USE OF PROTOTYPING IN ATROPHIC JAW RECONSTRUCTION: CASE REPORT

O USO DE PROTOTIPAGEM EM RECONSTRUÇÃO DE MANDÍBULA ATRÓFICA: RELATO DE CASO

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ABSTRACT

Mandibular atrophy is a universal disease characterized by extensive bone resorption due to edentulism and bone remodeling caused by it. Data released by Pesquisa Nacional de Saúde (PNS – IBGE), in 2015, reveal that 16 million Brazilians are total edentulous, representing 11% of the population. Patient, female, 78 years old, , leucoderma, total edentulous, using lower overdenture on three anterior implants, was admitted to the Service, referring pain in the left side of the mandible. At the physical examination, no crepitation or displacement was observed. When analyzing a panoramic radiography, a fracture was noted in the left side of mandibular body, due to mandibular atrophy. The conduct applied to resolution of the case was printing of a mandibular prototype for pre-modeling a reconstructive 2.4mm locking plate, across the mandibular body and ramus. The surgery was performed at the hospital, through transcervical access. After exposure of the mandible, the pre-folded reconstruction plate was fixed. A mixture of iliac crest particulate graft, with particulate lyophilized bone graft was used in areas of larger mandibular resorption (bilateral mandibular body), enveloped by a collagenous membrane. Mandibular reconstruction, therefore, allowed the occlusal stability, preventing the risk of new spontaneous fractures, reestablishing function, aesthetics, and quality of life.

KEYWORDS: Arcade edentulous, spontaneous fractures, reconstruction, atrophy.

RESUMO

A atrofia mandibular é uma doença universal caracterizada por extensa reabsorção óssea, devido ao edentulismo e a remodelação óssea causada por ele. Dados divulgados pela Pesquisa Nacional de Saúde (PNS), do IBGE, em 2015, revelam que 16 milhões dos brasileiros são edêntulos totais, representando 11% da população. Paciente de 78 anos, gênero feminino, leucoderma, edêntula total, em uso de overdenture inferior sobre três implantes anteriores, compareceu ao Serviço, referindo dor em mandíbula em lado esquerdo. Ao exame físico, não se observou crepitação ou deslocamento. Ao analisar radiografia panorâmica, notou-se fratura em corpo mandibular esquerdo, devido à atrofia mandibular. A conduta aplicada para resolução do caso foi a impressão de protótipo mandibular para pré-modelagem de placa reconstrutiva *locking* do sistema 2.4mm, em toda a extensão de corpo e ramo mandibular. A cirurgia ocorreu em ambiente hospitalar, através de acesso transcervical. Após a exposição da mandíbula, fixou-se a placa de reconstrução pré-dobrada. Uma mistura de enxerto particulado de crista ilíaca com enxerto ósseo liofilizado particulado foi usada nas áreas de maiores reabsorções mandibulares (corpo mandibular bilateral), envoltos por uma membrana colágena. A reconstrução mandibular, portanto, permitiu a estabilidade oclusal do paciente, evitando o risco de novas fraturas espontâneas, restabelecendo a função, a estética e a qualidade de vida.

PALAVRAS-CHAVE: Arcada edêntula; Fraturas espontâneas; Reconstrução; Atrofia

1. INTRODUCTION

The treatment of atrophic mandible fractures in edentulous patients represents a challenge for the oral and maxillofacial surgeon due to unfavorable biological and biomechanical conditions, such as lack of bone quantity and often quality, as well as systemic problems inherent to age and to the patient's general health, like this, atrophic jaw fractures may be difficult to treat. In most cases, these fractures affect the process of bone regeneration, local vascularization is reduced and poor quality of the mandible is insufficient for adequate osteosynthesis, according to Ellis III *et al.* (2008)[1].

Ellis III *et al.* (2008)[1], also said that the atrophy can be considered the last step of a condition of progressive reduction of the mandibular bone directly linked to the loss of teeth.

Management of this type of lesion in case of

osteosynthesis with steel wire, use of prosthesis, fixation with external pins and even conservative treatment. With the introduction of rigid internal fixation into the surgeon's arsenal, this technology brought with it the potential for increased stability during the repair of this type of fracture. However, despite these improvements, problems still occur, such as infection, non-consolidation, masticatory disability, neurosensory deficits, and high direct costs, as well as high indirect social costs, according to Madsen *et al.*[2], in 2006.

The biological problems associated with this patient include the systemic diseases associated with advancing age and the reduction of local blood flow, osteoporosis and altered bone quality.

2. CASE REPORT

Patient, 78 years old, female, leucoderma, total edentulous jaw, attended the Service of Oral Maxillofacial Surgery referring to pain in the left side of the mandible.

