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Case Report

Mandibular Reconstruction with a Free Rib Graft: Case Report and Literature Review

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Abstract: The reconstruction of mandibular defects is essential to restore facial function and aesthetics in patients undergoing mandibular resections, a treatment indicated in approximately 41.8% of ameloblastoma cases. This study presents a secondary approach to partial mandibular reconstruction using a rib bone graft in the left mandibular body region of an adult female patient who underwent surgical resection of an ameloblastoma in 2019. Ten months postoperatively, the patient has shown reasonable maintenance of bone graft volume. The rib graft proved to be a viable surgical technique for mandibular reconstructions in centers lacking specialized teams for harvesting from other donor sites, as evidenced by this case and cited literature.

Keywords: Mandibular reconstruction; Autologous graft; Ameloblastoma.

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1. Introduction

The evolution of mandibular reconstruction reflects a continuous pursuit of improved techniques and outcomes. The first documented autogenous graft, performed in 1821 by Von Walther, laid the groundwork for future advancements in the field of bone grafting. Conversely, the discovery of anesthetics and antibiotics, along with sterilization techniques, improved surgical success rates. Subsequent efforts focused on free non-vascularized grafts from distant sites, such as the tibia and iliac crest, fixed with titanium metal plates. In 1950, Converse documented the use of multiple grafts for maxillary and mandibular defects, but complications arose due to radiotherapy, which increased the risk of infection and graft resorption [1].

The main etiological factors of mandibular defects include tumor resection, such as ameloblastoma, maxillofacial trauma, infections like osteomyelitis, and osteoradionecrosis. The treatment of these conditions can result in bone defects that affect masticatory function, speech, and facial aesthetics, requiring specialized treatments to restore both the form and function of the mandible [2]. The primary treatment for ameloblastoma is surgical and can be classified into conservative and radical methods. Approximately 41.59% of these tumors are treated with radical approaches, presenting an 8% recurrence rate, while the conservative approach has a recurrence rate of 41%. Although radical resection is superior to the conservative approach in preventing recurrences, it usually causes severe sequelae due to the extensive resection of pathological bone tissue. On the other hand, bone reconstructions reduce postoperative morbidity and provide improvements in the patient's quality of life [3,4].

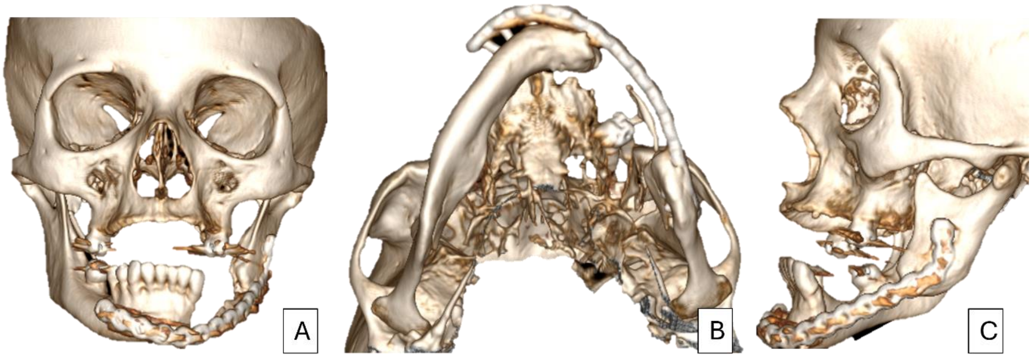
The most commonly used donor sites for this purpose are the iliac crest (76.1%), followed by the ribs (16.2%) and the fibula (5.6%) [5]. Although iliac crest grafts are widely used, in facilities where professionals with experience in this type of harvesting are not available, rib graft rehabilitation can be chosen. This method is simple, quick, and yields excellent results [5,6]. Bone reconstruction associated with meticulous surgical planning and technique elevates the patient's favorable prognosis. Thus, the importance of surgical methods that focus not only on the excision of pathological tissue but also on the maintenance of functionality and aesthetics is highlighted [7].

Given this, the objective of this study is to report the case of a patient who underwent mandibular bone reconstruction with an autogenous rib bone graft and discuss the feasibility of this technique in facilities where specialized teams for harvesting from other donor sites are not available.

2. Case Report

A 44-year-old female patient presented to the Oral and Maxillofacial Surgery Department at José Martiniano de Alencar Hospital and Maternity (Fortaleza, Ceará) with a history of segmental resection of an ameloblastoma in the mandible in 2019 and immediate placement of a 2.4 mm plate without bone reconstruction. Clinically, significant mobility was noted in the left mandibular body region, associated with pain. Computed tomography (CT) revealed a bone defect of approximately 5 cm, as well as displacement of the reconstruction plate from the distal bone stump, likely induced by local muscle activity (Figure 1). No signs of tumor recurrence were observed on the CT scan.

