with mandibular fractures have associated injuries (Mesgarzadeh et al 2011, Kraft et al 2012, Gassner et al 2004, Grant et al 2012, Kapoor et al 2012, Saddki et al 2010). The explanations of these differences in the literature are purely speculative, depending on the geographic region and etiology, and are inconclusive at present. Further studies are required in this respect.

The most frequent associated injury in the current study was contusion, followed by abrasion and laceration, a similar result to those mentioned by other authors (Adewole et al 2011, Batista et al 2012, Kapoor et al 2012, Daniel et al 2013, Le et al 2001, Saddki et al 2010, Shepherd et al 1990). This is in contradiction with the results of Kraft et al (2012), Okoje et al (2010), Nonato et al (2011), Hashim et al (2011) and Hitosugi et al (2011), which indicate laceration as the associated injury with the highest incidence. The predominance of contusions in this study emphasizes the reduced severity of the traumas included in the study. Other studies indicate dental injuries to be most frequently associated with mandibular fractures, unlike soft tissue injuries (Andreasen et al 2000, Gassner et al 2004, Roccia et al 2013, Silveira et al 2000, Zhou et al 3013). The data obtained in this study show a relatively low incidence of dental injuries. This is probably due to the fact that some of the patients included in the study were partially or totally edentulous when the trauma occurred. The most frequent dental injury was crown fracture, followed by dental avulsion, which is in accordance with the results published by some authors (Adekoya- Sofowora et al 2005, Andreasen et al 2000, Kraft et al 2012, Nonato et al 2011). In contrast, other authors report dental avulsion (Batista et al 2012, Kapoor et al 2012, Ravindran et al 2011, Zhou et al 2013) or dental dislocation (Marchiori et al 2013, Roccia et al 2013) to be the most frequent post-traumatic dental injury. The type of dental injury depends on a multitude

of factors such as the patient's dental-periodontal status, the type of causative agent, its direction of action and kinetic energy, as well as the position of the patient's head and mouth at the time of the trauma, etc. (Bucur et al 2004, Alvi et al 2003, Lynham et al 2012, Burlibaşa et al 2005, Businger et al 2012). This explains the contradictory literature results referring to the type of post-traumatic dental injuries. This limitation of the study can be overcome by increasing the number of patients, as well as by extending the geographic area of the study.

The correlation of associated injuries with the degree of fracture displacement evidenced the highest incidence of associated injuries in the case of displaced fractures, which is supported by other authors (Mesgarzadeh et al 2011, Kraft et al 2012, Batista et al 2012, Businger et al 2012, Le et al 2001, Lynham et al 2004, Marchiori et al 2013, Martins et al 2011, Mendes et al 2013, Muñante Cárdenas et al 2011,Thoren et al 2012, Wang et al 2011, Warnke et al 2011). This is due in the first place to the fact that in order to generate bone fragment displacement, the action of a traumatic agent with a high kinetic energy is required, whose force also acts on the overlying soft tissues and teeth (Bucur et al 2009, Burlibaşa et al 2005, Businger et al 2012, Fonseca et al 1997). Also, bone fragment displacement itself causes laceration of surrounding tissues, leading to the development of mouth floor, cheek, lip hematomas or gingival wounds that expose the fracture focus in the oral cavity, etc. (Bucur et al 2009, Burlibaşa et al 2005, Businger et al 2012, Fonseca et al 1997, Wilson et al 1997). In the case of non-displaced fractures, extensive associated injuries are generally absent, while soft tissue contusions, superficial wounds or excoriations are present, which indicate the site of impact of the traumatic agent (Businger et al 2012, Fonseca et al 1997). However, no significant differences regarding the relationship with the external environment were found between displaced and non-displaced fractures. This is contrary to the results published by other authors (Bucur et al 2009, Mesgarzadeh et al 2011, Lynham et al 2004, Burlibaşa et al 2005, Gandhi et al 2011) and can be explained by the fact that in the current study, some patients diagnosed with non-displaced fractures also had concomitant lacerations of the overlying soft tissues that exposed the fracture focus. This is only an assumption, as no accurate data referring to this aspect were available in the clinical observation charts at the time of the study. Additional research in our geographic area is required.

One of the most important limitations of the current study results from its retrospective nature. As data were collected from the observations charts, some of these could be incomplete or incorrectly recorded. To minimize this shortcoming, only complete observation charts were selected, but in this way, a number of cases from the statistical database were lost.

Conclusions

Total mandibular fractures with bone fragment displacement most frequently present associated soft tissue injuries. The most frequent associated injury of mandibular fractures is soft tissue contusion. Partial or non-displaced fractures are rarely associated with other injuries.

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