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Reconstruction of comminuted jaw with iliac crest graft and implant-supported prostheses – case report

Reconstrução de mandíbula cominuída com enxerto de crista ilíaca e próteses implanto-suportadas – relato de caso

Reconstrucción de mandíbula conminuta con injerto de cresta ilíaca y prótesis implantosoportadas - reporte de caso

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Abstract

Comminuted jaw fractures represent a challenge in terms of treatment. The advancement of fixation techniques and materials has contributed to the surgeon providing faster treatment and less complication. Even so, cases that present severe mandibular fragmentation require additional therapies, such as the use of bone grafts and dental implants, in order to recover function, aesthetics and anatomy of the mandible. This work aims to report a case of comminuted mandibular body fracture, which was treated with reconstruction, initially by rigid internal fixation, and secondly, by iliac bone graft and implant-supported oral rehabilitation. Although studies in the literature demonstrate that autogenous grafts show significant resorption, they are still considered the gold standard, and allow an ideal basis for obtaining osseointegration of dental implants. Thus, we concluded that the use of the autogenous bone graft coming from the iliac crest and rehabilitation with implants can be a satisfactory option for functional and aesthetic repair of patients who presented high impact fractures, and developed significant bone defects.

Keywords: Autologous graft; Comminuted fractures; Dental implants; Mandibular reconstruction.

Resumo

As fraturas cominutivas da mandíbula representam um desafio clínico. O avanço das técnicas e materiais de fixação tem contribuído para que o cirurgião proporcione um tratamento mais rápido e com menos complicações. Ainda assim, casos que apresentam fragmentação mandibular severa requerem terapias adicionais, como o uso de enxertos ósseos e implantes dentários, a fim de recuperar a função, estética e anatomia da mandíbula. Este trabalho tem como objetivo relatar um caso de fratura cominutiva do corpo mandibular, que foi tratada com reconstrução, inicialmente por fixação interna rígida e, posteriormente, por enxerto de crista ilíaca e reabilitação oral implantossuportada. Embora estudos na literatura demonstrem que enxertos autógenos apresentam reabsorção significativa, eles ainda são considerados padrão-ouro, e permitem uma base ideal para a obtenção da osseointegração de implantes dentários. Concluímos desta forma que a utilização de enxerto ósseo autógeno proveniente da crista ilíaca e a reabilitação com implantes pode ser uma opção satisfatória para a reparação funcional e estética de pacientes que apresentaram fraturas de alto impacto e desenvolveram defeitos ósseos importantes.

Palavras-chave: Enxerto autógeno; Fraturas cominutivas; Implantes dentários; Reconstrução mandibular.

Resumen

Las fracturas conminutas de la mandíbula representan un desafío clínico. El avance de las técnicas y materiales de fijación ha contribuido a que el cirujano proporcione un tratamiento más rápido y menos complicaciones. Aun así, los casos que presentan una severa fragmentación mandibular requieren terapias adicionales, como el uso de injertos óseos e implantes dentales, para recuperar la función, estética y anatomía de la mandíbula. Este estudio tiene como objetivo reportar un caso de fractura conminuta del cuerpo mandibular, que fue tratado con reconstrucción, inicialmente mediante fijación interna rígida y, posteriormente, mediante injerto de cresta ilíaca y rehabilitación oral implantosoportada. Aunque los estudios en la literatura demuestran que los injertos autógenos muestran una reabsorción significativa, todavía se consideran el estándar de oro y permiten una base ideal para obtener la osteointegración de los implantes dentales. Concluimos de esta manera que el uso de injerto óseo autógeno de cresta ilíaca y la rehabilitación con implantes puede ser una opción satisfactoria para la reparación funcional y estética de pacientes que presentaron fracturas de alto impacto y desarrollaron importantes defectos óseos.

Palabras clave: Injerto autógeno; Fracturas conminutas; Implantes dentales; Reconstrucción mandibular.

