

Therapeutic approach to mandibular fractures - a 3-year prospective clinical study

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Abstract. Introduction: The mandible is part of the lower face, contributing to facial appearance, and plays a role in nutrition, mastication, deglutition and speech. The fractures of the mandible lead through its discontinuity to severe aesthetic and functional disorders. The aim of the treatment of mandibular fractures is to reduce and immobilize the fractured fragments in anatomical position, to restore habitual dental occlusion and temporomandibular joint movements, as well as to restore the patient’s facial appearance. Objective: The aim of this study is to evaluate which therapeutic method of mandibular fractures is the most efficient by assessing the evolution and incidence of postoperative complications depending on each treatment method applied. Materials And Methods: The study was conducted prospectively in patients diagnosed with mandibular fractures, hospitalized and treated in the Clinic of Oral and Maxillofacial Surgery I in Cluj-Napoca over a 3 years period. Results: At the end of the 3-year period in which the prospective study was conducted 60 patients met all the criteria for inclusion in the study. Most of patients were treated orthopedic (n=29, 48.33%) and combined - both orthopedical and surgical treatment (n=25, 41.67%). Non-displaced fractures were treated, in principle, orthopedically, while for displaced fractures, combined surgical-orthopedic treatment was chosen in most of the cases (p=0.001). Only 4 patients (6.67%) developed postsurgical complications. All the complications were septic (n=3-osteitis alone, n=1- osteitis complicated with submandibular abscess). In all 4 cases removal of the osteosynthesis material, surgical debridement and intermaxillary fixation assured proper healing in the fracture foci. Conclusions: The degree of bone fragment displacement directly influence the choice of the treatment method. Perfect reduction of the fracture focus and impeccable fixation of the bone fragments, as well as patient compliance with postoperative indications ensure a favorable postoperative evolution of the cases regardless of the chosen treatment method or the characteristics of the mandibular fracture.

Key Words: mandibular fractures, treatment, prospective, oral and maxillo facial surgery

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Introduction

The mandible is part of the lower face, contributing to facial appearance, and plays a role in nutrition, mastication, deglutition and speech (Ellis et al 1985). The fractures of the mandible lead through its discontinuity to severe aesthetic and functional disorders (Chrchanovic et al 2000). The aim of the treatment of mandibular fractures is to reduce and immobilize the fractured fragments in anatomical position, to restore habitual dental occlusion and temporomandibular joint movements, as well as to restore the patient’s facial appearance (Mohammad et al 2015). At present, mandibular fractures are treated by orthopedic, surgical or combined methods (Boffano et al 2015). There are many techniques to reduce and immobilize mandibular fractures, but there are currently no standardized criteria for the choice of the optimal therapeutic method at international level (Alkan et al 2007). According to the literature, orthopedic treatment has

the advantage that it does not require general anesthesia, it is minimally invasive, it involves reduced costs and a short duration of hospitalization, but it has many disadvantages due to intermaxillary fixation: difficult feeding with deficient nutritional intake, weight loss, difficult self-hygiene resulting in tooth decay, improper speech and deglutition and social integration difficulties, insomnia and general discomfort (Schneider et al 2008). Surgical treatment consisting of open reduction and internal fixation with titanium plates and screws eliminates the mentioned shortcomings through the absence of intermaxillary block, allowing early mandibular mobilization, maintenance of impeccable oral hygiene, adequate dietary intake, immediate restoration of speech and implicitly, early reintegration into society (Țeț et al 2016). The shortcomings of surgical treatment are limited to the need for general anesthesia with the related anesthetic risks, the high cost and prolonged hospital stay (Moraes et al 2010).

The aim of this study is to evaluate which therapeutic method is the most efficient by assessing the evolution and incidence of postoperative complications depending on each treatment method applied.

Materials and methods

The study was conducted in patients diagnosed with mandibular fractures, hospitalized and treated in the Clinic of Oral and Maxillofacial Surgery I in Cluj-Napoca, in the period 1 January 2014 – 31 December 2016. All patients included in the study signed an informed consent to undergo the surgical or orthopedic procedure under the required type of anesthesia, as well as for the use of their anonymized medical data in the current study.

