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MAJOR CLINICAL CONSIDERATIONS AND TREATMENT OF MANDIBLE FRACTURE: A CONCISE SYSTEMATIC REVIEW

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ABSTRACT

Introduction: In the scenario of mandible fractures, traumas are the main reasons for these events. In this context, the rates of mandible fracture complications vary from 7 to 29% and were correlated with the severity of the fracture. Motor vehicle assaults and collisions significantly outperformed all other causes of mandibular injury. Most consultations for mandible fractures begin with a diagnosis of computed tomography imaging (CT). CT scans were 100 percent sensitive for fractures of the mandiblecompared to 86 percent for panoramic radiographs. Despite this, radiographic images are not a substitute for a complete history and clinical examination. **Objective:** To carry outa narrative and systematic review of the literature, to explore the main literary findings and clinical results on fractures of the mandibles. **Methods:** It followed a systematic literature review model on the main clinical findings of mandible fractures, according to the rules of PRISMA. The research was carried out from January 2021 to May 2021 and developed based on Google Scholar,Scopus, PubMed, Scielo, and Cochrane Library. The quality of the studies was based onthe GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 170 studies were analyzed, with only 34 studies ofmedium and high quality being selected, according to GRADE standards, and with risks of bias that do not compromise scientific development. Most mandible fractures require stabilization for proper treatment and to restore pre-injury occlusion. Although mandiblefractures with good dentition on both sides of the fracture line can be treated in some cases by a period of intermaxillary fixation, most surgeons and patients prefer open reduction and internal fixation, as the process is faster. The use of two mini-plates results in better results with minimal complications. The treatment of mandibular fractures should aim to restore functional occlusion and mandibular continuity with the lowest possible risk. Open treatment of unilateral mandibular condyle fractures results in better functional results, especially in terms of mandible mobility. Finally, the application of low-intensity pulsed ultrasound can reduce postoperative pain and facilitated fracture healing in patients with impaired healing potential.

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INTRODUCTION

In the scenario of mandible fractures, traumas are the main reasons for these events (Agudelo-Suárez, 2015). Facial and head injuries account for half of the trauma deaths (Obimakinde, 2017). Such accidents affect people independent of socioeconomic status (Afrooz *et al*., 2015; Roccia, 2019). Thus, facial fractures are considered a public health problem in several countries such as the United States of America, which analyzed the occurrence of mandible fractures using the same parametersused in the present study, in Italy, Germany, India, and studies carried out in Brazil report various types of facial trauma and fractures (Sameer Kaura, 2018; Schneider, 2010; Brucoli *et al*., 2019), with different etiologies (Benjamin *et al*., 2018; Plawecki, 2017). In this sense, accidents are related to age and gender (Benjamin, 2018; Plawecki, 2017). The etiologies also depend on the regions and countries, and in some places, there is a higher incidence of traffic accidents, in others a higher incidence of aggression, and sports accidents such asfootball, combat sports, and cycling accidents

affecting adults and children (Plawecki, 2017). In this context, the complication rates of mandible fractures range from 7 to 29% and have been correlated with fracture severity (Recreational, 2017; Passeri, 1993). In one study, authors assessed the rate of complications in 363 patients with mandible fractures treated at a tertiary care university hospital (Teenier, 1997). They found that hardware failure was the most common complication (15.4%) followed closely by infection (15.1%). Higher complication rates were observed among smokers and patients with systemic diseases. The use of antibiotics does not seem to affect the incidence of these complications. In addition, it is increasingly common for patients to present isolated mandible fractures. In one study (Gutta, 2014), the authors reported a proportion of mandibular and zygomatic fractures of 3: 1. In this same study, they found that motor vehicle assaults and collisions significantly outperformed all other causes of mandibular injury by a factor of10 (Gutta, 2014). Most consultations for mandible fractures begin with a diagnosis of computed tomography imaging. In another study, a group of fractures with computed tomography and panoramic radiographic data were assessed (16). CT scans were found to be 100 percent sensitive for mandible fractures compared to 86 percent for panoramic radiographs. However, CT scans provide very little useful information about dental trauma. This is particularly important in the context of the third molar and its involvement in mandible angular fractures. In addition, if there is a doubt about the integrity or condition of the third molar or any other tooth, additional images such as a pantomography should be performed (Haug, 1990; Wilson, 2001). Despite this, radiographic images are not a substitute for a complete history and clinical examination. Interpersonal altercations tend to result in a higher incidence of fracture angles, while motor vehicle collisions are more commonly associated with parasymphysis fractures.