1. Introduction

Situations that produce a high-energy impact, as seen in traffic accidents and firearm shots, can generate sufficient concentrated force to cause mandibular comminution. This type of injury is defined by the presence of multiple fracture lines, resulting in several fragments within the same area (Finn et al., 1996; Lee et al., 2014). Treatment represents a major challenge, due to the serious injuries associated with this type of fracture and the lack of consensus on the most appropriate treatment method (Abreu et al., 2009). The surgeon should aim to restore the jaw function and anatomy, in addition to the patient's aesthetic appearance (Ellis et al., 2003), which is often achieved through open reduction and rigid internal fixation (Kazanjian & Converse, 1959).

Comminuted mandible fractures usually result in tissue defects, as many bone fragments are lost. There are some alternatives for the bone contour recovery, among them, the autogenous graft, which is considered as the gold standard (Cunha et al., 2018; Sakkas et al., 2017). The iliac bone, when collected, can be shaped to fit most mandibular defects, and because of its natural shape and abundance, it has become a popular replacement for the

mandible (Kumar et al., 2015). However, its removal has some disadvantages, such as the morbidities caused in the donor region (Sakkas et al., 2017; Maiorana et al., 2019).

Another relevant criterion is the need for rehabilitation of fractured areas where tooth loss has occurred. The survival rate of osseointegrated implants installed on the grafted area is described as lower compared to native areas (Souza et al., 2019). However, it proved to be an excellent base for implantation due to its adequate height and thickness (Kumar et al., 2015). In this context, this article aims to report a clinical case of a patient victim of a motorcycle accident, diagnosed with a comminuted fracture of the mandibular body, which required the bone defect reconstruction with iliac graft, and allowed a successful implant-supported oral rehabilitation.

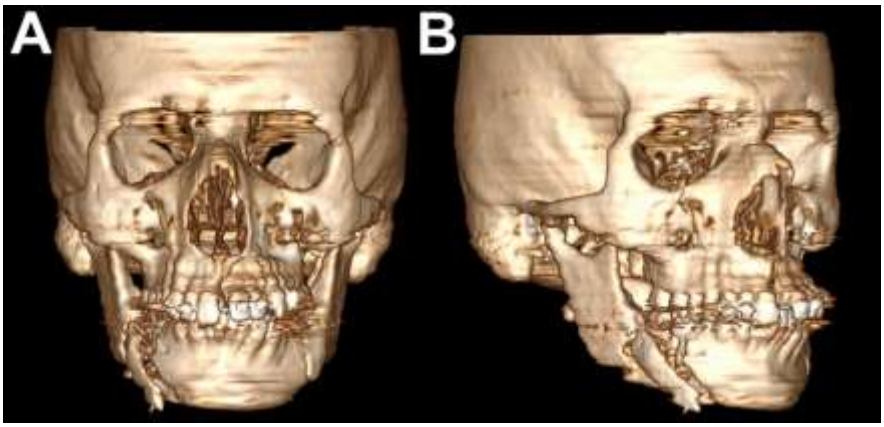
2. Methods

This article consists of a descriptive case study. The work was not submitted to the ethics and research committee, as it is a case report, whose procedure to be performed was not experimental. The patient has a signature on the free and informed consent form about the surgical procedures performed during the treatment and regarding the use of images.

2.1. Case report

A 19-year-old male patient was seen in the hospital emergency room for having suffered a motorcycle accident. After performing physical and imaging exams, the patient was diagnosed with bilateral mandibular body fracture (Figure 1), in addition to other facial fractures, such as: parasagittal palate fracture; bilateral orbital zygomatic complex fracture, and dentoalveolar fracture of teeth 21 and 22. The mandibular body fracture on the right side had multiple exposed bone fragments in the submandibular region. In the initial care, under local anesthesia, sutures of the wounds, semi-rigid splint of teeth 21 and 22 and installation of Erich bar were performed.