The study inclusion criteria were as follows:

- Patient under continuous hospitalization in the Clinic of Oral and Maxillofacial Surgery I Cluj-Napoca
- Written informed consent signed by each patient
- Diagnosis of mandibular fracture supported by imaging investigations (orthopantomographic X-ray, anteroposterior facial X-ray or computed tomography)
- Traumatic origin of the causal agent of the mandibular fracture
- Patient's compliance with postoperative indications during treatment
- Possibility of postoperative follow-up for 6 weeks after hospital discharge.

The exclusion criteria were the following:

- Patient's refusal to participate in the study
- Absence of paraclinical investigations confirming the clinical diagnosis of mandibular fracture
- Non-traumatic origin of the causal agent of the mandibular fracture
- Patients' refusal to be treated
- Treatment performed in an outpatient setting
- Patient's non-compliance with postoperative indications during treatment
- Impossibility of postoperative follow-up for at least 6 weeks after hospital discharge.

The variables monitored in this study were the treatment performed (orthopedic, surgical, orthopedic-surgical and mandibular cerclage), the therapeutic approach to the teeth in the fracture focus (tooth extraction, apical resection, incision and drainage, watchful waiting), postoperative evolution (favorable, unfavorable), and development of complications.

The treatment of mandibular fractures was carried out according to the internal protocol of the host clinic in which the study was conducted, the therapeutic method being chosen based on it. Strictly orthopedic treatment was applied to all patients with non-displaced mandibular fractures, stable occlusion and dento-periodontal status favorable to the application of vestibular Erich splints and circumdental wires. Surgical treatment was chosen as a therapeutic approach under the following conditions: double or multiple mandibular fractures, concomitant midface fractures, displaced mandibular fractures, dento-periodontal status unfavorable to the application of vestibular splints and circumdental wires, patients with general diseases representing absolute contraindications to intermaxillary block (epilepsy, alcoholism, various neuropsychic disorders).

Combined treatment was applied to all patients with old mandibular fractures with osteitis in the fracture focus or soft tissue

suppuration. Cerclage using circummandibular wires was performed in patients with subtotal or total edentation, whose general state contraindicated osteosynthesis surgery.

Operative protocol

Orthopedic treatment was performed under local plexal anesthesia by infiltration (4% xylene). Vestibular Erich splints were fixed on the clinical tooth neck by circumdental wire ligature 0.4 mm in diameter, and bimaxillary fixation was carried out using wire with a diameter of 0.6 mm. Patients were administered antibiotic, analgesic and anti-inflammatory drug treatment during admission and for 5 days after discharge. They were hospitalized for 2 days. The patients were followed up weekly for 6 weeks for evaluation of dental occlusion, integrity of the fixation system and assessment of oral hygiene status. At 6 weeks postoperatively, a control orthopantomographic X-ray was taken and the fixation system was removed.

Osteosynthesis surgery was performed under general anesthesia with nasotracheal intubation. An intraoral approach was used, through an incision at the bottom of the vestibular sulcus. In the case of mandibular angle fractures, a combined extra- and intraoral approach was used with a transjugal trocar. The trocar was inserted through a genial skin incision of 0.5 cm. When perimandibular transfixing wounds were present, surgery was carried out through these, while avoiding the creation of additional gaps. After hemostasis, mucoperiosteal detachment and exposure of the fracture focus were performed. The granulation tissue in the fracture focus was curetted and the mandibular fracture was reduced under direct visual control. Intraoperatively, temporary intermaxillary block with a role in restoring habitual occlusion was initiated. The 2 mm thick titanium miniplates with 4 holes were applied by 2 on each fracture line (one positioned superiorly toward the mandibular alveolar process in the maximum tension area, and one positioned inferiorly toward the basilar margin in the maximum pressure area). The orifices were drilled, under continuous cooling with physiological serum, perpendicular to the outer mandibular cortex and at least 5 mm distal to the fracture line. The monocortical titanium screws 2 mm in diameter and 7 mm long were placed sequentially from distal to mesial, being tightened in inverse order of their application. After the correctness of osteosynthesis was verified, the operative field was extensively washed with physiological serum, and 4.0 monofilament polypropylene sutures in separate points were placed. When maintenance of intermaxillary block was required, this was maintained for 2 weeks; otherwise, it was removed immediately after the suture of the operative wound. All patients were administered antibiotic, analgesic and nonsteroidal anti-inflammatory drugs intraoperatively and during hospitalization. Patients were discharged at 4 days postoperatively. The sutures were removed at 7 days postoperatively, and the intermaxillary block in the case of combined treatment was removed at 14 days in an outpatient setting. At 6 weeks, a control X-ray was taken in order to assess evolution and possible complications.