The patient should be asked about a history of orthodontic or dental treatment and any problems with the temporomandibular joint. Still, the most important component of the clinical examination is the evaluation of the occlusion. A subjective report of malocclusion by a patient must be taken seriously. The area of suspected fracture should also be palpated bimanually to check for mobility at the fracture site. The lack of mobility is an indicator of a stable fracture that can be amenable to conservative treatment, as long as the occlusion has not been altered (Ellis, 2007). Also, the state of the dentition must be evaluated. Severely decayed or damaged teeth, especially at the fracture site, should be considered for extraction to facilitate the healing fracture. Tooth extraction is recommended if a comminuted or displaced fracturecontains a tooth if the tooth root is fractured, if there is periodontal disease or an abscess near the fracture line, or if the tooth has no function due to the lack of opposing teeth. Lacerations or bruises at the fracture site are also important, as they can lead to an increased risk of infection, complicating treatment. Also, the sensitivity in the lower lip must be tested. Finally, the function of the marginal branch of the mandibular nerve in depressing the lower lip should be evaluated and documented. Although this is rarely a preoperative finding, weakness may occur after postoperative mandibular fracture reduction and stabilization procedures (Pickrell, 2017). Therefore, the present study aimed to conduct a narrative and systematic review of the literature, to explore the main literary findings and clinical results on fractures of the mandibles.

METHODS

Study Design: This was followed by a systematic literature review model on the main clinical findings of mandible fractures, according to the PRISMA rules.

Data sources and research strategy: The search strategies for this review were based on the descriptors: *"Fracture of the mandible. Traumas. Treatments. Complications. Stabilization. Fixation. Miniplates. Open reduction. Healing"*. The research was carried out from January 2021 to May 2021 and developed based on Google Scholar, Scopus, PubMed, Scielo, and Cochrane Library.In addition, a combination of the keywords with the Booleans "OR", "AND", and the operator "NOT" were used to target the scientific articles of interest.

Study quality and risk of bias: The quality of the studies was based on the GRADE instrument, with randomized controlled clinical studies, prospective controlled clinical studies, and studies of systematic review and meta-analysis listed as the studies with the greatest scientific evidence. The risk of bias was analyzed according to the Cochrane instrument.

RESULTS

Quantitative and Qualitative of the findings and General Results: After the selectivity of articles and literary findings through the following descriptors: mandible fracture, trauma, treatments, complications, stabilization, fixation, miniplates, open reduction, and healing, 170 studies were analyzed, with only 34 medium and high-quality studies selected, according to GRADE rules, and with risks of bias that do not compromise scientific development, based on the Cochrane instrument (Figure 1).

