

Fracture treatment in atrophic mandible

Tratamiento de fracturas en mandíbula atrófica

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Abstract

Background: Fractures of the atrophic mandible have been historically treated in various ways, from intermaxillary fixation to internal fixation, some cases require bone grafts. Besides, the Luhr classification serves as a guide to select the type of treatment. **Objective:** To show the treatment of fractures in atrophic mandible with plates and screws, and the potential indications of bone graft in this type of fractures. **Method:** We presented a serie of 17 patients with atrophic mandible treated with plates and screws, some of them no blocked system and other with locked screws. For patients in luhr classes II and III cancellous bone grafts were used, looking for best osteogenic response, harvesting for the proximal third of the tibia. **Results:** Postoperative progress was generally uneventful. Oral intake with purees was resumed 24 hours after surgery, as well as ambulation. Fracture healing at 6 months was seen in 17 patients. One patient died before the 6-month time point as the result of a stroke. Delayed union was diagnosed 3 months after surgery in another patient, who refused secondary treatment. **Conclusions:** Treatment of fractures in atrophic mandibles with plates and screws is a reliable procedure. Luhr classification provide useful guidance regarding the use of bone grafts for best osteogenic response in the fracture. This treatment allows a quick restart of the feeding by mouth and mobilization of the patients.

Keywords: Mandibular fractures. Edentulous jaw. Fracture osteosynthesis. Bone grafting.

Resumen

Antecedentes: Las fracturas en mandíbula atrófica han sido tratadas desde con fijación intermaxilar hasta con osteosíntesis. Pueden requerir injertos óseos. La clasificación de Luhr es una guía para orientar el tratamiento. **Objetivo:** Mostrar el tratamiento de fracturas en mandíbula atrófica con placas y tornillos y las posibles indicaciones de uso de injerto óseo en este tipo de fracturas. **Método:** Se presenta una serie de 17 pacientes con mandíbula atrófica fracturada tratada con placas y tornillos, algunas con sistemas no bloqueados y otros bloqueados. En las de clase II and III se aplicó injerto óseo esponjoso para mejorar la capacidad osteogénica. El injerto se tomó del tercio proximal de la tibia, previa evaluación radiológica. **Resultados:** La evolución en general fue satisfactoria. Se inició la vía oral con papillas y los pacientes deambularon a las 24 h de posoperatorio. Se observó consolidación en 17 pacientes. Hubo una defunción por enfermedad vascular cerebral antes de 6 meses. Una paciente tuvo retardo de consolidación diagnosticado al tercer mes, pero no aceptó tratamiento secundario. **Conclusiones:** El tratamiento de las fracturas mandibulares atróficas con placa y tornillos bajo concepto de carga absorbida es un procedimiento confiable. La clasificación de Luhr es útil para orientar la utilización de injerto óseo, buscando mejorar la capacidad osteogénica en la fractura. Este tratamiento permite un pronto reinicio de la vía oral, así como la movilización de los pacientes.

Palabras clave: Fracturas mandibulares. Mandíbula edéntula. Osteosíntesis de fracturas. Injerto de hueso.

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Introduction

The treatment of fractures in atrophic mandibles has been a challenging for quite a while. Factors such as tooth loss, the degree of mandibular height loss (often associated with maxillary loss), poor bone quality, and changes to local circulation result in consolidation disorders.

The increased life expectancy, along with a low socio-economic level, limit the possibility of oral rehabilitation with implants as an adjunct therapy to reduce bone loss.

Historically, atrophic mandibular fractures have been treated using intermaxillary fixation, Gunning splints, local wiring associated with rib grafts, bio-implants, etc^{1,2}. In the 1970s and 1980s, the treatment approach shifted to using dynamic compression plates³, and then to non-compression plates with bicortical screws (Prein, 1993) with autologous bone grafts. Back in 1996, Luhr published a report on the use of dynamic compression plates and categorized mandibular atrophy based on height⁴: class I = 16-20 mm, class II = 11-15 mm, and class III ≤ 10 mm (Figs. 1 to 3). By the late 1990s, blocked or locked systems were advised due to stability issues, and to preserve bone biology¹.

Method

The patients' health records with facial fractures treated at Hospital de Traumatología y Ortopedia Lomas Verdes, Instituto Mexicano del Seguro Social, Mexico City, Mexico from January 2008 through December 2017 were retrospectively reviewed. During this period, a total of 2549 patients with facial fractures underwent surgical treatment, 834 of whom had mandibular fractures as the sole injury or associated with other facial fractures. Among these, 19 cases showed atrophic mandibular fractures. The ages of the 19 cases with atrophic mandibular fractures (12 men and 7 women) ranged from 43 to 85 years (mean, 65.3 years). Two patients with atrophic jaws were excluded from this study as they had subcondylar mandibular fractures, 1 as a sole injury and the other ones associated with maxillary and orbital fractures.