In the case of patients with old fractures with osteitis in the fracture focus and perimandibular or deep space suppuration, the treatment of the infection was first performed (incision at the chosen site, drainage and washing), and only after the inflammatory signs were ameliorated, osteosynthesis surgery was

carried out according to the described protocol. Antibiotic treatment in this case was based on the bacteriological antibiogram. Mandibular cerclage treatment was performed under locoregional infiltration anesthesia (4% xylene solution), by using biteplates fixed on the mandible with circummandibular Wipla wires. The circummandibular wires were introduced through a trocar inserted from the skin to the oral cavity. The trocar was inserted 2 cm from the basilar margin of the mandible in order to avoid injury to the marginal ramus of the facial nerve. Patients were submitted to antibiotic, analgesic and nonsteroidal anti-inflammatory medication. The hospitalization period varied between 3-5 days after the procedure. The patients received a semi-liquid diet for 8 weeks. They were monitored weekly for 2 months for oral hygiene as well as integrity and stability of the fixation systems. At 8 weeks postoperatively, a control orthopantomographic X-ray was taken. In the case of a favorable evolution, the circummandibular sutures and biteplates were removed in an ambulatory setting, and patients were subsequently referred to the dental service for adequate definitive prosthetic restoration. Data were centralized in electronic format using Microsoft Excel software. Descriptive statistics of the evaluated cases was performed with a two decimal percent accuracy. Statistical analysis was conducted using the MedCalc Statistical Software version 17.2 (MedCalc Software bvba, Ostend, Belgium; <https://www.medcalc.org>; 2017). Continuous data were expressed as mean and standard deviation, and nominal data were expressed as frequency and percentage. The comparisons of the frequencies of a nominal variable between the categories of another nominal variable were made with the chi-square test. The comparison of a continuous nominal variable between two groups was made with the T test for independent variables. A p value <0.05 was considered statistically significant.

Results

At the end of the 3-year period in which the prospective study was conducted 60 patients met all the criteria for inclusion in the study.

The most frequently used method for the treatment of mandibular fractures in the current study was the orthopedic method, followed by combined orthopedic-surgical treatment; osteosynthesis surgery alone and mandibular cerclage were used in a small number of cases (Fig. 1).

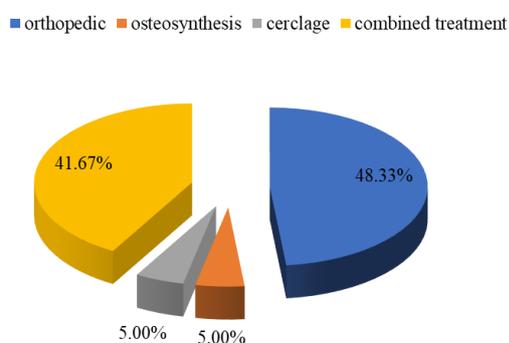


Fig. 1. Distribution of patients depending on the type of treatment

The majority of the patients had a favorable evolution, without postoperative complications (Fig. 2); at 6 weeks, consolidation of the bone fragments in anatomical position in the fracture focus was observed.

