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Original Research Article

Use of three-dimensional versus mini fixation plates in open reduction of mandible fractures in patients of a Mexican hospital between 2017-2023

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ABSTRACT

Background: Mandibular fractures are the second most frequent facial fracture, after nose fractures. There are multiple treatments, with reduction and fixation with osteosynthesis plates being the gold standard. Our surgical center uses two types of osteosynthesis plates, 3D, and linear plates. We designed a study to assess whether the use of a 3D plate results in an improvement in terms of surgical time, bleeding volume and post-surgical complications.
Methods: We measured bleeding and surgical time from the incision to its closure. Evaluation of the results by computerized axial tomography was obtained at 3 months post-surgery, as well as clinical evaluation of occlusion and other complications.
Results: Sixty-three patients met the inclusion criteria. Overall, a 7.9% rate of complications was observed; 5.7% for patients treated with 3D osteosynthesis plates and 10.7% for those treated with linear plates. Surgical time in single fractures between Linear System versus 3D System was similar (p=0.7322) as was surgical time (p=0.4574). The amount of bleeding in single fractures between Linear vs. 3D System was also similar (p=0.285), as was that of double fractures (p=0.6642).
Conclusions: These data suggest that the procedure employed, and the material used is at the discretion of the surgeon.

Keywords: Mandible fractures, 3D mini plate, 2-mm locking plates

INTRODUCTION

The anatomical configuration, prominence and position of the mandible are factors that underlie its high rate of fractures. In developed countries, car accidents represent the main cause of mandible fracture; in our center, however, as is the case in many developing countries facilities, they are in their majority the result of physical aggression. The mandible is a mobile bone, predominantly U-shaped, which can be divided into horizontal segments are in the body, parasymphysis and the symphysis. The vertical segments consist of the angles and ramus, which articulate with the skull through the condyles and the temporomandibular joints. The mandible is attached to other facial bones by muscles and ligaments and articulates with the maxilla through occlusion of the teeth.

The jaw is a strong bone, but it contains several weak spots that are prone to fracture. The body of the mandible is composed mainly of dense cortical bone with a small spongy substance through which blood vessels, lymphatic

vessels, and nerves pass. The mandible is thin at the angles where the body meets the ramus and may be further weakened by the presence of an unerupted third molar or previous tooth extraction.[1,2] The mandible is also weak at the condylar neck, the canine root (the longest root), and the mental foramen through which the mental nerve and vessels extend to the soft tissues of the lower lip. Weak areas most prone to fractures are the subcondylar area, the angle, the distal body, and the mental foramen.[3]

Jaw fractures are the second most frequent facial fracture after nasal fracture, so plastic surgeons are very commonly faced with the treatment of these injuries, having a wide range of classifications and treatments. However due to the great diversity of injury mechanisms, fracture lines and material availability, different types of osteosynthesis material are used in the treatment.[4] The gold standard to corroborate the clinical diagnosis of jaw fracture is computerized axial tomography, with which we can classify the fracture according to its fracture line, location, and extension.[5] The fracture is then classified according to, among other factors, its extension, being either a simple, that is, located in a single place in the mandible, without significantly displaced bone fragments or a double or multiple, in which cases fractures are observed in two or more parts of de mandible, for example body and angle or condyle and parasymphysis.

The classification of jaw fractures is important because it helps determine the best course of treatment.[6] Osteosynthesis is a surgical technique that involves the use of metal plates, screws, or wires to align pieces of bone so they can heal properly. In the case of a mandibular fracture, the osteosynthesis procedure consists of making an incision in the skin and exposing the fractured bone. The surgeon then uses specialized tools to carefully realign the broken pieces of bone and hold them in place with metal plates, screws, or wires.[6–8] The goal of the procedure is to restore normal jaw occlusion, including the ability to speak, eat, and breathe properly. Internal fixation generally results in a faster and more complete recovery compared to non-surgical treatments, such as immobilization with a wire jaw.

After the procedure, patients are generally advised to follow a specific diet and take pain relievers as prescribed by their physician. They may also need to avoid certain activities, such as chewing hard or sticky food, for several weeks while the bone heals. In some cases, patients may need to undergo additional treatments, such as physical therapy or orthodontic treatment, to fully restore the function and appearance of the jaw.

