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Treatment of comminuted mandibular fractures: A critical review

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Abstract

The treatment of comminuted fractures of the mandible is challenging due both to the severity of the injuries generally associated with this type of fracture, and the lack of consensus as to the most appropriate treatment method. There are two distinct approaches for treating comminuted fractures of the mandible: closed reduction with maxillomandibular fixation (MMF) - the oldest and classical treatment - and open operation and internal fixation. The morbidity rate of closed reduction is lower but, with the advent of modern anaesthesia and antibiotics, open surgery has become more frequent. Stable internal fixation (SIF) is achieved using plates, miniplates and/or screws. The advantage of this approach is that there is a more precise reduction of the fragments, with the possibility of early function by eliminating or reducing the time of MMF. This paper reviews the main advantages, disadvantages and differences between the two techniques.

Key words: Mandibular fracture, mandibular fracture treatment modality, fracture fixation.

Introduction

Comminuted fractures of the mandible are an important traumatism, as a result of the extensive degree of violence associated with this injury, in which the mandible bone is splintered or crushed, pulverized or broken into several pieces, giving rise to many small fragments (1-5).

Treatment of this type of fracture has always been a challenge to surgeons, considering both the severity of this trauma, in which, particularly as a result of gunshot wounds, there are frequently other serious fractures and associated situations, such as fractures at the base of the

cranium and infections; and also considering the lack of consensus as regards the ideal type of treatment for this type of injury (1-5).

The aim of treatment of fractures of the mandible is to restore the anatomy and function of the mandible and the patient's esthetic appearance. These fractures have been treated by a series of methods, including closed reduction, external pin fixation, internal fixation with Kirschner wires, and, more recently, open reduction with stable internal fixation (SIF), using miniplates, plates and/or screws (3). There are few topics with respect to the treatment of maxillofacial complex frac-

tures that are as controversial as the ideal treatment of comminuted fractures of the mandible. Historically this condition has been treated conservatively, by proceeding with its closed reduction and stabilization by maxillomandibular fixation (MMF); the suggestion being that the main blood supply for repairing the mandible comes from the periosteum, and that manipulation of the tissues and stripping of the periosteum, as a result of open reduction, would devitalize the tissues, thus harming its nutrition and defense, which would consequently increase the chances of this tissue developing infections and necrosis (1,5-7).

In conservative treatments of comminuted fractures of the mandible, the undisturbed biological environment required for the cure must be attained through MMF, which can be obtained in patients who have teeth, with the use of intermaxillary bars and elastics, and in edentulous patients, by means of splints and dentures or external fixators. With this therapy, one endeavors to obtain the formation of a bone callus, without the need for accessing the tissues, which could compromise the blood supply to the comminuted bone tissue (1-5,7,8).

For years, closed reduction and MMF was the only method for treatment fractures of the mandible. However, with the introduction of modern anesthesia, antibiotics and blood transfusions, open reduction with fixation of the fragments became routine in the treatment of fractures with gross displacement, comminution and in edentulous mandible. There are authors (2-4,9-11) who recommend open reduction and the use of internal fixation devices, such as plates and screws, as being the best way of treating these traumatisms. They defend the theory that the causative agent of infections and necroses in this situation does not result from the surgical manipulation of the tissues and stripping of the periosteum, but from the lack of stabilization among the bone fragments. Therefore, closed reductions would result in interfragmentary movement, providing an inadequate environment for cure, and SIF, is an absolute indication for the treatment of comminuted fractures.

In the literature there is no consensus as regards the best approach to treatment of comminuted fractures of the mandible. Therefore, the aim of this article is to conduct a critical review of reports in the literature about the ways of treating it, in an endeavor to provide the reader with support, when faced with this clinical condition, to decide on the most adequate treatment.