The mechanisms of injury included 14 falls, 4 motor vehicle accidents, and 1 bicycle fall.

Table 1 illustrates the characteristics of the 17 patients included in the study.



Figure 1. Mandible with class I atrophy (16 mm to 20 mm) and fracture of bilateral mandibular body.

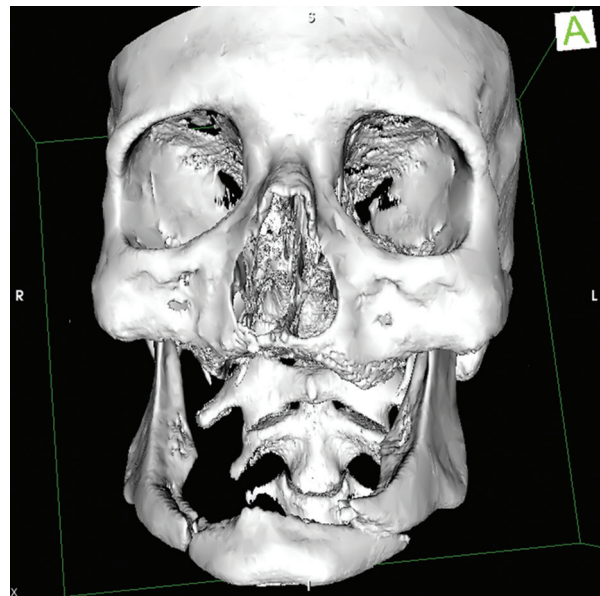


Figure 2. Mandible with class II atrophy (11 mm to 15 mm) and fracture of bilateral mandibular body.

Results

All 17 patients were treated with osteosynthesis using plates and screws. Preoperative computed tomography (CT) with thin slices (1 mm) showed mandibular height at the fracture site and the deficiency of cancellous bone at the fracture edges, which eventually guided the decision on whether to use bone grafts or not. Bone grafts, aimed at improving osteogenic response at the fracture site, were harvested from the proximal third of the tibia to minimize donor site morbidity associated with the iliac crest. Patients who



Figure 3. Mandible with class III atrophy (≤ 10 mm) and a unilateral mandibular fracture.



Figure 4. Intraoral approach to perform the osteosynthesis of the mandibular body.

received bone grafts had class II and III atrophy according to Luhr's classification.

Extraoral access was used in patients treated with universal fracture plates (2.4 screws) due to the precision in plate adaptation and fracture simplification using a small plate and 2.0 screws at the basal edge (for the anatomical reduction of the fracture). In patients treated with locked 2.0 systems without grafts, mandibular fractures were treated via intraoral access (Fig. 4) due to the adaptability advantages of this plate type. Subcondylar fractures were treated via retro-mandibular access (Fig. 5) for osteosynthesis with plates and screws. In cases involving bone grafts, even with locked plates, extraoral access (Fig. 6) was chosen to reduce the risk of graft contamination.

Locked systems with 2.4 screws were applied via extraoral access. Osteosynthesis plates were secured with 3 or 4 screws on each side of the fracture (Fig. 7). In cases with bilateral fractures and a single plate, an equal number of screws was placed in both angle-ramus regions and the chin (Fig. 8).

Patients were given analgesics (IV paracetamol, 1 g/8 h) and antibiotics (oral clindamycin, 300 mg/8 h, for 5 days). Patients with eligible intraoral access were instructed to use alcohol-free chlorhexidine mouthwash 4 times/day for 3 weeks. Patients treated with extraoral access, in addition to achieving careful hemostasis, had a suction drainage placed under the platysma for 36 hours. Patients with condylar fractures had a Penrose-type drain left in place for the same amount of time.

The postoperative recovery of the patients was favorable. Oral intake resumed a few hours after the

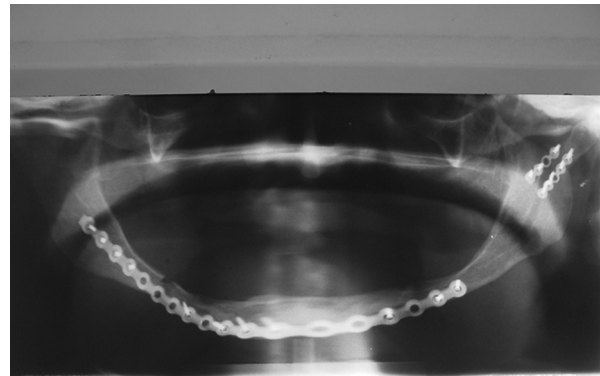


Figure 5. Mandibular body fracture associated with a subcondylar fracture.

procedure. Mobilization out of bed and ambulation, including patients with bone grafts, began the morning after surgery with minimal pain and uneventfully. Healing of both intra- and extra-oral accesses occurred uneventfully, with no hematomas or seromas being reported. All patients underwent imaging modalities 24 hours after the intervention.