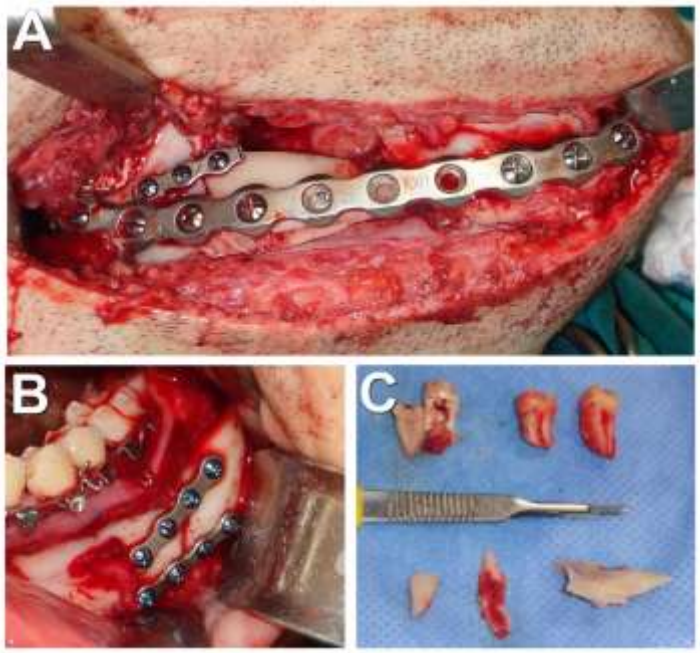
Figure 1 - Preoperative computed tomography images in three-dimensional reconstruction. **A)** Front view; **B)** Right side view.



Source: The authors.

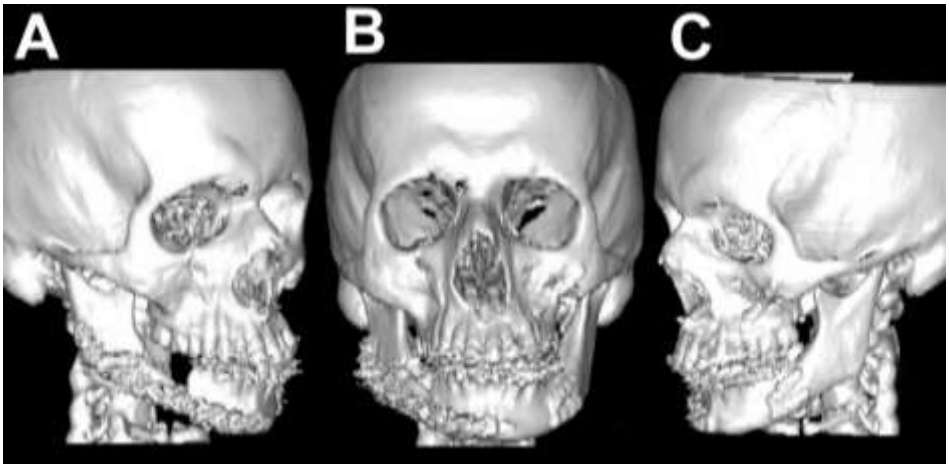
In a surgical approach under general anesthesia, the fixation of the left mandibular body was performed with 2.0 system mini plates through an intraoral access. The mandibular fracture on the right side, due to severe comminution with loss of tissue and teeth, was fixed with a 2.0 system plate in the tension zone and a 2.4 system locking type plate in the compression zone (Figures 2 and 3). The right mandibular region was accessed by an extra oral approach, taking advantage of the existing wound in the area.

Figure 2 - Transoperative photographs. **A)** Right mandibular body fracture fixation; **B)** Left mandibular body fracture fixation; **(C)** Bone fragments and teeth removed.



Source: The authors.

Figure 3 - Postoperative computed tomography images in three-dimensional reconstruction. **A)** Right side view; **B)** Front view; **C)** Left side view.



Source: The authors.

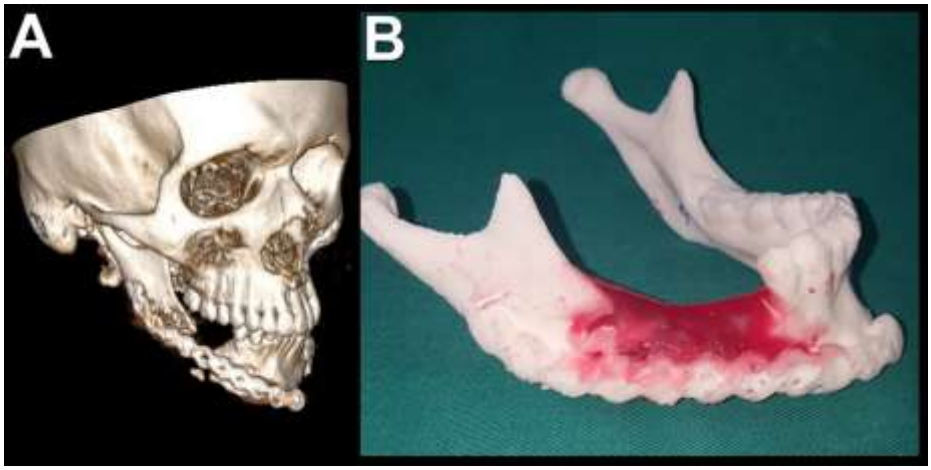
The patient was instructed to maintain a soft diet for 60 days and was followed up on an outpatient basis. In the 63-day postoperative period, a 26 mm mouth opening, healed wounds and absence of infection were noted (Figure 4).