Figure 1. Three-dimensional reconstruction of preoperative CT. Frontal view (A), right view (B), left view (C), showing a bone defect in the left mandibular body region and anterior displacement of the bone fixation material.



The surgical planning consisted of performing mandibular reconstruction with a rib graft and fixation using a 2.4 mm "Locking" system plate. To facilitate the molding of the reconstruction plate, prototyping was performed based on the patient's CT scan to optimize planning and reduce surgical time. Three prototypes were created: the first was an exact reproduction of the mandible with the bone defect, the second was a mirrored image of the contralateral (healthy) mandible, using the mirroring feature of MeshMixer® software (Version 3.5.0, Autodesk) (Figure 2), and the third corresponded to the graft, serving as a guide for both graft cutting and plate fixation and modeling.

A bone segment from the 6th left costal arch was harvested by the General Surgery team (Figure 3). During the procedure, a pleural injury was observed and sutured without further complications.

Figure 2. A and B. Virtual planning images for the creation of the mirrored prototype.

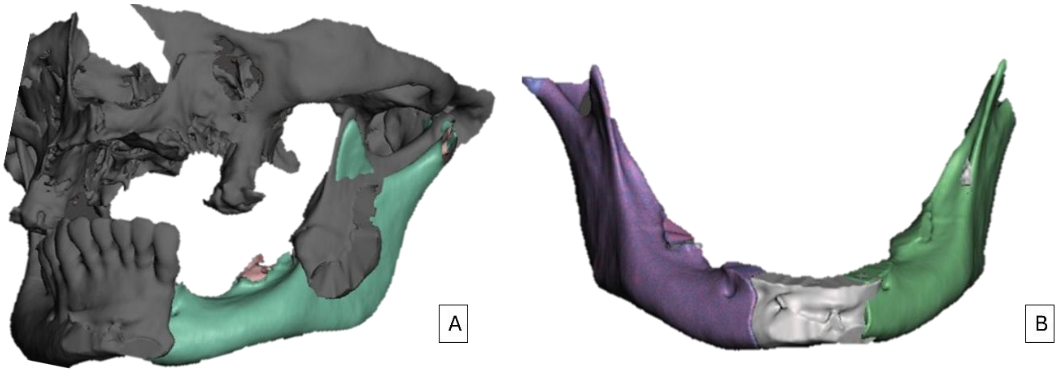
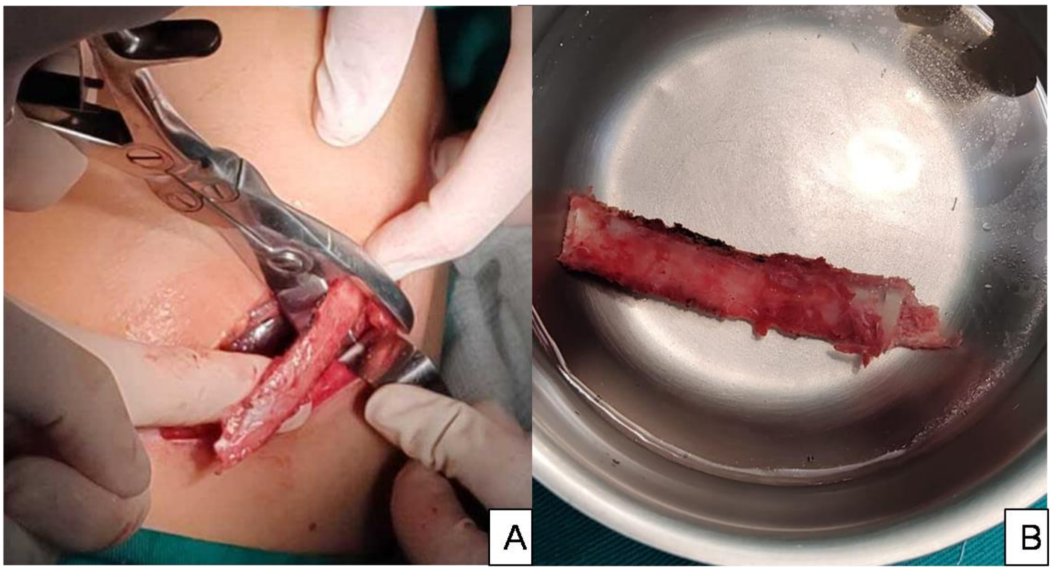


Figure 3. Rib Graft Harvesting. A. Removal of the 6th costal arch by the General Surgery team. B. Harvested rib bone segment.



