Treatment of Atrophic Mandibular Fractures with the Pencilboneplate: Report of 2 Cases

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Abstract The incidence of fractures of the atrophic edentulous mandible is still low, even with the increasing life expectancy. The reduced blood supply of the sclerotic bone, the diminished contact area between bone fragments and the patient's systemic condition makes the treatment of those fractures a challenge for any professional. Treatment of atrophic mandibular fractures by means of miniplate osteosynthesis has not been the preferred method of fixation by many authors. Yet, many surgeons have applied this type of fixation for the atrophied jaw sections. This paper reports 2 cases of fractured atrophic mandibles treated with the pencilboneplate, a monocortical 2.0 mm titanium, 8 or 10-hole hardware with reinforcement on its middle portion, highlighting important considerations of its use. The pencilboneplate appears to be a valuable option for the treatment of atrophic mandibular fractures, especially by an intra-oral approach, and warrants further biomechanical and clinical studies.

Keywords Fracture · Mandible · Elderly · Osteosynthesis

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Introduction

The incidence of fractures of the atrophic edentulous mandible is still low, even with the increasing life expectancy [1–3]. Therefore, controversies regarding the treatment of such injuries usually engender great debate among oral and maxillofacial surgeons, since no large series of cases or prospective controlled trials are available throughout the literature. The reduced blood supply of the sclerotic bone, the diminished contact area between bone fragments and the patient's systemic condition makes the treatment of those fractures a challenge for any professional [1, 3–6].

Many authors have advocated the use of larger bone plates on atrophied jaw sections [1, 2, 6, 7], whereas others have proposed different types of miniplate osteosynthesis [3–5, 8, 9]. Generally, whenever a stronger bone plate is chosen as the treatment option, an extra-oral approach is preferred and general anesthesia is needed. Likewise stronger systems are applied by the extra-oral route when grafting materials are used as part of the treatment. On the other hand, by using miniplates the clinician has the possibility to apply the intra-oral approach reducing length and morbidity of the surgical procedure.

This paper reports 2 cases of fractured atrophic mandibles treated with the pencilboneplate (Medartis AG, Basel) (PBP), highlighting important considerations of its use.

Case Reports

Case 1

An 88 year-old male attended the emergency room of a local hospital complaining of pain and abnormal mobility

Fig. 1 Pre-operative panoramic radiography for case 1. *Right* mandibular body fracture on a Class III atrophic mandible

on the right mandibular body region after a fall. A thorough examination was conducted and the patient was diagnosed with a right class III [6] atrophic edentulous mandibular body fracture (Fig. 1), however the proposed surgical treatment was declined by the patient at that moment. Approximately 3 weeks after the initial evaluation, the patient returned with the same complaints added by numbness on the right lower lip, and agreed to undergo open reduction and internal fixation of the fracture under general anesthesia. The medical history revealed controlled diabetes without any other significant systemic consideration.

Nasotracheal intubation was performed and the following surgical steps were carried out: intra-oral access by means of a crestal incision with special care to avoid damage to the mental nerve; careful local debridement; reduction of the fracture and application of the PBP (Figs. 2–4) with monocortical screws for internal fixation. Wound closure was performed and the patient was discharged 2 days after surgery with oral antibiotics for a period of 1 week and soft diet for 1 month.

The healing was uneventful except for a minor sensory disturbance on the right lower lip. The patient was encouraged to wear his dental prosthesis after 1 month and

Fig. 2 An 8-hole pencilboneplate. Note the middle reinforced portion of the plate, which can be of 6 and 9 mm long, surrounding the proximal holes. This part is responsible for the improved stress distribution to the system. This plate was used on case 2

Fig. 3 Intra-oral view of the 10-hole pencilboneplate used on case 1. Monocortical screws were applied and the use of a 90° screwdriver facilitates positioning of the screws

Fig. 4 Post-operative panoramic radiography for case 1. Bone remodeling can be seen at the fracture site

returned to normal function with a follow-up period of 2 years.

Case 2

A 57 year-old male attended the emergency room of a local hospital for maxillofacial evaluation after an assault. The physical examination showed fractures (Fig. 5) on the right body and left angle regions of an atrophic edentulous mandible (Class II [6]). The patient's medical history revealed controlled hypertension, gout and alcohol abuse.