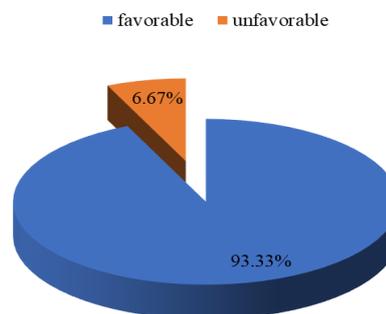


Fig. 2. Distribution of patients depending on evolution

Postoperative complications were found in 4 cases. Three patients (5%) had osteitis in the fracture focus at 2 weeks postoperatively, and one patient (1.67%) had a submandibular abscess starting from osteitis in the fracture focus, which required incision and drainage of the suppuration.

The topographic location of the mandibular fracture lines was correlated with the type of treatment used. However, differences were not statistically significant; the location of the fracture line did not influence per se the choice of the therapeutic option. The degree of displacement was also correlated with the type of treatment. Non-displaced fractures were treated, in principle, orthopedically, while for displaced fractures, combined surgical-orthopedic treatment was chosen in most of the cases. These differences were statistically significant (Table 1). Postoperative evolution was correlated with the location of the fracture line, the results being statistically insignificant (Table 2). The frequency of complications depending on the method of treatment applied was determined. The most frequent postoperative complications occurred in the case of surgical treatment, while orthopedic treatment generated complications in the smallest number of cases. This result was statistically significant (Table 3).

Discussions

The most frequent treatment used for mandibular fractures in our study was orthopedic treatment, which is in accordance with the results of other authors (Anyanech et al 2011; Ramli et al 2011). This was based on the protocol of the host clinic applied to patients with recent mandibular fractures, without displacement or with minimal displacement, but with the possibility of easy and anatomically perfect closed reduction, with stable occlusion and teeth present in both fractured fragments. Similar approaches are found in other literature publications (Anyanechi et al 2011; Ramli et al 2011). However, we mention that these indications of orthopedic treatment were also extended in our study to patients who were candidates for osteosynthesis, not orthopedic treatment. This was due to patients' refusal of surgery or precarious general status, under which conditions general anesthesia and implicitly surgical treatment are

Table 1. Correlation of the frequency of the type of treatment applied depending on the location of the mandibular fracture line and the degree of displacement of the bone fragments

LOCATION		TYPE OF TREATMENT				P
		ORTHOPEDIC	SURGICAL	CERCLAGE	COMBINED	
PARAMEDIAN	Absent	19(48.7%)	2(5.1%)	2(5.1%)	16(41%)	0.999
	Present	10(47.6%)	1(4.8%)	1(4.8%)	9(42.9%)	
LATERAL	Absent	21(55.3%)	1(2.6%)	2(5.3%)	14(36.8%)	0.426
	Present	8(36.4%)	2(9.1%)	1(4.5%)	11(50%)	
MANDIBULAR ANGLE	Absent	15(41.7%)	3(8.3%)	3(8.3%)	15(41.7%)	0.185
	Present	14(58.3%)	0(0%)	0(0%)	10(41.7%)	
SUBCONDYLAR AND CONDYLAR	Absent	19(47.5%)	3(7.5%)	2(5%)	16(40%)	0.66
	Present	10(50%)	0(0%)	1(5%)	9(45%)	
FRAGMENT DISPLACEMENT	Without	16(88.9%)	0(0%)	1(5.6%)	1(5.6%)	0
	With	13(31%)	3(7.1%)	2(4.8%)	24(57.1%)	

Table 2. Distribution of postoperative complications depending on the topographic location of the fracture lines

LOCATION		POSTOPERATIVE COMPLICATIONS		P
		NO	YES	
PARAMEDIAN	Absent	36(92.3%)	20(95.2%)	1
	Present	3(7.7%)	1(4.8%)	
LATERAL	Absent	37(97.4%)	1(2.6%)	0.135
	Present	19(86.4%)	3(13.6%)	
MANDIBULAR ANGLE	Absent	32(88.9%)	4(11.1%)	0.143
	Present	24(100%)	0(0%)	
SUBCONDYLAR AND CONDYLAR	Absent	37(92.5%)	3(7.5%)	1
	Present	19(95%)	1(5%)	
FRAGMENT DISPLACEMENT	Without	18(100%)	0(0%)	0.306
	With	38(90.5%)	4(9.5%)	