After maxillomandibular fixation, the 2.4 mm system plate was installed along with the graft prototype, which served as a guide for the final position of the reconstruction plate (Figure 4). The rib graft was then prepared with some perforations in its lateral and cortical areas and divided according to the dimensions of the prototype. The two halves were overlaid to increase thickness and subsequently fixed to the plate. Layered suturing was performed to prevent the formation of dead space.

In the immediate postoperative (PO) period, a chest X-ray showed no signs suggestive of pneumothorax. At 15 days PO, left mandibular branch paresis of the facial nerve was observed, but there were no other complications, such as dehiscence or infection of the surgical sites. The patient has been under follow-up for 10 months PO, with complete recovery of VII cranial nerve function, as well as maintenance of facial aesthetics and masticatory function.

At the CT scan performed during this period, the rib graft showed good radiological integration, defined in this case as a continuous homogeneous area between the native bone and the graft. Areas of resorption and remodeling were concentrated in the central portion of the graft. The remaining volume of the grafted area was 12.4 mm in height, 9.24 mm in the anterior portion, and 5.03 mm in the posterior portion in width. The smallest width, 4.52 mm, was measured in the central portion of the graft. Although almost all of the lingual segments of the graft had resorbed, CT reconstructions showed satisfactory bone volume and maintenance of facial contour (Figure 5).

Figure 4. Intraoperative view. A. Fixation of the pre-molded plate and rib biomodel in the patient. B. Positioning of the graft in the surgical site with satisfactory adaptation to the bone defect.

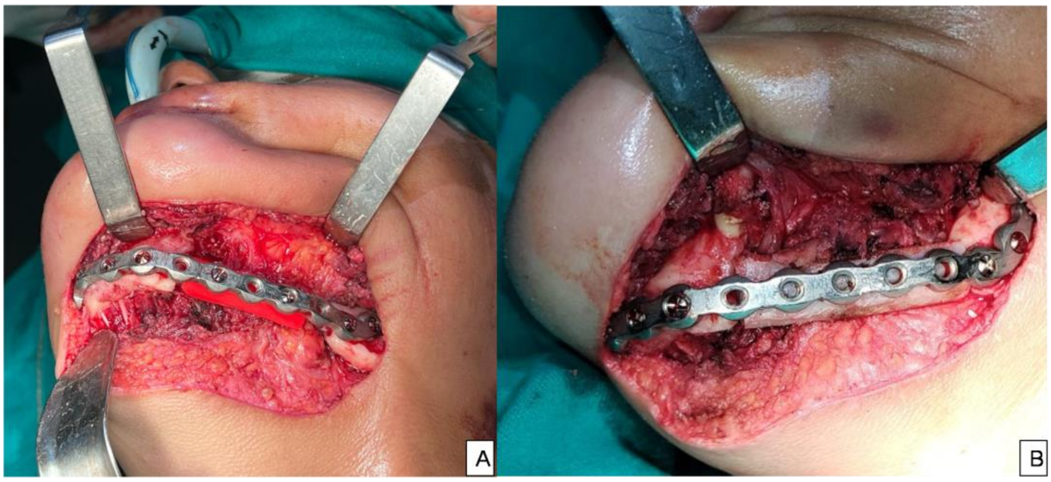
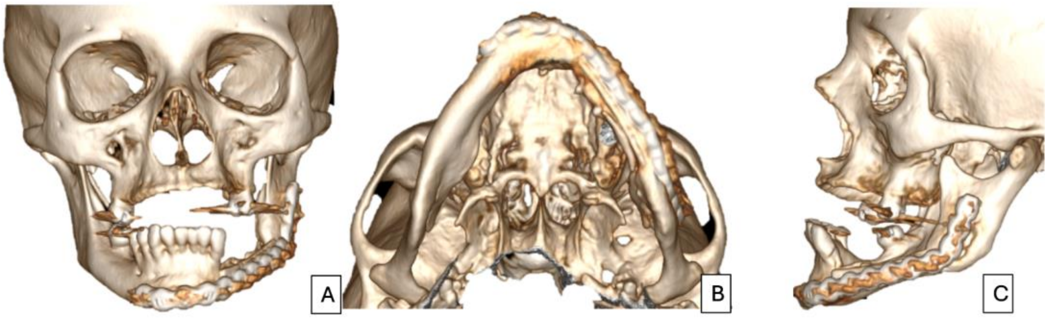


Figure 5. A, B, and C. 3D reconstruction of the postoperative CT scan at nine months, showing maintenance of bone volume and contour.