The AO Foundation/ Orthopaedic Trauma Association (AO/OTA) recommends the use of a lag screw, Maxillomandibular Fixation (FMM) + 1 linear plate in tension or compression line or 2 linear plates to manage forces. However, in 1991 the Leibinger-Würzburg® house, by Mostafa Farmand, described the concept of three-dimensional plates (3-D) for maxillofacial trauma management, proposing a geometrically closed plate, with monocortical fixation and self-tapping screws, controlling flexion, compression, and torsion forces, with less periosteal dissection, which provides excellent functional results.[9] 3D miniplate systems are used in the treatment of jaw fractures in our facilities. The system is advantageous compared to conventional plates due to stabilization of the areas of tension and compression, improved initial stability, and biomechanical behavior.[10] As our unit is a reference center for facial trauma, we attend patients in whom we use both fixation systems. We hypothesized that the use of 3D plates, being smaller, requires a smaller incision size, decreases the area of periostization, uses less osteosynthesis material, less time in reduction and placement of plates, less surgical time, and less bleeding. In addition to the ability of 3-dimensional stabilization, would lead to fewer complications.

METHODS

We performed a retrospective cohort study in which data from patients treated at the Department of Aesthetic and Reconstructive Plastic Surgery of the Ruben Leñero General Hospital from March 2017 to March 2023, with a single or double fracture of the mandible that was not accompanied by another fracture in a different bone, were evaluated. All patients included in the study underwent a computerized axial tomography with 3D reconstruction, surgically treated with linear osteosynthesis plates or with 3D osteosynthesis plates,

A sample of 364 patients was originally obtained, of which 63 met the inclusion criteria, which were: complete clinical record, record of surgical time, record of the amount of bleeding and pre- and post-surgical computed tomography with 3D reconstruction. Patients who did not continue with their outpatient follow-up or who did not have a complete electronic file were also excluded. Physical and electronic clinical records were evaluated from 2017 to 2023, reviewing anesthesiology, nursing, and post-surgical notes from our service.

All data were analyzed using GraphPad Prism 9 software. A Shapiro-Wilk test was first performed on each group to establish whether the distribution was normal. Student *t* tests were performed when both groups had normal distribution. Otherwise, a Mann-Whitney test was performed. In all cases, significance was set at $p<0.05$.

The study was approved by the Teaching, Research, Training and Ethics Committee of the Rubén Leñero General Hospital of Mexico City.

RESULTS

We obtained a sample of 63 (61M and 2F) patients with fractures of the symphysis, parasymphysis, body and/or angle of the mandible. They were divided into 4 groups:

Groups 1 and 2 included patients with a single fracture or double fracture, respectively and these groups were further subdivided in A or B according to whether they were treated with linear plate or with 3D plate, respectively (Table 1). The main objective of the study was to assess whether using 3D osteosynthesis plates lead to fewer complications, less surgical time, and/or less bleeding, given that the periosteal dissection area as well as the osteosynthesis material used are smaller.

Table 1: Treatment on single fracture or double fracture.