Fig. 5 Pre-operative panoramic radiography for case 2. Bilateral mandibular fracture (*right* mandibular body and *left* mandibular angle regions)

Fig. 6 Post-operative panoramic radiography for case 2. This figure provides a gross comparison between the pencilboneplate and the larger 2.4 mm system used for treatment of atrophic mandibular fractures. Monocortical screws were also used on this case for the pencilboneplate, whereas bicortical screws were applied on the reconstruction hardware

The patient, who did not wear dentures previously, has not required dental rehabilitation yet.

Discussion

Conventional miniplate osteosynthesis for atrophic mandibular fractures has not been the preferred method of fixation for those injuries by many authors due to the potential lack of stability provided by such bone plates precluding an early return to function [1, 6, 7], and this statement is also the authors' opinion when dealing with such complex injuries. Yet, many surgeons have applied this type of fixation for the atrophied jaw sections [3–5, 10].

Iatrou et al. [5] and Mugino et al. [3] reported series of cases demonstrating reasonable treatment outcomes using miniplate osteosynthesis on fractures of edentulous mandibles, despite the fact that not all mandibles were atrophic as defined by Luhr et al [6]. Nevertheless, their principles of treatment were based on bone buttressing areas of the mandible for placement of the plates. This concept must not be supported, since in the atrophied jaw there is minimal or no bone buttressing to share the load with smaller osteosynthesis devices and there may not be enough space for placement of two miniplates [1, 7] especially on Class III [6] mandibles.

Important advantages cited throughout the literature in favor of the use of smaller bone plates include: possibility of surgery under local anesthesia and sedation, less invasive surgical procedure and avoidance of a scar and facial nerve lesion due to the use of an intra-oral access [3–5].

A patient who cannot withstand general anesthesia may be the only clear indication at the present time for closed treatment of fractures of the atrophic mandible [1]. Hence it is interesting to have a hardware that can carry the properties of a miniplate providing more stability than the conventional miniplates available and leaving the possibility of treating the patient without imperative need for general anesthesia [5].

The decreased periosteal stripping provided by the miniplate osteosynthesis is a significant benefit. When using a 2.4 mm reconstruction bone plate, the symphyseal and angle regions must be the ones used for fixation, given that the body region is an area of major atrophy leading to possible damages on the bone (fractures) and the alveolar inferior nerve by the large bicortical screws [3–5, 10]. As a result, ample exposure is mandatory for application (and also for removal, if it turns out to be necessary) of 2.4 mm reconstruction bone plates. The locking 2.0 mm larger bone plates might be an option for diminution of the screw diameter, however if applied with bicortical screws, they may still represent some danger. In the authors' opinion,

the placement of bone plates in a supra-periosteal fashion is not recommended, since one will not be able to achieve perfect reduction between the fragments, a key factor for adequate fracture healing.

To perform extra-oral incision and the bending of larger reconstruction bone plates requires more time, subsequently the avoidance of its use obviously reduces the surgical time, complexity of the procedure and potential facial nerve injuries [3, 4], which is naturally interesting for the patient and the surgical team.

There are other important factors to be addressed when using miniplates. The likelihood of damage to the mental nerve by an intra-oral incision is a true concern, since its position changes to an upward direction on the atrophic mandible. Careful planning of the access is paramount to rule out this complication. In some cases, even the alveolar inferior nerve gets exposed on the top of the alveolar crest due to the intense bone resorption, being covered only by the oral soft tissues. Oral rehabilitation with dental prosthesis is facilitated with the use of smaller bone plates in comparison to larger reconstruction devices [1]; however the positioning of the latter on the inferior border of the mandible may overcome that matter with interesting reported outcomes [2].

As a final point, one must keep in mind that in comminuted or defect fractures on atrophic jaw sections, the use of miniplate osteosynthesis must be precluded, since the treatment will involve use of grafting materials, preferably autogenous bone grafts that require extra-oral access and larger reconstruction bone plates to be performed in a predictable way [1].

After those relevant considerations, the PBP was developed by Medartis AG (Basel, Switzerland) with aid of a German group of surgeons [8]. The main difference of such hardware is its middle reinforcement bar. Plate length is variable. The 8-hole plate has two presentations: 47 and 50 mm long, with the middle reinforcement bar of 6 and 9 mm long, respectively. The 10-hole plate has 65 mm with a bar of 12 mm. Plate thickness is 1.0 mm and height is 5 mm. The two proximal holes are spherical sliding holes that allow minor compression even with monocortical screws. The PBP is also available on the locking system with slight variations on plate characteristics. However the titanium used on this system is less rigid than the trauma system; therefore the authors do not apply the locking PBP for the treatment of atrophic mandibular fractures.