Review of the literature and Discussion

Comminuted fractures of the mandible generally affect young, adult men, and have a widely varying incidence and etiology, according to the socio-economic conditions of the location in which this epidemiological study is conducted. In countries where there is armed conflict, the incidence of this type of fracture is high, and its

main etiologic agent is injuries due to low-velocity gunshot injury. Among the fractures of the face, the mean incidence of this type of situation is low, around 2 to 6 %, and their main etiologic agent is automobile accidents. They are also caused by falls, interpersonal aggressions and sports. The region of the mandibular body is generally the most affected, followed by the symphysis and angle. Usually, there is only one area of comminution, but there may be other associated fractures in the mandible (1-5,8,10,11).

In the XIXth century, during social conflict in the USA, McLeod noted that firearm injuries to the face, due to its excellent vascularization, could be managed without removing the fragments, a procedure which, if adopted in another region of the body, could be fatal. According to Ivy's experience with comminuted fractures of the mandible, during the First World War, this condition should be treated with a minimum of manipulation, and by fixation and stabilization as early as possible, to avoid delay in repair and deformities; he also observed the open reduction resulted in infection and necrosis. Whereas Kazanjian, during the Second World War, stated that the majority of comminuted fractures of the mandible that did not repair, were due to inadequate immobilization of the fragments, which resulted in generating infection and bone sequestration. Therefore, stabilization of the fragments would be essential for successful treatment (2-4).

The classical paradigm of closed treatment for comminuted fractures of the mandible began to be questioned as from 1958, when around 50 surgeons formed the AO (Arbeitsgemeinschaft für Osteosynthesefragen) in Switzerland, which was later known in the United States as ASIF (Association for Study of Internal Fixation), and developed the technical and instrumentation principles for open reduction and rigid internal fixation (ORIF). In accordance with the principles of the AO/ASIF, the goal of ORIF in the treatment of comminuted fractures of the mandible is to achieve undisturbed biological environment, restore the shape and early return to function without the adjunct use of MMF, by means of absolute immobilization of the bone fragments and primary bone repair, obtained with plates and bicortical screws. However, Champy, in 1973, reported that the use of miniplates and monocortical screws placed in strategic regions of the mandible would be sufficient for stabilizing fractures and promoting their cure. Thus, at present, there is discussion about SIF of mandible fractures, which can be attained by rigid compression (AO/ASIF) or stabilization (Semi-rigid - Champy). In these techniques the main advantages being the elimination of or reduction in MMF time (3,4,7,9-11).

Those who defend open reduction with SIF of comminuted fractures of the mandible assert that in fractures with extensive displacements, by exposing the fracture,

one is able to reduce all these comminuted fragments to a pretraumatic anatomic position. They also state that by closed reduction one is able to re-establish occlusion, but the bone fragments that have been significantly displaced will seldom return into position and remain there, thus making it impossible to adequately restore the bone contour, which could cause collapse in the anteroposterior dimension as well as widening of mediolateral dimension of the face. Thus adequate occlusion does not always mean anatomic bone reduction, but open reduction will enable occlusion as well as the proportions and symmetry of the face to be restored (2-4,7,9).

But, there are authors who see disadvantages to SIF, among these, performing a surgical procedure, frequently under general anesthesia, which could be a risk factor in patients who are elderly, have cardiopathies or ventilatory diseases. Furthermore, the disadvantages are the need for extraoral approach, mainly when using the AO/ASIF system, which could result in scars, as well as the risk of injuries to nerves, particularly to the cervical ramus of facial nerves, the placement of SIF devices may cause lesions to the roots of teeth, and stripping of the periosteum could result in infections and nonunion of the bone fragments. Moreover, it is a sensitive technique that requires a longer operative and operator training time and has higher costs than closed reduction (2-4,7,9,10).

In this context, against the ORFI, could be related an unusual case of a drill breakage during ORFI of a comminuted mandibular fracture and the complication of this, like another surgery to remove it (12).

The closed reduction of comminuted fractures of the mandible would be indicated in cases of fractures with minimal displacement, in which anatomic repositioning of the fractured fragments is not necessary; and in grossly comminuted fractures, with loss of substance, in which access to these numerous small fragments could generate their devitalization and necrosis. It would also be indicated for patients in the mixed dentition stage, due to the risk of screws causing lesions to tooth germs, in edentulous mandibles, for uncooperative patients, and in hospitals with high demand and limited facilities (1,5-7).