Treatment	Single	Double
3d	20	15
Linear plates	5	23
Total	25	38

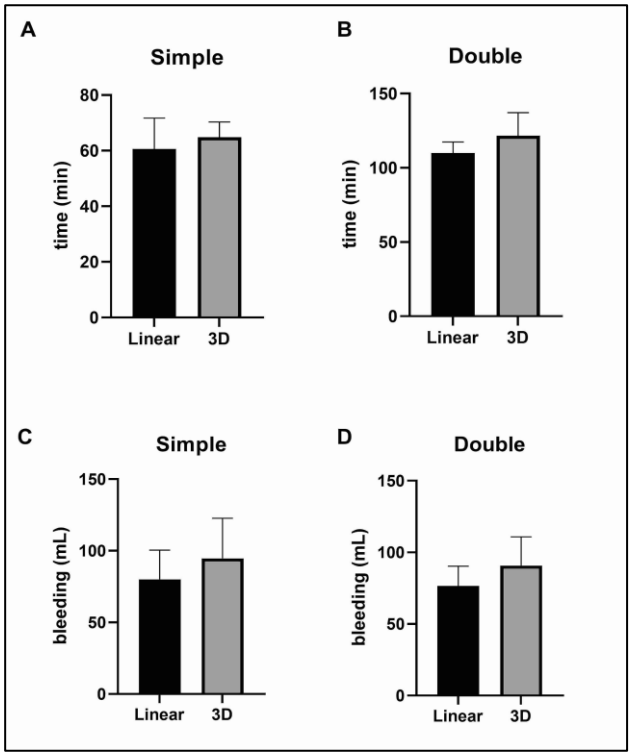

Figure 1: (A) Average surgical time in min ±SE for single fractures was similar between the linear system and the 3D System (60.60±11.1 min versus 64.85±5.5 min, respectively; t(23)=0.35, p=0.732; (B) surgical time in min ±SE in double fractures was also similar between the Linear System and the 3D System (109.9±7.6 min versus 121.7±15.4, respectively; U=116,5, p=0.798; (C) as for bleeding, no difference was observed between the linear and the 3D systems in single fractures, the average amount for the former being 80±20.4 ml and 94.63±28.1 ml for the former (U=24.5, p=0.285; (D) bleeding in double fractures was also similar between the two procedures (76.67±13.7 ml for Linear and 90.77±20.1 ml for 3D; U=106, p=0.664.

Overall, a 7.9% rate of complications occurred, including 5.7% for patients treated with 3D osteosynthesis plates (1 patient with hematoma that required surgical drainage and 1 patient with bite lateralization) and 10.7% for those treated with linear plates (1 patient with surgical wound infection, 1 patient with wound dehiscence and 1 patient with open bite).

Average surgical time in min ±SE for single fractures was similar between the linear system and the 3D system (60.60±11.1 min versus 64.85±5.5 min, respectively; t(23)=0.35, p=0.732; Figure 1A). Surgical time in min ±SE in double fractures was also similar between the linear system and the 3D system (109.9±7.6 min versus 121.7±15.4, respectively; U=116,5, p=0.798; Figure 1B).

As for bleeding, no difference was observed between the linear and the 3D systems in single fractures, the average amount for the former being 80±20.4 ml and 94.63±28.1 ml for the former (U=24.5, p=0.285; Figure 1C). Bleeding in double fractures was also similar between the two procedures (76.67±13.7 ml for linear and 90.77±20.1 ml for 3D; U=106, p=0.664; Figure 1D).

DISCUSSION

In our sample of patients, no benefit was observed between the use of 3D or linear plates in the treatment of mandible fractures. There was no significant difference in surgery time or bleeding between using a 3D plate vs a linear one for the management of simple or combined mandible fractures. The occurrence of complications was also similar between both procedures. Therefore, even though we consider that by only observing that the size of the periosteal dissection area is smaller and that the 3D plates are smaller and have less amount of osteosynthesis material, we did not obtain any statistical significance in superiority to linear plates. Our results of a lack of difference between 3D and linear plates are similar to those obtained at an oral and maxillofacial surgery facility in India, where, interestingly over 85% of patients included in the study suffered the fracture as a result of a car accident, contrasting with our group of patients which, in most cases, suffered the fracture as a result of a violent encounter.[11] A more recent randomized clinical trial, however, found that the use of 3D Delta plates significantly improved post-operative stability, resulted in faster healing, and reduced complications.[12]

An important limitation of our study is that given that it consists of a retrospective comparison or two surgical procedures on the cohort of patients that were treated at our center for a mandibular fracture, it does not match the quality of evidence that could have been obtained by a randomized controlled trial. Moreover, the fact that the data was collected from a cohort of patients treated by five different surgeons at our center could have introduce variability that may have increased the possibility of a type-2 error.

CONCLUSION

Overall, our data suggest that, as has been done up to now, the choice of material required for the treatment of mandibular fractures should remain at the discretion of the surgeon, at least when said fracture result because of violent encounters. However, a randomized clinical trial comparing the efficacy of linear versus 3D plates in mandibular fractures would be required to confirm our findings.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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