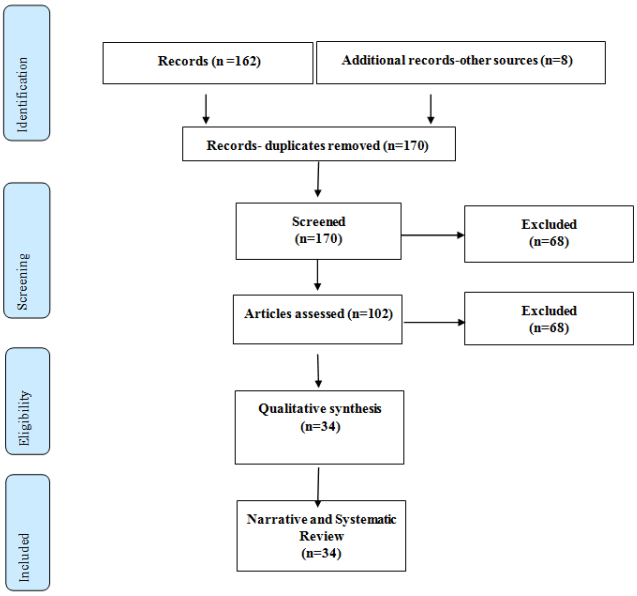

Figure 1. Selection of studies

As a corollary to the exploration of the 34 studies, most mandible fractures require stabilization for proper treatment and to restore pre-injury occlusion. In this scenario, the internal fixation for mandible fractures can be divided into load support and load sharing (Wilson, 2001; Chidyllo, 1992; Morrow, 2014; Ellis, 2002). The load support fixation denotes a constructionthat is capable of supporting all the loads generated by the mandibular function. This mayrequire the application of a large reconstructive plaque to the lower edge of the mandible, in cases of bone failure at the fracture site (Ellis, 2000). Load sharing, on the other hand, fixation characterizes a fixation scheme in which the functional load is shared between the fixation hardware and the bone along with the fracture site (Wilson, 2001). Non-rigid (stable) fixation allows some movement (micro-movement) at the fracture site but provides sufficient stability to allow bone healing with callus formation (Ellis, 2007; Morrow, 2004). By comparison, rigid fixation restricts micromotion and allows primary bone healing without callus formation. The indication of the load sharing fixation is only for simple and isolated fractures, with good bone-bone contact at the fracture line. On the other hand, multiple fractures, infected fractures, and fractures with poor bone-bone contact require rigid fixation (Ellis, 2007). In this sense, galvanizing systems have a variety of plate thicknesses that accommodate screws from 2 to 2.7 mm in diameter, that is, all screws are compatible with all plates in the set. Plate thicknesses vary in some sets from 1mm profile to 2.8mm profile. A 2.8 mm profile plate, the use of a 2.7 mm screw would achieve a rigid fixation.A 1 mm profile plate with a 2 mm screw, on

the other hand, would achieve non-rigid fixation. Larger and thicker plaques are much more difficult to adapt to irregularities in the external cortex of the mandible, increasing the possibility of malocclusion by poorly adapted plaque. This is less common with smaller plates or miniplates (Ellis, 2007). Still, in terms of complications of mandible fractures, it is important to understand the relationship between hardware failure and infection. Ongoing infection can lead to hardware failure and can result in hardware failure in the infection. Failure to correctly apply the hardware may lead to screws loosening or continuous mobility of fracture fragments. However, the most significant complication in the postoperative period is malocclusion, which is related to a technical error in the placement of the fixation (Ellis, 2007).

Major Clinical Studies: A randomized clinical trial compared the efficacy of single versus two uncompressed miniplates in treating unfavorable mandible angle fractures. A total of 28 patients who required open reduction of the mandibular angle fracture were included in the study. Group, I consisted of patients treated with two miniplates, and those in group II were treated with a single miniplate without compression. The evaluation parameters were malocclusion, infection of the surgical site, need to remove the implant, time of surgery, the opening of the interincisal mouth, and cost of the implants used, in both groups. Of the 14 patients in group II, the inadequate reduction was observed in three patients, while loosening of the screw occurred in two cases. Loosening of the screw hasalways been associated with chronic infection. In these cases, removal of the hardware was considered necessary. Bending of the plaque was observed in two cases, resulting in malocclusion and difficulty in eating. The non-union of the fracture occurred in a patient treated in group II. In group I, there was no flexion of the plate, loosening of the screw, infection of the surgical site, non-union, or malocclusion. No patient had to undergo implant removal in group I. Therefore, the use of two mini-plates results in better resultswith minimal complications (Ellis, 2014). Also, a clinical case report study showed a 33-year-old male patient with a history of aggression. After radiographs in posteroanterior view of the mandible, isolated horizontal fracture of the anterior mandible was suggested. Under general anesthesia, this unusual fracture was treated by open reduction and internal fixation with a three- dimensional plate and miniplates. The case was successfully conducted, without postoperative complications (Rai, 2018). Also, surgical removal of third molars is associated with complications. The fracture can occur when the resistance of the bone tissue is less than the forces applied by the surgeon during the procedure. Thus, a study presented a case of mandible fracture after extraction and subsequent surgical treatment of the fracture under general anesthesiawith the option of a submandibular approach.