Patients were discharged from the hospital 48 hours after their surgery. They were evaluated in follow-up appointments 1 and 2 weeks after surgery, and then, 1, 3, and 6 months later. Imaging controls were performed at the 3- and 6-month visits. Among the 17 patients, one 73-year-old woman with hypertension and a long history of smoking, with class I atrophy, showed delayed consolidation at the 3-month evaluation. The possibility of a bone graft procedure was discussed, but the family declined treatment. An 86-year-old patient with class I atrophy and a benign tumor adjacent

Table 1. Summary of the characteristics of the 17 patients, their fractures, associated injuries, and treatment used

Age (years)	Gender	Class	Symphysis	Parasymphysis	Body	Angle	Condyle	Approach	Implant
60	M	I			Right			Intraoral	2.4 Universal plate
64	W	I			Left			Extraoral	2.4 Universal plate
49	M	I			Right		Subcondylar Left	Extraoral	2.0 Blocked
43	M	II	Yes		Right		Bilateral Articular	Intraoral	2.0 Blocked
73	M	I			Left	Right		Intraoral	2.0 Blocked
79	W	III			Left			Extraoral	2.0 Blocked Graft
63	M	I				Left	Subcondylar Right	Intraoral Extraoral	2.0 Blocked
84	M	II			Bilateral		Subcondylar Left	Extraoral Extraoral	2.0 Blocked Graft
52	M	I	Yes				Subcondylar Bilateral	Intraoral Extraoral	2.0 Blocked
86	W	I			Right Tumor			Intraoral	2.0 Blocked
74	M	II			Bilateral			Extraoral	2.0 Blocked Graft
55	M	I		Left		Right		Intraoral	2.0 Blocked
58	W	I		Left	Right			Extraoral	2.4 Blocked
69	M	II			Right			Extraoral	2.4 Blocked
85	W	I	Yes		Right			Intraoral	2.-2.0 Blocked
73	M	I			Bilateral			Intraoral	2.0 (2) Blocked
65	M	I	Yes		Right	Left	Subcondylar Right	Intraoral Extraoral	2.0 Blocked

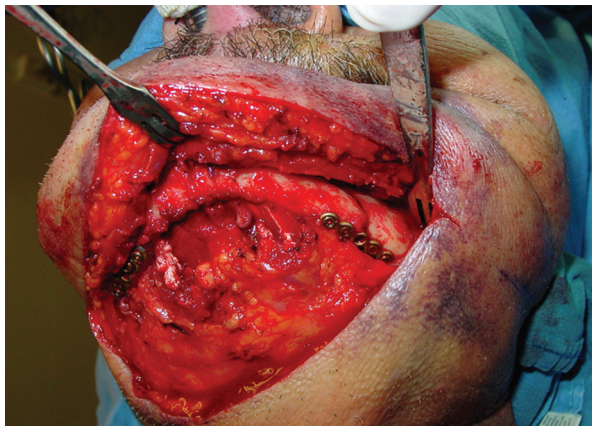


Figure 6. Extraoral approach used to treat a bilateral mandibular fracture. Both fractures were pre-simplified with plates and short screws at the basal edge before osteosynthesis with a locked plate and the application of a bone graft.

to the fracture died of a stroke nearly 2.5 months after surgical treatment. The remaining patients achieved fracture consolidation.

Discussion

Historically, fractures in atrophic jaws have been challenging to treat. For about 30 years, the most common and effective approach has been the use of plates and screws, with locked systems being the preferred choice to this date. In atrophic jaws, factors such as reduced contact surface, poor vascular supply, decreased bone quality, and patient morbidity are known to reduce the chances of fracture healing⁵⁻⁸.

As life expectancy increases, the elderly population, especially those older than 65 years, is growing. It is estimated that by 2050, the United States will have approximately 85 million residents older than 65 years, which will lead to more atrophic mandibular and maxillary conditions. In this series, most fractures were due to falls, which is common in older patients, as reported by former studies^{6,7}.

Using Luhr's classification can be helpful as a guide to determine the type of material and the possible need for bone grafting, in addition to preoperative CT scans.