At physical examination, the patient had inferior overdenture on three anterior implants (two implants osseointegrated and one provisional). No crepitation or displacement with manipulation was observed in the lower jaw.

A panoramic radiograph was requested, in which it was noticed a spontaneous fracture in the left mandibular body, due to severe mandibular atrophy (Figure 1).

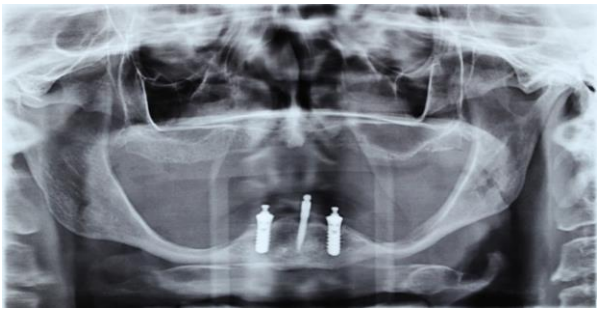

Figure 1. Pre-operative panoramic radiography showing left body mandibular fracture.

The conduct applied to resolution of the clinical case was the printing of a mandibular prototype for pre-modeling a reconstructive locking plate of the system 2.4mm, throughout the mandibular ramus and body, bilaterally.

The mandibular prototype was printed using the DDS-Pro software (Digital Dental Service Brazil), where, from a computed tomography (CT) of the face and skull, with cuts of 0.6 mm, recorded in DICOM format. In the software, a compost skull model is obtained with the CT (Figure 2A). From that, it was possible to isolate the mandible as a separated object (Figure 2B) and print it through the MoonRay 3D printer in Formalabs resin.

From the prototype impression (Figure 3), the locking system plate was pre-folded, respecting the curvature of the mandible, with branch extension to the mandibular ramus.

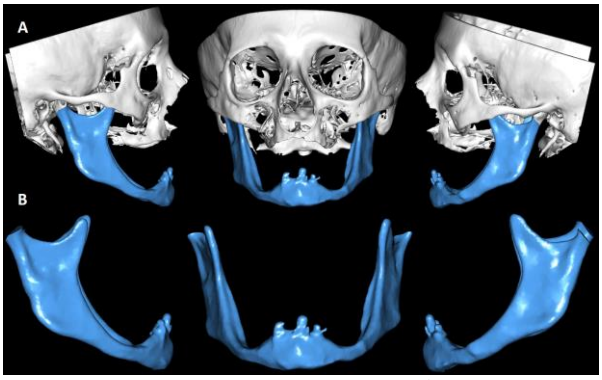

Figure 2A. Compost skull model in the software obtained by computed tomography, showing the isolation of the mandible **B.** Isolated mandible for stereolithography model printing.

Figure 3. Stereolithography model printing in light-cured resin.

Through the stereolithography model it was found that, in the mandibular bodies, the plate had not been adapted to the bone, due to the bigger resorption in these areas (Figure 4). Due to this, it was proposed the use of anterosuperior iliac crest graft for a gain a bone height and for the prevention of future spontaneous fractures.

Figure 4. Pre-bended reconstruction plate showing

Surgery occurred in a hospital environment, into general anesthesia and orotracheal intubation, through transcervical access. This access was chosen to prevent exposure and contamination of the plate, since the oral mucosa is a thinner tissue. In the divulsion and detachment by muscular planes, facial veins and arteries were connected for better trans-operative visualization. After exposure of the mandible (Figure 5), the pre-folded reconstruction plate was fixed, quickly, and with reliable adaptation, as predicted by

the biomodel printed (Figure 6).

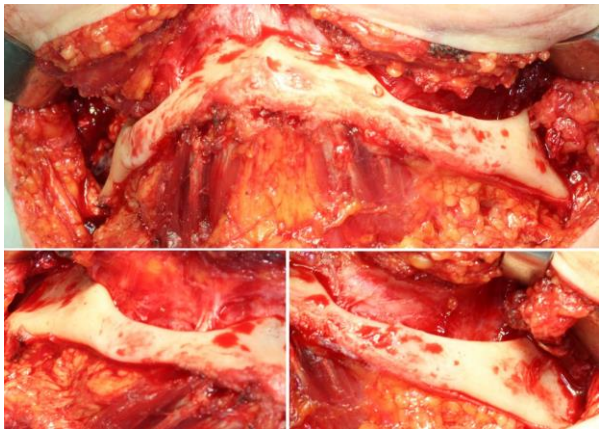

Figure 5. Transoperative aspect showing atrophic mandible with bigger atrophy in mandibular bodies and fracture line healing in left mandibular body.