A plate and screw system with a 2.4 mm profile was used for osteosynthesis after fracture reduction. The patient was followed up for 6 months after surgery and did not report any functional or aesthetic complaints. The treatment of mandibular fractures should aim to restore functional occlusion and mandibular continuity with the lowest possible risk (Jain, 2020). In addition, the resorption of the mandible is well documented in edentulous patients. In this context, the genial tubercles, originating from the genioglossus and geniohyoid muscles, become more prominent and prone to trauma, especially due to poorly adjusted lower total dentures and lead to fracture and separation of the genital tubers of the mandible. As an example, a study addressed a case report of spontaneous fracture of the genital tubercles of the mandible in an 85-year-old patient. Although rare, fractured genital tubercles should be considered in the differential diagnosis of painful swelling on the floor of the mouth in the edentulous patient (Silva, 2019). Besides, absorbable plates have been used for various types of facial fractures. However, in the case of mandibular fractures, a large amount of force is applied after fixation. Thus, a firm fixation is required. Thus, a study determined the clinical efficacy and usefulness of the system composed of non-sintered hydroxyapatite (u-HA) / poly (L-lactide) (PLLA) by clinical application and monitoring of fixation in patients with mandible fracture. A total of 13 patients with mandible fractures were assessed for compliance with the selection criteria. After reducing the fracture site through an oral orskin incision, the OSTEOTRANS plates were placed on the fracture line and we performed the rigid fixation with OSTEOTRANS-MX screws. Follow-up was performed at 1 week, 1, 3, and 6 months after surgery. All patients finished all follow-ups. They were satisfied with the results without complications, such as malocclusion, foreign bodysensation, or sensitivity (Wan, 2017). Still, mandibular fractures in the elderly range from 10.1% to 56%. Fragment reduction and fracture consolidation are difficult due to bone atrophy, decreased bone regeneration capacity, and lack of anatomical references to guide the fragment alignment. In this sense, a study reported 2 patients with different approaches regarding the treatment of bilateral fractures in the atrophic mandible. The first patient refers to the removal of plates from the 2.4 mm system with a low profile, which failed during the mandibular function, being replaced by the 2.4 mm system with a high profile. The 2nd clinician reports the use of the 2.0 mm system just to simplify the mandibular fracture, then reconstructing it with a 2.4 mm system with a high profile, using the loading principles. To mandibular fractures, an important objective is to neutralize muscle action aiming at bone stability. The incorrect choice of fixation in these patients can result in complications such as poor union, material failure, infection, and consequent treatment failure (Lee *et al*., 2018). Also, a study presented an innovative osteofixation system designed to stabilize bone fractures, making it possible to precisely adjust the implant to the shape of the bone. This precise adjustment is particularly important in the case of multiple fractures, where adequate stabilization is a condition for restoring bone geometry. The results indicate that the proposed system can be used to successfully stabilize fractured bone fragments, and the stabilization obtained would allow the unrestricted use of masticatory function duringbo