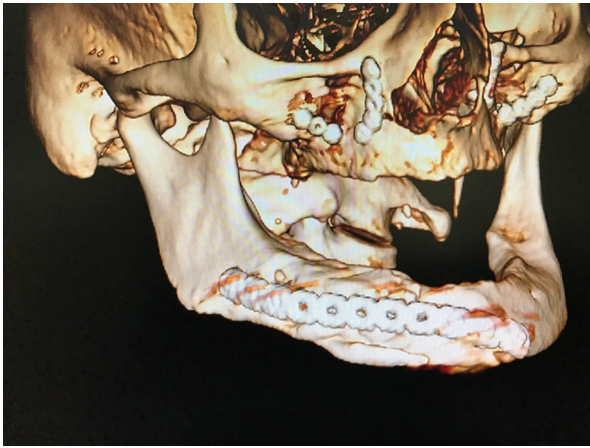


Figure 7. Unilateral mandibular fracture treated with a universal fracture plate. Note the application of 3 screws in each segment.

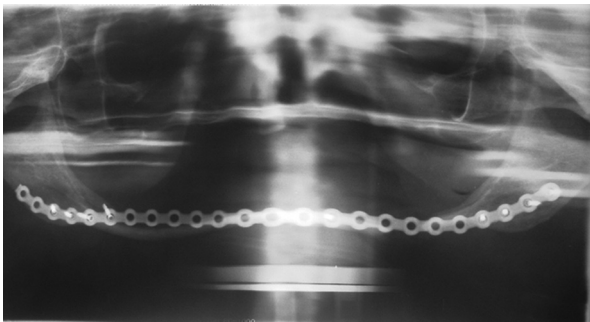


Figure 8. Bilateral mandibular fracture treated with a single locked plate, with 4 screws at each end and 2 screws in the anterior mandibular region.

Current topics of discussion include the use of locked systems with mono- or bicortical screws due to their angular stability, which requires less dependence on screw anchorage to the bone. This makes the use of monocortical screws a viable option.

Regarding the surgical approach, it is essential to consider the reduction of the fracture, which can be challenging depending on its location and pattern, the presence of bilateral fractures (in the body), displacement due to local muscle tension, the absence of dental structures to restore dental occlusion, and the need for bone grafting. In cases of atrophy, achieving anatomical reduction through the application of small plates and short screws intraoperatively (6 mm in length and 2 mm in diameter) on the basal edge can simplify the fracture. This is performed through extraoral transcervical access (aligned with neck folds), positioned more caudally compared to the traditional submandibular approach. Also, the initial dissection is

performed below the platysma. This approach reduces the likelihood of damaging the facial nerve caudal branches. Also, it is an easily identifiable plane of dissection with minimal morbidity, which offers aesthetic advantages as it blends with the neck folds while reducing fibrosis significantly.

When bone grafting is required to improve the quality of the consolidation process, preoperative CT scans should be performed to assess mandibular bone density at the fracture ends. The intentional search for trabecular bone at the fracture ends should be part of preoperative planning^{4,8,9,10}. Another aspect that should be considered is whether mandibular dissection for plate application should be performed sub- or supra-periosteally. Advocates for placing plates on the periosteum argue that it does not reduce mandibular vascular supply significantly, thus resulting in fewer consolidation disorders. While the subperiosteal application of osteosynthesis material spares periosteal and muscular insertions on the mandible lingual surface, it is enough to keep vascularity and the consolidation process by avoiding periosteal detachment on the mandible vestibular surface. However, the mechanical stability achieved by mandibular osteosynthesis should not be underestimated, as it can be beneficial for the consolidation process. Former studies suggest the possibility of applying osteosynthesis to the mandibular basal edge^{6,9} to minimize interference with prosthetic adaptation, provide better soft tissue coverage over the plate, and reduce the risk of surgical access dehiscence in cases of intraoral access.

Conclusions

Fractures in edentulous mandibles are rare in our environment. However, we should consider that their incidence may gradually increase with the aging population, poor oral hygiene habits, smoking, and low economic status leading to inadequate dental rehabilitation.

In case of such fractures, evidence shows that prognosis is better when treated surgically through open reduction and osteosynthesis using plates and screws compared to closed or wired treatments. Among the various osteosynthesis techniques available, the option that offers the best chance of successful consolidation is using locked systems, even with profiles of 2 mm to 2.5 mm in thickness and with screws of 2 mm in diameter. It is advisable to use long plates, placed as a bridging effect over the mandibular body since it

is the most common site of fracture in the atrophic mandible, anchoring 4 screws at each end, for example, angle-ramus and symphysis-parasymphysis, which happen to be the 2 areas of the mandible with better bone quality. In cases of bilateral body fractures, osteosynthesis should occur with a single plate covering both angles and the chin area, thus providing enough mechanical stability to support the consolidation process. We should mention that screws should be placed in the angle-ramus area and others in the chin, ideally 4 or, at least, 3 in each segment.