Ghazal, Jaquiéry and Hammer (6) (2004), treated 28 patients with mandible fractures only with soft diet and observation, without the use of MMF, and observed that all had adequate bone repair. They observed that the intact periosteum maintains adequate stability so that the movement of the fractured bone fragments does not exceed the tolerable limit for repair, and that a certain amount of movement improve repair, particularly in the elderly. Thus, they affirmed that repair does not depend on mechanical factors only, but also on the osteogenic cells generated from the bone marrow and periosteum, their preservation being fundamental.

Finn (1) (1996) reported that the complication rates of comminuted fractures of the mandible treated with SIF are high, particularly infections and poor union. The author treated 22 patients with this condition by closed reduction, external pin fixation, lingual splits and circumferential skeletal fixation, with MMF being maintained, and had 4 cases of infection (18%), 3 malocclusion (13.6%) and 2 facial asymmetry (9%).

Al-Assaf and Maki (5) (2007) reported their experience with the treatment of comminuted and multiple fractures of the mandible in Iraq. For the authors, such fractures should be managed as "a bag of bone", with the use of closed techniques without violating the integrity of the vascular supply of bone fragments. And in spite of the technical advances, the complication rates of this type of injury remain unaltered, thus the new technologies, such as open reductions and SIF do not automatically ensure improved results. In 1 year, 100 comminuted fractures of the mandible were treated, the majority caused by missile injuries, 74% being managed in the closed field, and 26% submitted to open surgical intervention. Open reduction and SIF with miniplates was used when they were unable to obtain an adequate bone contour; in these cases the patients were not submitted to MMF. This study demonstrated that there was a strong relationship between the severity of the fracture or its etiology and the complication rate; such a relationship is unclear as regarding the treatment modality. Of the total number of fractures treated, 84 had adequate repair, 14 presented poor bone union or dental malocclusion, 4 had infections and 17 patients later required reconstructive surgeries. The authors reported that most of the complications in this series were associated with missile injuries, reflecting the severity of this injury, which affects both soft and hard tissues. They were directly related to the severity of injury and independent of treatment modality.

On the other hand, there are authors (2,8,11) that mention that the ideal treatment for comminuted fractures of the mandible must be performed by means of ORIF with large reconstruction plates. They suggest that a small number of complications would occur if the absolute stability of this fracture were achieved. They point out the advantages of ORIF as being the anatomic reduction of the fractured fragments, early return of function and the possibility of absence or shorter time of MMF. Internal stable fixation would therefore, be indicated for patients, in whom there are contra-indications for the use of MMF, such as epileptics, alcoholics, drug users, patients with chronic respiratory obstruction or any other ventilatory obstruction. Some aspects must be observed as regards the use of ORIF in the face (2-4,7,11), such as the contra-indication of the use of compression plates in comminuted fractures, in these situations compression of the comminuted fragments could generate

distortions in the bone contour and infections. In this situation, plates with passive perforations must be used, the fragments must be reduced by MMF or splints before being fixed, and the smaller sized bone fragments must be treated as though they were free grafts and be approximated by miniplates (1.5 – 2.0) or lag screws. The body of the fracture must be stabilized with a simple reconstruction plate or locking (2.4 – 2.7). Recent studies have reported preference for reconstruction plates of the locking type, in which fixation is achieved by locking the screw to the plate, rather than compressing each fragment of bone to the plate, thus reducing the superficial necrosis of the bone tissue resulting from compression of the plate and alterations in the reduction of the fracture by placement of the screws (3,7). However, when there is loss of substance, it is not possible to use miniplates (2.0), and thus, in patients with teeth, MMF with a guide for orienting the position of the bone fragments must be used, in which the largest fragments must be stabilized by a reconstruction plate. In these cases the use of grafts is only possible in cases in which it will be possible to cover them adequately with soft tissues (11).