Table 3. Distribution of the frequency of postoperative complications depending on the type of treatment

	Complications		Total
	No	Yes	
ORTHOPEDIC	29	0	29
	51.80%	0.00%	48.30%
SURGICAL	1	2	3
Type of treatment	1.80%	50.00%	5.00%
CERCLAGE	2	1	3
	3.60%	25.00%	5.00%
COMBINED	24	1	25
	42.90%	25.00%	41.70%
Total	56	4	60
P<0.001	100.00%	100.00%	100.00%

contraindicated. The choice of the treatment method was also influenced by the social status of the patients; many of these were unemployed, without medical insurance, and could not afford the cost of osteosynthesis surgery or the prolonged hospital stay following it. In their case, orthopedic treatment was the optimal solution considering the relatively low cost of the required materials and the reduced hospital stay. These shortcomings, with which other authors have also been confronted in current practice, are characteristic of developing countries and can explain the great number of patients treated orthopedically in the context of the currently available modern treatment methods (Anyanechi et al 2011; Kummoona et al 2011; Ramli et al 2011; Charles et al 2016).

In contrast to our results, other authors show that in their current practice, the most frequent treatment used is combined orthopedic-surgical treatment (Van Den Bergh et al 2012). Combined treatment in our study also had a relatively high incidence (41.67%). We treated with the combined approach all double, triple or multiple mandibular fractures in edentulous patients without stable occlusion and in patients who did not present teeth in both fractured fragments. Under the mentioned conditions, their perfect reduction and fixation by orthopedic treatment alone was impossible, and association of osteosynthesis in the fracture focus was quasi-necessary. These indications are also found in the protocols presented by other authors (Depprich et al 2007; Bassej et al 2011; Van Den Bergh et al 2012).

Contrary to our approach, there are authors who treat mandibular fractures regardless of their characteristics by osteosynthesis surgery alone, without additional intermaxillary fixation (De Gabrielli et al 2003; Matos et al 2010). These authors advocate that mandibulomaxillary fixation under conditions of impeccable open reduction and rigid fixation in the fracture focus with at least 2 titanium plates for each focus is not beneficial for healing (De Gabrielli et al 2003; Matos et al 2010). They emphasize the benefits provided by the lack of intermaxillary block, such as the possibility of an optimal dietary intake that leads to a rapid improvement in the general status of the traumatized patient, immediate restoration of mastication, speech and the possibility to maintain optimal oral hygiene. All these factors contribute to the rapid social reintegration of the patient (De Gabrielli et al 2003; Matos et al 2010; Mangone et al 2011; Brajdic et al 2011). However, in order for surgery alone to be successful, patient compliance with oral hygiene and a semi-liquid diet for 4 weeks are required (Mangone et al 2011; Brajdic et al 2011). Also, periodic follow-up visits are compulsory for monitoring the evolution of the case under these circumstances (Brown et al 1991). These objectives can be generally achieved in developed countries, where the presence of information programs and patients' educational level favor compliance with postoperative indications (Ellis et al 2012). Among the population of our country, where the main traumatic etiology is interpersonal violence, most of the affected patients having a low educational level, collaboration between the treating doctor and the patient is generally difficult, and there is a high risk of complications in the absence of mandibulomaxillary fixation for at least 2 weeks postoperatively (Paul Andrei Țeț et al 2016; Țeț PA et al 2016). These are the reasons why we preferred combined treatment over surgery alone.