ne consolidation and remodeling (Florentino, 2020). In addition, a prospective study evaluated the effectiveness of using a single miniplate on the lower edge in treating a deviated angle fracture. 52 patients with angular fracture of the mandible were evaluated. All fractures were dislocated. The fracture displacement was assessed on panoramic radiographs by measuring the displacement of the lower alveolar canal. Fractures with a displacement greater than 2 mm were included in the study. Fixation was performed with a miniplate without compression of 4 holes along the bottom edge and 2 bicortical screws on each side of the fracture. Results: Among these 52 patients, 20 sustained angle fractures alone, 2 sustained bilateral ankle fractures, and 30 sustained angle fractures associated with contralateral paraphysis or body fracture. Five patients (9.5%) had complications. All were considered minors and did not require hospitalization. Two had a slight occlusal discrepancy requiring selectiveocclusal rectification, and 2 minor infections were treated by incision and drainage. One patient suffered from facial nerve paresis that resolved after 3 months (Pałka, 2020). Coupled with this, a randomized clinical study evaluated the effect of the pulsed electromagnetic field (PEMF) on the healing process in mandibular bone fractures. Participants were divided into two groups of 16 each (controls = 16, cases = 16). Control group patients received conventional therapy without any extra treatment, while patientsin the case group received PEMF therapy in addition to conventional therapy. For PEMFtherapy, patients in the case group received PEMF therapy after immediate surgery for 6h.

Then, they received 3 h of exposure for the next 6 days and, finally, the same process was repeated for 1.5 h for the postoperative days 8-13. The maxillomandibular fixation device (MMF) was removed at week 4 of the postoperative period. There was no significant difference in the mean bone density values between the two groups ($p > 0.05$). However, the percentage of changes in bone density of the two groups revealed that the case group had insignificant decreases on the 14th postoperative day and a significant increase on the 28th postoperative day compared to the control group ($p<0.05$). After releasing the MMF, a bimanual mobility test of the fractured segments showed the stability of the segments in all patients. In the case group, the mouth opening was significantly more stable than in the control group ($p <0.05$) (Singh, 2011). Another randomized clinical study compared the functional results of open vs. closed

treatment of unilateral mandibular condylar fractures. Patients were evaluated for maximum mouth opening, deviation of the mandible at the opening, and occlusal status six months after surgery. As a result, open treatment of unilateral mandibular condyle fractures results in better functional results, especially in terms of mandible mobility (mouth opening) (Mohajerani, 2019). Another randomized clinical study compared open reduction with internal fixation of mandibular subcondylar fracture with a closed reduction in terms of adequate mouth opening. Of the 70 patients, 35 (50%) were in each of the two groups. The mean age in Group-A was 28.88 ± 11.86 years compared to 28.22 ± 10.80 years in Group-B ($p > 0.05$). The average mouth opening in both groups was consistently positive and significant in the last two follow-ups ($p < 0.001$). Thus, the difference in the results of both treatment modalities was significant, indicating that open reduction and internal fixation should be the treatment of choice (Asim, 2019). In addition, another randomized clinical trial with 40 mandibular fractures evaluated the effect of low-intensity pulsed ultrasound (LIPUS) on improving fracture healing in patients with mandibular fractures. After fixation, the study group received LIPUS stimulation (1.5 MHz, 30 mW / cm^2) on postoperative days 4, 8, 14, and 20 for 20 minutes daily; the control group did not receive LIPUS stimulation. The pain score was reduced in the study group on all postoperative days ($p < 0.001$). The average amount of wound healing was better in the study group than in the control group on days 5 and 9 ($p < 0.004$ and $p < 0.019$, respectively). The mean score for the ultrasound assessment of fracture healing was higher in the study group, with a statistically significant difference. Therefore, the application of LIPUS reduced postoperative pain and facilitated fracture healing in patients with impaired healing potential (Balouch, 2020).

CONCLUSION

Most mandible fractures require stabilization for proper treatment and to restore pre-injury occlusion. Although mandible fractures with good dentition on both sides of the fracture line can be treated in some cases by a period of intermaxillary fixation, most surgeons and patients prefer open reduction and internal fixation, as the process is faster. The use of two miniplates results in better results with minimal complications. The treatment of mandibular fractures should aim to restore functional occlusion and mandibular continuity with the lowest possible risk. Open treatment of unilateral mandibular condyle fractures results in better functional results, especially in terms of mandible mobility. Finally, the application of low-intensity pulsed ultrasound can reduce postoperative pain and facilitated fracture healing in patients with impaired healing potential.

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