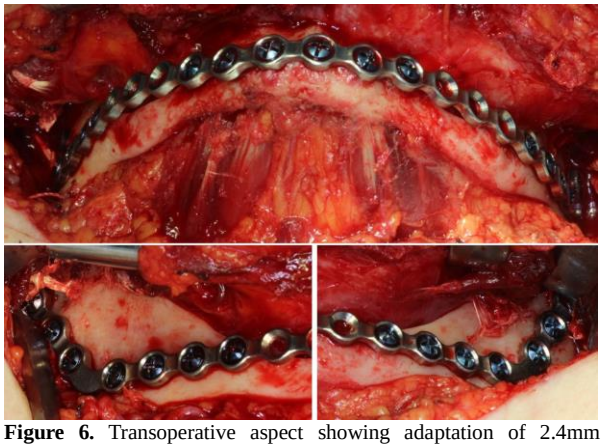

Figure 6. Transoperative aspect showing adaptation of 2.4mm locking plate in atrophic mandible.

After of the mandibular stabilization, antero-superior iliac crest particulate graft, taken by the orthopedist doctor, along with particulate lyophilized bone graft (Geistlich Bio-Oss®), were used in the areas of bigger mandibular resorption - bilateral mandibular body. The grafts were enveloped by a collagen membrane, for adequate stabilization of the grafts (Figure 7).

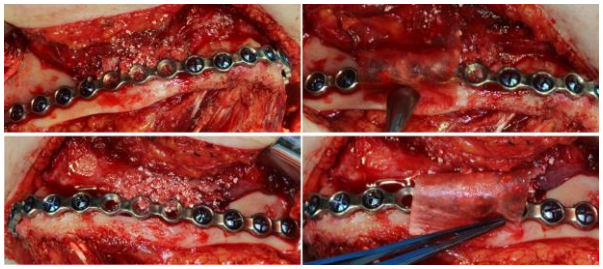

Figure 7. Particulate anterior iliac crest bone graft interposition with Bio-Oss in areas of larger mandibular atrophy and resorbable collagen membrane.

After 6 months of the surgery, the patient did a new panoramic radiograph, where maturation and incorporation of bone graft into bilateral mandibular bodies were observed, and an adequate stabilization of the locking plate (Figure 8).

To continue the rehabilitation, the patient underwent to a new surgery, under local anesthesia, at the dental office. The temporary implant was removed and a new osseointegrated implant (Nobel, Biocare) was installed, with an immediate loading protocol with cast metal base in the mandible. In the maxilla, a new mucosa-supported overdenture was performed (Figure 9).

Figure 8. Panoramic radiograph 6 months after the surgery, showing the mandibular bodies with adequate hight and the locking plate in position.

Figure 9. Patient's final occlusion.

A new panoramic was made after 3 months, showing the adequated implant osseointegration, the metal base of the protocoll in position, and the maintenance of results of the reconstruction surgery (Figure 10).

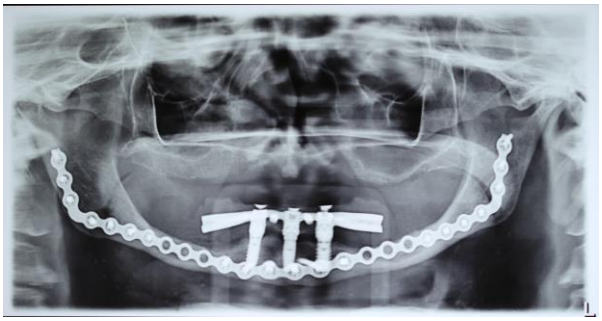

Figure 10. Panoramic radiography 3 months after implant surgery, showing adaptation of the reconstruction plate, the osseointegration of the implants and the metal base cast in position.

3. DISCUSSION

In 1996, Luhr's and his colleagues[3] classified mandibular atrophy accordingly to bone height present in fractured sites. Class I, corresponded to the mandibles with height at the fracture site 16 to 20 mm; Class II, corresponded the mandibles with 11 to 15mm of bone height; Class III, jaws with height less than or equal to 10mm, group in which the patient in question frames. In this study, a retrospective study was carried out. Eighty-four edentulous patients with atrophic

mandible fractures were included. Twenty-five patients (30%) were in the Class I atrophy group, 33 fractures (39%) occurred in Class II and 26 fractures (31%) were in extremely atrophic Class III jaws. The treatment was performed by means of compression plates without any postoperative maxillo-mandibular fixation.