For Smith and Teenier (2) (1996) the failures of open reductions of comminuted fractures of the mandible occur as a result of their non-rigid immobilization and with the advent of SIF, it was demonstrated that devascularized segments of bone may survive when sufficiently immobilized. This generally involves spanning the comminuted area with a large reconstruction plate. For the authors, due to the absence of a stable occlusal relationship required for MMF, edentulous patients are benefited by SIF. Although splints and dentures are useful in these cases and frequently used together with SIF, splints and MMF in isolation did not produce adequate reduction. Patients with atrophic mandibles are also benefited by the extra-buccal approach and SIF, in which, in spite of the disadvantage of detachment of the periosteum, the approach allows a graft to be placed simultaneously with the anatomic reduction.

For Scolozzi and Richter (4) (2003) the success of ORIF in comminuted fractures of the mandible is directly related to two fundamental principles: fixation needs to support the full functional loads and absolute stability of the fracture. This is the pre-requisite for sound bone healing and a low rate of infection. The authors treated 53 patients with comminuted fractures of the mandible with reconstruction plates. All the patients were submitted to MMF in the pre and trans-operative periods, and it was removed at the end of the surgery. The reconstruction plates were fixed with at least 3 bicortical screws, and miniplates were used to stabilize the smaller fragments. In the postoperative period, 10 patients with an associated subcondylar fracture required post-operative MMF for 2-3 weeks, 13 patients had minor

complications, such as hypoesthesia and malocclusion and 2 sustained a nonunion requiring plate removal and reosteosynthesis with autologous bone graft. For the authors, the surgeon must perform osteosynthesis capable of supporting the entire functional load and neutralizing the forces of stress, while maintaining the fragments in an anatomical position. This would be impossible to obtain by closed reduction or with the use of semi-rigid fixation with miniplates using Champy's protocol.

In this context, Kuriakose et al. (1996) (10) compared SIF of the mandible by means of two techniques: with the use of ORIF (AO/ASIF) and with semi-rigid internal fixation (Champy). They observed that in comminuted fractures of the mandible, the miniplates are more subject to infection, due to being less stable in comparison with the reconstruction plates of the rigid system (AO/ASIF).

Ellis et al. (3) (2003) treated 198 patients with comminuted fracture of the mandible, and, whenever possible, SIF was the first treatment option. The comminuted regions were treated by closed reduction and MMF in 35 fractures; open reduction with SIF in 146 fractures, and 17 were treated with external pin fixation. For those patients treated with open reduction, a single reconstruction plate was used in 114 fractures, 54 patients were treated with a locking reconstruction plate, 11 had a single mandible plate (positional), 11 had a single 2.0 miniplate, 6 had double 2.0 miniplates, and 4 used multiple lag screws with or without small bone plates. An extraoral approach was used in 52 patients and intraoral in 98 patients. Closed reduction was used for fractures that had multiple lines of fracture but without displacement, or with very little displacement. In others, mostly gunshot wounds, these patients had so much comminution and soft tissue disruption that the goal was to maintain the spatial relationship of the fractured fragments until healing occurred. In these cases, if there were sufficient teeth on each side of the comminuted fragment, MMF was used, and if not, external pin fixation was selected. During follow-up, the authors reported complications in 26 fractures (13%), 8 being malocclusions and 18 infections or nonunion of the bone fragments. They observed a relationship between development of complications and the degree of fragmentation and incidence of complications. They reported that gunshot wounds generated a greater degree of fragmentation among the etiologic agents, and consequently the worst prognosis. They also observed a relationship between the type of treatment and complications, being 32.5% for external fixation, 17.1% for closed reduction and 10.3% for SIF. Malocclusion occurred in 23% of the patients submitted to external fixation; in 17.1% with closed reduction and 5.5 % with internal fixation.