The use of bone grafts should be considered in class II and III atrophies, where the contact surface is small, and circulatory conditions are not optimal, as well as in cases of decreased spongiosa at the fracture ends, which can be detected through thin-slice CT scans.

Regarding the donor site, taking spongy grafts from the proximal third of the tibia has lower morbidity compared to the iliac crest, and patients typically experience less postoperative pain. A preoperative radiographic evaluation of the tibia is essential to avoid grafting from areas with poor bone quality. Also, attention should be paid not to harvest the graft too close to the tibial plateau to prevent stress fractures.

Surgical access is another crucial consideration. Extraoral access is used for bilateral fractures and fractures that require intraoperative simplification with small plates and short screws. This access provides excellent visibility and facilitates the surgical procedure while preventing potential contamination of the intraorally applied bone graft. Intraoral access is useful for unilateral fractures of simple morphology that do not require simplification or bone grafting. The use of aluminum templates for plate contouring can be beneficial in these cases, reducing material fatigue from excessive manipulation during contouring.

Finally, we must consider that early treatment of atrophic mandibular fractures benefits patients with comorbidities. It facilitates prompt feeding, quick mobilization and ambulation, and avoids prolonged admission, thereby reducing the deterioration of these patients, which would result in higher health spending.

We believe that the future looks promising, with the potential use of resources that can simplify the treatment of these injuries, improve their prognosis,

and reduce the morbidity of reconstruction procedures. These resources may include bone morphogenetic protein, virtual planning, and the use of locked systems tailored to the type of load-bearing osteosynthesis¹⁰⁻¹³.

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Conflicts of interest

None declared.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

References

1. Castro-Núñez J, Cunningham LL, Van Sickels JE. A historical perspective with current opinion on the management of atrophic mandibular fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2017;124:e276-82.
2. Buchbinder D. Treatment of fractures of the edentulous mandible, 1943 to 1993. *J Oral Maxillofac Surg*. 1993;51:1174-80.
3. Spiessl B, editor. Closed fractures. En: Internal fixation of the mandible. Berlin-Heidelberg, Germany: Springer-Verlag; 1989. p. 208-40.
4. Luhr HG, Reidick T, Merten HA. Results of treatment of fractures of the atrophic edentulous mandible by compression plating: a retrospective evaluation of 84 consecutive cases. *J Oral Maxillofac Surg*. 1996;54:250-4.
5. Flores-Hidalgo A, Altay MA, Atencio IC, Manlove AE, Schneider KM, Baur DA, et al. Management of fractures of the atrophic mandible: a case series. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2015;119:619-27.
6. Madsen MJ, Haug RH, Christensen BS, Aldridge E. Management of atrophic mandible fractures. *Oral Maxillofac Surg Clin N Am*. 2009;21:175-83.
7. Liu FC, Halsey JN, Oleck NC, Lee ES, Granick MS. Facial fractures as a result of falls in the elderly: concomitant injuries and management strategies. *Craniomaxillofac Trauma Reconstr*. 2019;12:45-53.
8. Ellis III E, Price C. Treatment protocol for fractures of the atrophic mandible. *J Oral Maxillofac Surg*. 2008;66:421-35.
9. Van Sickels JE, Cunningham LL. Management of atrophic mandible fractures: are bone grafts necessary? *J Oral Maxillofac Surg*. 2010;68:1392-5.
10. Castro-Núñez J, Cunningham LL, Van Sickels JE. Atrophic mandible fractures: are bone grafts necessary? An update. *J Oral Maxillofac Surg*. 2017;75:2391-8.
11. Batbayar EO, Bos RRM, van Minnen B. A treatment protocol for fractures of the edentulous mandible. *J Oral Maxillofac Surg*. 2018;76:2151-60.
12. Maloney KD, Rutner T. Virtual planning and hardware fabrication prior to open reduction and internal fixation of atrophic edentulous mandible fractures. *Craniomaxillofac Trauma Reconstr*. 2019;12:156-62.
13. Van der Kolk-Bender CA, Koudstaal MJ, Wolvius EB. Treatment of severely atrophic edentulous mandible fractures: load-bearing or load sharing? *Craniomaxillofac Trauma Reconstruction Open*. 2018;2:e55-e60.