Figure 4 - Photographs in the 63-day postoperative period. **A)** Occlusion in frontal view; **B)** Maximum mouth opening; **C)** Mandibular projection.

Source: The authors.

After one year of follow-up, no signs of infection, bone necrosis and non-union were observed. From this, planning began to reconstruct the right mandibular body for oral rehabilitation. Surgical planning was performed with the aid of a computed tomography, and included a jaw prototyping (Figure 5). With that, it was possible to mold the new plate that would be installed, as well as to have a forecast of the size of the gap generated to reconstruct the area with autogenous bone graft, collected from the iliac crest.

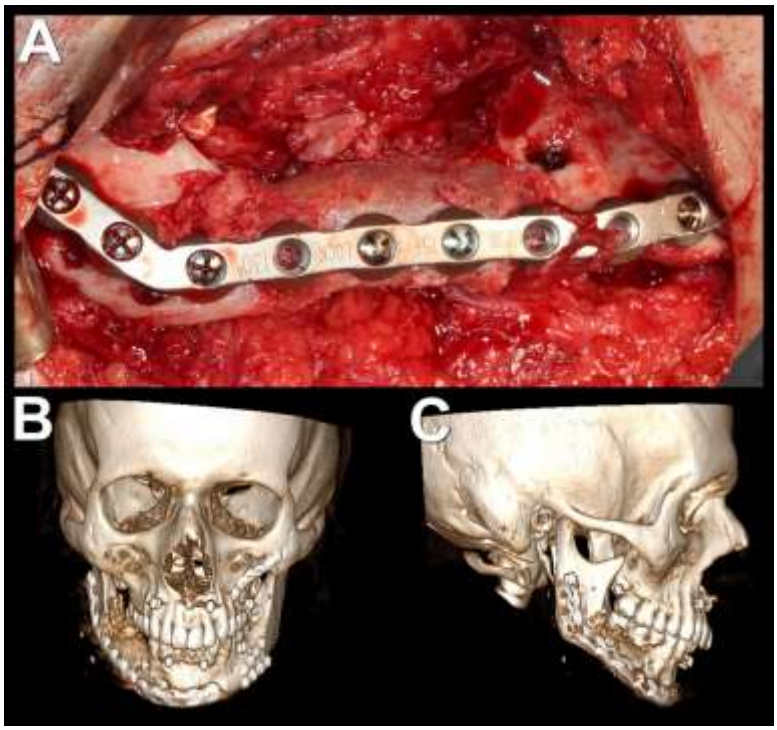
Figure 5 - One year postoperative. A) Three-dimensional reconstruction of computed tomography; (B) Prototyping with the defect region reconstructed.



Source: The authors.

In order to reconstruct the area affected by the trauma, a second surgical approach was performed in a hospital setting. The procedure was performed through a right submandibular access, and the old plates and screws were removed for the installation of the new 2.4 locking system reconstruction plate, previously molded in the prototyping. With the new plate in position, the gap was filled with the autogenous bone graft collected from the iliac crest, measuring 35mm in length, which after being modeled was fixed on the plate. The particulate bone tissue collected from the donor site was positioned over the remaining spaces between the grafted bone block and the mandibular segments (Figure 6), being subsequently protected by a collagen membrane.