The biomechanical analysis was made through finite-element analysis showing that the stress distribution to the bone plate is significantly lower compared with the conventional 2.0 bone plates with such fact attributed to its middle reinforcement [8, 9]. We do not bend that area in order to maintain the plate's rigidity. Clinical evaluation of the hardware enrolled two papers published by the same

group. The first was published in 2003 [8] and they reported no major complications, with the use of the new bone plate for fixation of 16 fractures on 14 patients. One reoperation using a stronger bone plate was necessary owing to a new trauma at the area. It is important to note that five fractures in their study were on partially edentulous patients (Classes I and II [6]). The second paper from 2004 [9], published as letter to the editor, involved 20 patients with 22 atrophic mandibular fractures and a healing process without major complications on 90% of their patients. Again five patients (Classes I and II [6]) were partially edentulous. It was not stated whether the patients from one study were included on the other.

Accordingly, our case reports have demonstrated two patients successfully treated with the PBP with a minimally invasive procedure and no major complications were observed. Such a bone plate carries good properties of a miniplate with an improved stability. None of the patients presented with severely displaced fractures and a good reduction was achieved. The authors do not indicate the PBP if a fine contact between the fracture segments is not accomplished.

For both cases, the treatment modality of open reduction and internal fixation was performed because both patients were able to undergo general anesthesia. Open treatment allows better reduction of the fracture, better stability and early return to function, when compared to conservative approaches or the application of external fixation devices. In case 1, soon after treatment, the patient stopped feeling pain in the fractured site, one of his major complaints. In case 2, after an unsuccessful attempt of intra-oral reduction of the angle fracture, the extra-oral approach was performed and the reconstruction bone plate was applied, taking advantage of the ample exposure and providing better stability to the fracture.

Both patients were encouraged to have a soft diet for 1 month as a precaution according to what is generally done when using miniplates [5]. The sensory disturbances perceived may be attributable to the fracture, time taken to

execute the treatment or the surgical procedure itself. However the altered sensation was not seen as a bothering condition by those patients. The PBP appears to be a valuable option for the treatment of atrophic mandibular fractures, especially by an intra-oral approach, and warrants further biomechanical and clinical studies.

References

1. Ellis E, Price C (2008) Treatment protocol for fractures of the atrophic mandible. *J Oral Maxillofac Surg* 66:421–435
2. Madsen MJ, Haug RH (2006) A biomechanical comparison of 2 techniques for reconstructing atrophic edentulous mandible fractures. *J Oral Maxillofac Surg* 64:457–465
3. Mugino H, Takagi S, Oya R, Nakamura S, Ikemura K (2005) Miniplate osteosynthesis of fractures of the edentulous mandible. *Clin Oral Investig* 9:58–62
4. Choi BH, Huh JY, Suh CH, Kim KN (2005) An in vitro evaluation of miniplate fixation techniques for fractures of the atrophic edentulous mandible. *Int J Oral Maxillofac Surg* 34:174–177
5. Iatrou I, Samaras C, Theologie-Lygidakis N (1998) Miniplate osteosynthesis for fractures of the edentulous mandible: a clinical study 1989–96. *J Craniomaxillofac Surg* 26:400–404
6. Lühr HG, Reidick T, Merten HA (1996) Results of treatment of fractures of the atrophic edentulous mandible by compression plating: a retrospective evaluation of 84 consecutive cases. *J Oral Maxillofac Surg* 54:250–254
7. Sikes JW, Smith BR, Mukherjee DP (2000) An in vitro study of the effect of bony buttressing on fixation strength of a fractured atrophic edentulous mandible model. *J Oral Maxillofac Surg* 58:56–61
8. Blume O, Seper L, Meyer U, Piffkó J, Joos U (2003) Experimental and clinical study of a newly developed osteosynthesis plate for the treatment of the fractured atrophied mandible. *Mund Kiefer GesichtsChir* 7:323–329
9. Seper L, Piffkó J, Joos U, Meyer U (2004) Treatment of fractures of the atrophic mandible in the elderly. *J Am Geriatr Soc* 52:1583–1584
10. Sugiura T, Yamamoto K, Murakami K, Kawakami M, Kang Y, Tsutsumi S, Kirita T (2009) Biomechanical analysis of miniplate osteosynthesis for fractures of the atrophic mandible. *J Oral Maxillofac Surg* 67:2397–2403