Pereira-Filho *et al.* (2013)[4], investigated the number of locking screws that is sufficient to withstand loading when applied with a locking reconstruction plate in the fixation of atrophic mandible fractures. Sixty-three edentulous polyurethane jaws (Nacional Ossos – 4010), with a vertical cut in the midline of the symphysis to simulate a linear fracture, were used. For all experimental groups, a 16-hole locking reconstruction plate and screws were used. The specimens were divided into nine groups of seven mandibles each, with different fixations: control group: intact mandibles; group I: one screw on each side of the fracture; group II: two screws per side; group III: three screws per side; group IV: four screws per side; group V: five screws per side; group VI: six screws per side; group VII: seven screws per side; group VIII: eight screws per side. All mandibles went through a load test. As results, it was obtained that higher values of resistance were consistently obtained from groups III and IV, which later stabilized, even when more screws were added. In conclusion, at least three screws should be applied to each side of the fracture line. When using more screws, the load values remain similar and there is no significant gain in the rolling resistance. Confirming, to the case report presented, the number of screws used on each side of the fracture was sufficient to plate stabilization.

New approaches in prosthetic and surgical planning using rapid prototyping replicas are gaining space Today's fastest prototyping technology is the stereolithography, which reproduces reliable parts by printing with a photosensitive monomer resin applied to a laser, according to Cohen and its colleagues (2009)[5].

In our study, we obtained a replica with a mandibular bone defect for better surgical planning of the case. The possibility of printing biomodels provides quicker and easier surgical procedures, and allows fewer incidences of complications, as Erickson and colleagues[6] add, in a study published in 1999. In our case, a significant reduction in surgical time was obtained, in addition to an excellent adaptation of the pre-folded reconstruction locking plate, of the 2.4mm system, which corroborates with the bibliographic findings.

Regarding fixation methods, Sikes, and his collaborators (2000)[7] tested different fixation techniques. Five groups of 6 bovine ribs were tested based on the vertical rib size and fixation method (group 1, 40 mm, miniplate), (group 2, 30mm, miniplate), (group 3, 2mm, miniplate), (group 4, 10mm, miniplate), (group 5, 10mm, reconstruction plate). In the 4 groups stabilized with miniplate, a miniplate of titanium of 3 holes by segment, 2,0 mm of titanium and titanium screws of titanium of 6.0 mm was used. In group 5, a 2.4 mm titanium reconstruction plate with 3 screws per segment, 2.4 mm, and 2.4 mm bicortical titanium screws were used for fixation. As a result, it has been found that in fractures of the edentulous jaws, a miniplate is more likely to provide adequate fixation if the mandible is 30 to 40 mm high (non-atrophic). At higher loads, groups with higher vertical height (30 mm and 40 mm) provided equivalent displacement resistance to the 10 mm group repaired with a reconstruction plate. Therefore, atrophic mandible fractures can be better treated with more rigid techniques, corroborating with our clinical case.

Locking plate and screws systems are available in the last 10 years. These systems have potential advantages in the treatment of atrophic mandible fractures. The main advantage is that the locking plate does not need to be adapted to the underlying bone. This facilitates the process because small gaps between the plate and the bone are tolerable. Haug and his colleagues (2002)[8], who demonstrated that stability for fracture does not decrease when the plate is 4 mm away from the surface of the bone. Small spaces under the plate may also allow better cortical bone revascularization, according to Prain and Rahn (1958)[9]. Another advantage of a locking system is that it provides greater fracture stability compared to the standard non-locking screws. An in vitro study by Gutwald *et al.* (1999)[10] found that a locking system provided more stability to simulated mandibular fractures than a standard plate where the screws did not attach to the plate.

Autogenous grafts, are a reliable method for rehab of the atrophic mandibles, seeing as advantages to achieve a bigger volume of bone needed from a one donor site. Pogrel *et al.* (1997)[11], reported that non-vascularized iliac crest bone grafts used to reconstruct defects of 7cm or less have a success rate of 83%, confirming the high success rate in the autogenous graft chosen for the presented case. The main disadvantages of free fibular flaps when compared to the iliac crest, according to Foley and colleagues colegues (2013)[12], are the greater morbidity of the donor site, longer operative time, length of hospital stay, and total cost. Thus, the iliac crest is considered the gold standard for mandibular reconstructions up to 6cm in length, as discussed in the present case

According to Ellis (2008)[1], bone grafts can be used for three purposes: facilitating bone union, providing fracture stability (analogous to what a bone plate would be used today), and adding bone mass to prevent pathological fractures and increasing reconstruction possibilities prosthetic

Corroborating with Ellis last point and with the paper of Thoma and Holland (1951)[13], who discussed the addition of bone to atrophic jaws to prevent spontaneous fractures, in our study, bone grafting was used to increase bone height and to prevent spontaneous fractures in the future.

4. CONCLUSION

Mandibular reconstruction can be a real challenge for the surgeon. Biomodels should be necessary in complex cases because they allow a shorter surgical time, a shorter anesthesia period, promoting trans and post-surgical benefits to patients. The patient was satisfied with the postoperative result, which promoted aesthetics, function, and quality of life.

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