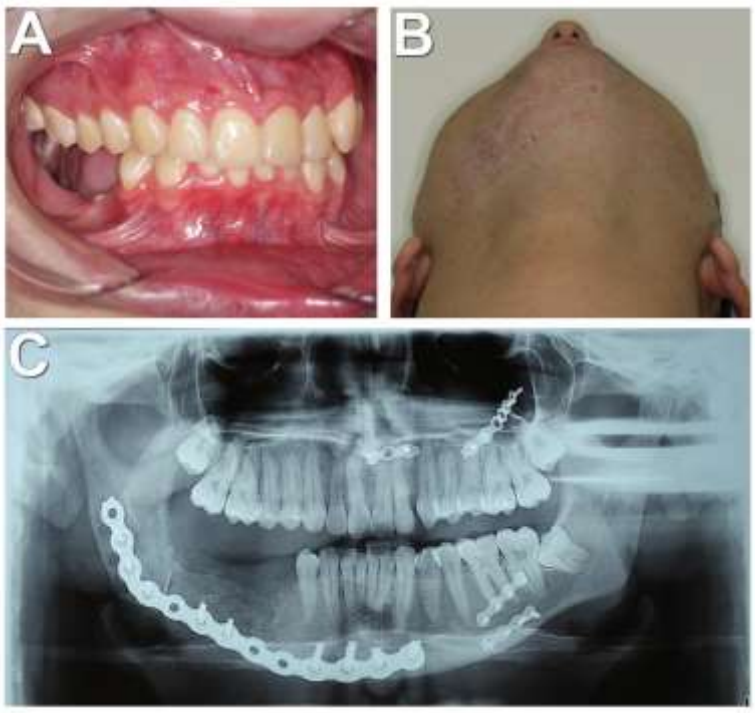
Figure 6 - Mandibular reconstruction by iliac crest graft. **(A)** Transoperative image of the plate and graft in position; **(B)** Three-dimensional reconstructions of the immediate postoperative computed tomography, in frontal view and **(C)** right lateral view.



Source: The authors.

The patient was followed up on an outpatient basis, and after six months of reconstruction, he had good healing, intact gingival soft tissue and no bone exposure. On radiographic examination, he presented an image suggestive of graft incorporation in the area, with no signs of resorption, good bone height and recovery of the mandibular contour (Figure 7).

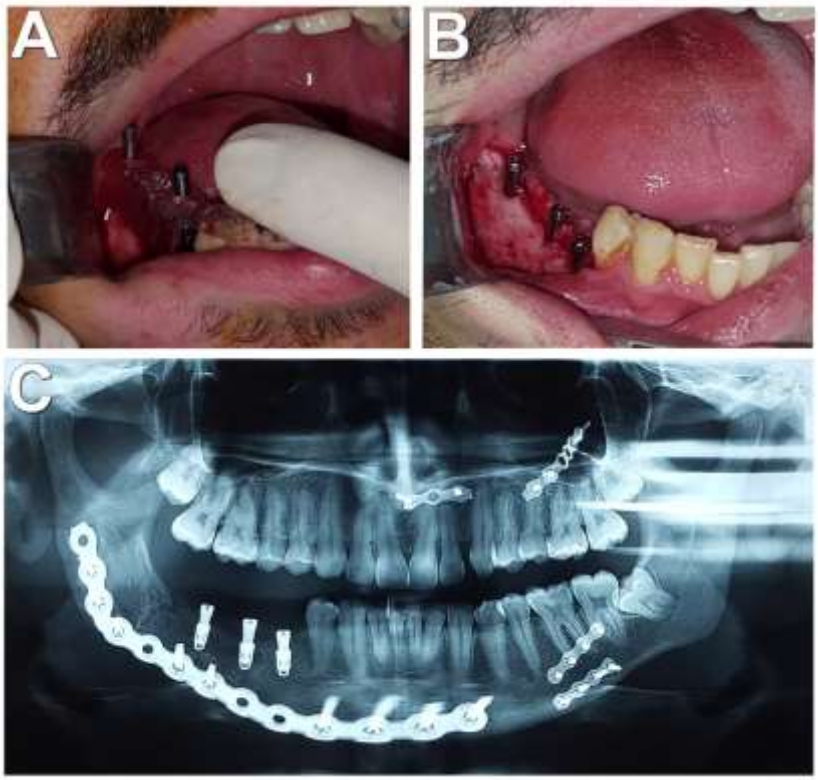
Figure 7 - 06 months postoperative follow-up after bone grafting. **(A)** Intraoral photograph of occlusion in right side view; **(B)** Mandibular projection; **(C)** Panoramic radiography.