Surgical treatment alone was applied to a small number of cases (5%). This was mainly used in the case of subcondylar fractures with the condylar head dislocated from the temporomandibular joint. The technique used in this case was an open extraoral transparotid approach. Considering the need for functional restoration of the temporomandibular joint after the trauma, in order to prevent ankylosis, intermaxillary block was avoided in these cases. Similar approaches are described by other authors (Schneider et al 2008; Andreas et al 2014). Currently, endoscopic treatment of condylar fractures is gaining ground in modern medicine. This therapeutic option has a strong impact on postoperative rehabilitation compared to open surgical treatment by transparotid approach, the technique being minimally invasive with a minimal scar, and the risk of injury to the facial nerve being exponentially reduced (Arcuri et al 2012; Filiaci et al 2013). Treatment by cerclage with circummandibular wires was rarely chosen in the present study. The fact that most of the patients included in this study were young, dentate patients without general chronic diseases explains the low rate of this type of treatment. Similar results are described in the literature (Ramli R et al 2011; Kummoona et al 2011; De Matos et al 2010). Overall, regardless of the therapeutic method used, the postoperative evolution of the cases was favorable, a result similar to those of other authors (Ramli R et al 2011; Kummoona et al 2011; De Matos et al 2010). Contrary to our results, Rana M. et al. (2011) indicate the highest rate of postoperative complications following orthopedic treatment.

In this study, the complications that occurred postoperatively were septic. This result is also found in the studies of other authors, who evidence the predominance of septic complications after mandibular fracture treatment (De Matos et al 2010; Van den Bergh et al 2012; Vajgel et al 2013). This is not surprising given the increased septicity of the oral cavity. Contrary to our results, other authors describe delayed union as the most frequent complication of mandibular fractures (Yamamoto et al 2013). All complications occurred in the case of lateral mandibular fractures, but this result had no statistical significance, probably due to the small number of cases that developed complications. This result is in contrast to those of the literature, which describe the highest incidence of complications in the mandibular gonion (Laverick et al 2012; Van den Bergh et al 2012).

It should be noted that all 3 patients with osteitis in the fracture focus had poorly controlled diabetes mellitus, and at the time of presentation they had the intermaxillary block self-removed. We found only one case of submandibular space infection with osteitis in the fracture focus as a starting point, in a patient with an intraorally open lateral fracture with mandibular displacement, treated exclusively by osteosynthesis because of total edentation. This can be due to the severity of the trauma (open displaced fracture) and to the secondary septic contamination from the oral environment on the one hand, but it can also be due to patient non-compliance with postoperative indications. We mention that at the 2-week postoperative visit, the patient's oral hygiene was precarious, and the patient admitted that he did not follow the indications regarding the semi-solid diet. Thus, overtension of the osteosynthesis focus combined with deficient oral hygiene can explain the development of the complication. These facts lead us to assert that the development of postoperative complications was due to patients' deficient terrain and

non-compliance with postoperative indications rather than to the topographic location of the fracture focus or the incorrect treatment method applied.

In the 3 cases of osteitis, removal of the osteosynthesis material, surgical debridement of the bone stumps and fixation of the fracture by bimaxillary block were performed. In the case of the submandibular abscess, incision and drainage of the suppuration were first carried out, and only after the improvement of the inflammatory signs, the osteosynthesis material was removed. Similar approaches are adopted by other authors (Rottgers et al 2011; Van den Bergh et al 2012).

As shown above, the opinions regarding the ideal treatment of mandibular fractures are divided. It is extremely difficult to develop a uniform treatment protocol considering the multitude of factors that influence its choice, such as patient's social status, hospital equipment, surgeon's experience or preferences. However, we believe along with other authors that primary stability in the fracture focus and early postoperative restoration of functionality are currently imperative for rapid and complete recovery (De Matos et al 2010; Schneidr et al 2008; Boffano et al 2015).

The limitation of this study consists of the relatively small number of patients who met all the inclusion criteria, statistical analysis and the correlation of some variables being irrelevant in this context. Studies in larger groups of patients are required in the future in order to identify these differences.

Conclusions

The degree of bone fragment displacement directly influence the choice of the treatment method. Perfect reduction of the fracture focus and impeccable fixation of the bone fragments, as well as patient compliance with postoperative indications ensure a favorable postoperative evolution of the cases regardless of the chosen treatment method or the characteristics of the mandibular fracture. The most frequent postoperative complications are septic. Surgical treatment with the removal of the initially applied osteosynthesis material, curettage of the granulation tissue in the fracture focus and open osteosynthesis fixation is the optimal therapeutic method for postoperative osteitis.

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