In another study (10) the treatment of 266 consecutive fractures of the mandible were evaluated, being 62 frac-

tures treated in the closed manner by MMF and 204 by SIF, in which 88 were fixed with ORIF (AO/ASIF) and 116 with miniplates (Champy). Intraoral approach was used in 12% of the fractures in the ORIF group and in 93% of the Champy group, this access being more conservative and therefore, pointed out as an advantage when miniplates are used. MMF was not performed in any patient treated with ORIF; in the group with miniplates, 25% of the patients were treated with MMF for 10 days. The authors observed the incidence of infection and malocclusion in 12.9% and 4.7% respectively, of the patients treated with miniplates, against 2.3% and 9.6% of those treated with ORIF. Miniplates were used in the treatment of 12 patients with comminuted fractures, and 4 (33%) of these patients developed malocclusion. In contrast, none of the 7 patients with comminuted fractures treated with ORIF developed malocclusion. The authors stated that miniplates must be regarded as a semi-rigid fixation and therefore, frequently required the use of elastics and MMF of short duration, in order to obtain satisfactory results and that in comminuted fractures of the mandible, preference must be given to treatment with ORIF. Nevertheless, in many cases of fractures of the mandible treated with miniplates, elastic fixation for 2 to 6 weeks is necessary to avoid complications such as pseudoarthrosis or malocclusion (9).

Final considerations

There is no literature that is broad in scope with regard to treatment of comminuted fractures of the mandible, and in the existent reports, one observes that there is no consensus concerning the manner of treating these injuries, nevertheless, some observations may be considered:

- 1– In fractures with little displacement there is a tendency to treat them with closed reduction;
- 2 – In fractures with extensive displacement and other associated fracture of the middle third of the face, open reduction and stable internal fixation with reconstruction plates would be indicated;
- 3 – In fractures with loss of substance, closed reduction with extraoral pin fixation would be indicated;
- 4 – Irrespective of the type of treatment adopted, there is a greater prevalence of complications in fractures with extensive comminution and exposure of soft tissues, mainly as a result of gunshot wound.

References

1. Finn RA. Treatment of comminuted mandibular fractures by closed reduction. *J Oral Maxillofac Surg.* 1996;54:320-7.
2. Smith BR, Teenier TJ. Treatment of comminuted mandibular fractures by open reduction and rigid internal fixation. *J Oral Maxillofac Surg.* 1996;54:328-31.
3. Ellis E 3rd, Muniz O, Anand K. Treatment considerations for comminuted mandibular fractures. *J Oral Maxillofac Surg.* 2003;61:861-70.
4. Scolozzi P, Richter M. Treatment of severe mandibular fractures

- using AO reconstruction plates. *J Oral Maxillofac Surg.* 2003;61:458-61.
5. Al-Assaf DA, Maki MH. Multiple and comminuted mandibular fractures: treatment outlines in adverse medical conditions in Iraq. *J Craniofac Surg.* 2007;18:606-12.
6. Ghazal G, Jaquiéry C, Hammer B. Non-surgical treatment of mandibular fractures--survey of 28 patients. *Int J Oral Maxillofac Surg.* 2004;33:141-5.
7. Stacey DH, Doyle JF, Mount DL, Snyder MC, Gutowski KA. Management of mandible fractures. *Plast Reconstr Surg.* 2006;117:48e-60e.
8. Fonseca JR, Walker RV, Bettis JN, Dexter BH. Oral and maxillofacial trauma, vol 1. 2nd ed. Philadelphia: W.B. Saunders Company; 1997.
9. Uglesić V, Virag M, Aljinović N, Macan D. Evaluation of mandibular fracture treatment. *J Craniomaxillofac Surg.* 1993;21:251-7.
10. Kuriakose MA, Fardy M, Sirikumara M, Patton DW, Sugar AW. A comparative review of 266 mandibular fractures with internal fixation using rigid (AO/ASIF) plates or mini-plates. *Br J Oral Maxillofac Surg.* 1996;34:315-21.
11. Prein J. Bone as material. Manual of internal fixation in the cranio-facial skeleton. Berlin: Springer-Verlag; 1998.
12. Bodner L, Woldenberg Y, Puterman M. Drill failure during ORIF of the mandible. Complication management. *Med Oral Patol Oral Cir Bucal.* 2007;12:E591-3.