Source: The authors.

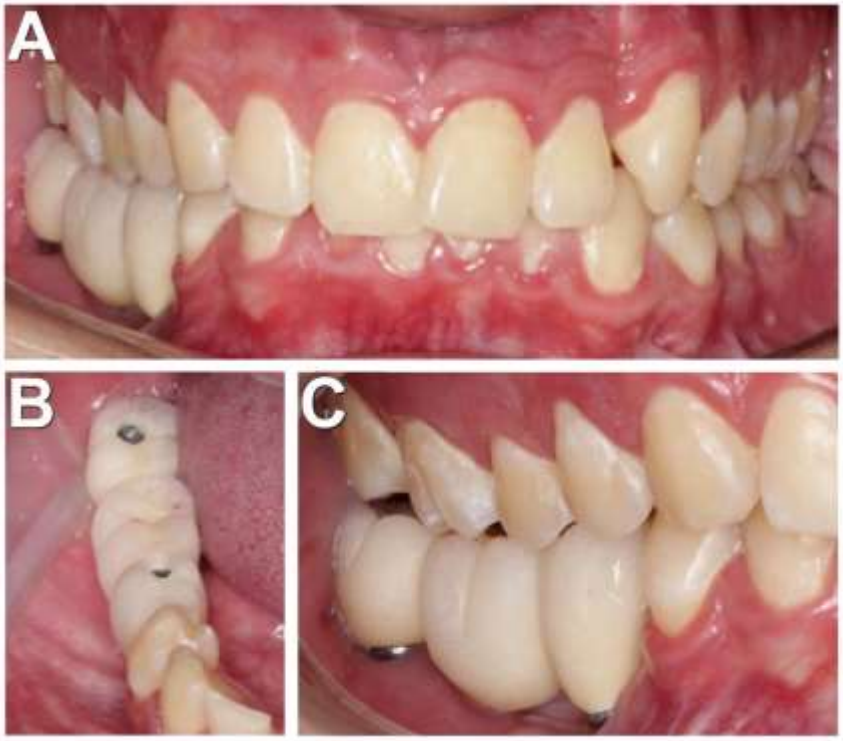
Aiming the improvement of occlusion, chewing and ensuring the maintenance of bone graft, planning for the installation of prostheses on implants in the region was initiated. Thinking of a reverse planning, a Cone Beam computed tomography and impression of the region were performed to make the diagnostic wax-up and the surgical guide. In the next step, three Bone Level implants (Straumann®) were installed in the region of teeth 45, 46 and 47 (Figure 8). After the six-month period for implant osseointegration, the patient returned with unsatisfactory oral hygiene. The implant in the 46 region was removed because it did not have osseointegrated, and the supported prostheses were made in the 45 and 47 teeth area. The patient was instructed throughout the period regarding local care and hygiene and is being followed up for three years, presenting peri-implant health and stability of bone grafts clinically (Figure 9) and radiographically.

Figure 8 - Transoperative images of dental implant installation. **A)** Surgical guide and parallelometers in position; **B)** Implants installed; **(C)** Panoramic radiography in immediate postoperative period.



Source: The authors.

Figure 9 - Follow-up after three years of bone grafting, showing implant-supported prostheses in position. **A)** Intraoral photographs of occlusion in frontal view; **(B)** Photograph in occlusal view; **(C)** Image of occlusion in the right side view.



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3. Discussion

The use of rigid internal fixation does not stimulate the formation of bone calluses, as there is no micro movement between the fragments (Alpert et al., 2009). Thus, bone defects generated after open reduction, as shown in Figures 2 and 3, require the use of resources to fill this space, such as the placement of grafts. The material of choice is cancellous autogenous bone, due to its fast revascularization, resistance to infections (Alpert et al., 2009), efficiency in reconstructing the anatomy and aesthetics of the jaw, and providing mechanical support for implant placement (Kumar et al., 2015; Jain and Baliga, 2015). If the soft tissue in the affected region is sufficient to close the wound and is free of infection, grafting can be performed in the initial intervention (Alpert et al., 2009). However, if there is inadequate coverage of the wound or possible necrosis of the region, the defect must be grafted to another stage, as in the reported case, in which the difficulty of total graft coverage and risk of contamination were considerable.

The autogenous graft is considered the gold standard, with a high percentage of success (Sakkas et al., 2017). This is due to its high osteoinductive and osteogenic potential (Souza et al., 2019). Extra oral sources are the most indicated when large amounts are needed, and the indicated donor sites are calvaria, iliac crest, tibia and fibula (Cunha et al., 2018). The iliac crest graft is preferable for large volume reconstructions. Restorations of defects of up to five centimeters can use grafts removed from the anterior iliac crest, which allows a collection of approximately 5 cm^3 (Miloro et al., 2016). In addition, as it allowed for simultaneous collection surgery, it was even more favorable. This graft consists of spongy and dense bone with a thin cortex, which allows the implant osseointegration (Sonmez et al., 2013). However, the choice of the iliac graft has some disadvantages, including the patient's difficulty in walking in the postoperative period, the risk of infection, pain, wound dehiscence and bone fracture. (Maiorana et al., 2019; Sakkas et al., 2017; Hof et al., 2014). In addition, large free bone grafts, as in our case, present an imminent risk of failure due to the lack of local vascularization. Thus, therapies that promote an improvement in vascularization and bone oxygenation are considered allies for the treatment success (Grassmann et al., 2015). Hyperbaric oxygenation therapy is a widely used example, which by providing the patient with high doses of oxygen at high pressure, induces better healing (Grassmann et al., 2015). The disadvantage of this technique, additionally to the risk of adverse reactions, would be the cost, since as several sessions are necessary; it ends up being unfeasible for patients who do not have financial conditions. In our case, the patient did not have enough salary income to pay for the treatment costs, and so he was unable to make this therapeutic option. Therefore, due to treatment with free bone graft presents advantages and disadvantages, each case must be evaluated individually, weighing the risk / benefit of each technique.

Studies indicate the probability of this type of graft to present significant resorption. (Jensen et al., 2016). And another relevant criterion to be considered is the survival rate of the implants installed on the grafted area. This is because studies indicate that survival in reconstructed areas has a lower percentage than in non-grafted regions (Souza et al., 2019). This information corroborates with the article by Nyström et al. (2004), whose implant survival rate was 50.9% in the grafted areas and 83.1% in the native areas. However, the percentage of survival of these implants has increased gradually over the years, generating a great discussion and production of scientific papers (Souza et al., 2019). The results that can be observed are above 90%, as in the studies by Souza et al. (2019) and Sakkas et al. (2017) which obtained results of 98.60% and 99.60% of implant survival rates in these regions,

respectively. This increase is the result of the evolution and improvement of materials and surgical techniques (Souza et al., 2019).

Understanding the grafts microstructure has also been a determining factor in the success of their incorporation. By making surgeons use blocks donated from medullary regions of the iliac crest, blocks are obtained that have a reduced volume loss and can produce an ideal reconstruction (Souza et al., 2019). Furthermore, in the case described, an autogenous graft maturation time of six months was expected prior to implant installation, which corroborates with Sakkas et al. (2017), which recommends a waiting time between three and six months. Additionally, bone reconstruction associated with guided surgical technique has been recommended, as it presents a lower risk of causing damage to anatomical structures, allowing fewer angulations of dental implants (Cunha et al., 2018). The correct inclination reduces the risk of failures in osseointegration and also reduces the excessive compressive forces against the bone structure (Anand et al., 2013). In our case, the patient presented adequate osseointegration in two installed implants, however, failure in the third. This failure in osseointegration can have several reasons, ranging from low survival on bone grafts, as well as the lack of local hygiene.

4. Final Consideration

Considering the satisfactory result of this case, we suggest that open reduction, rigid fixation with bone reconstruction using the autogenous graft from the iliac crest may be an adequate option for recovering the contour and bone volume. In addition, it allows aesthetic and functional rehabilitation with predictable results, through implant-supported prostheses. However, factors related to the technique (such as graft size, surgical access and use of auxiliary therapies, such as hyperbaric oxygenation), and related to the patient (such as thickness and amount of alveolar mucosa for coverage, functional masticatory retraction and adequate oral hygiene) are important factors to consider before choosing the treatment

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