3. Discussion and conclusion

The graft provides the necessary structural and aesthetic support for the patient's recovery and allows for future dental rehabilitations. For defects larger than 6–7 cm and in complex clinical situations, such as recipient sites with compromised blood perfusion, vascularized grafts are preferred due to their greater survival rates and osseointegration [5]. In the present case, the defect size was less than 6 cm, making the choice of a free rib graft an appropriate treatment option.

Iliac crest grafts are known to provide good aesthetic results, with satisfactory bone contour and volume. Their quality is evidenced by the amount of marrow and cortical bone, and the curvature similarity to the mandible makes it the donor site preferred by many authors. However, it has the disadvantage of significant donor site morbidity [5]. In the reported case, the patient did not experience any discomfort, pain, or respiratory difficulties in the donor site region postoperatively. This advantage arises because costochondral graft harvesting results in substantially less morbidity compared to iliac crest harvesting [8].

The fibula, on the other hand, is widely used due to its strength, length, and tubular structure, which contribute to greater resistance to resorption because of the graft's robustness. However, these grafts have reduced height and risks of sequelae such as difficulties in the extension and flexion of the first toe [9]. The main indications for free rib graft reconstruction are defects in the mandibular angle and ramus regions, as they adapt well to these recipient sites. Additionally, transferring cartilage tissue, as in costochondral grafts, is beneficial for reconstructing the temporomandibular joint (TMJ) in children, considering the graft's growth potential in developing patients [5,6,10]. In the reported case, cartilage harvesting was not performed since TMJ reconstruction was unnecessary.

Facial aesthetics is an important consideration. In this regard, rib grafts provide satisfactory results as their anatomy supports shape and symmetry, requiring minimal adjustments and refinements for adaptation to the bone defect [6]. Beyond aesthetic recovery, the choice of the donor area should also be based on the patient's specific needs and the characteristics of the defect to be reconstructed, aiming to optimize results [2,11]. The donor site was chosen due to the lack of professionals with technical training and experience in harvesting iliac crest and fibula grafts. Additionally, the choice of a rib graft was influenced by the need for a graft that would provide appropriate size and shape for mandibular body reconstruction, as the anatomy of the rib graft is compatible with this requirement.

A 2013 study evaluated 50 patients undergoing extensive mandibular tumor resections followed by reconstructions using rib grafts. Success rates were analyzed in terms of shape, function, symmetry, and aesthetics, showing that 90% of patients achieved good to excellent results. The authors concluded that in centers with limited specialists proficient in specific surgical techniques for graft harvesting, rib graft reconstruction is a suitable alternative due to ease of collection and reduced surgical time [6].

The limited amount of bone marrow in these grafts may compromise vascularization, increasing the risk of resorption [5,10]. However, resorption does not appear to be a significant issue when using split grafts. Ahmad and Shady [6] evaluated 320 patients with lateral mandibular defects without condylar removal reconstructed with free split rib grafts and observed 10 cases of graft resorption. Other complications included infection, graft exposure, resorption, failure of bone integration, donor site morbidity, seroma, visible or hypertrophic donor site scars, and pleural injuries. The most frequent complication was infection, reported in 42 patients (7%), associated with intraoral wound dehiscence and total graft loss [6]. The patient in the reported case developed VII cranial nerve paralysis but had no other complications such as infection, dehiscence, or graft integration failure. Despite partial graft resorption, satisfactory bone volume and contour were observed on CT after 10 months of follow-up.

Costochondral graft harvesting is associated with risks of pleural injury or, more rarely, pneumothorax [6]. In a study involving 17 patients who underwent free rib graft procedures, three patients experienced pleural rupture during harvesting, which was repaired intraoperatively with sutures without the need for chest drain placement. Judd et al. recommend performing chest X-rays in all cases of rib graft harvesting, even when no intraoperative injuries are identified [12]. The practices in the mentioned studies align with the reported case, where a pleural injury was repaired intraoperatively. The absence of pneumothorax or additional complications was confirmed intraoperatively and in postoperative chest X-rays.

Marechek et al. [13] defined success criteria as radiographic evidence of bone continuity and stability for a minimum of four months post-surgery, along with complete healing of surgical wounds. In our case, the patient has been followed up for 10 months postoperatively and meets the success parameters outlined by the authors [13]. Meville et al. [14], on the other hand, established success criteria that include bone integration characterized by a homogeneous radiopaque pattern continuous between native bone and the graft, absence of mandibular mobility, and adequate grafted bone volume. CT scans were performed six months post-surgery, and descriptive statistics were computed for each variable. Among 30 patients with mandibular continuity defects, 27 were successful, with an average height gain of 2.12 ± 0.64 cm and width gain of 1.53 ± 0.46 cm [14]. Ahmad and Shady [6] argued that bone continuity restoration alone cannot be considered a success criterion. For the authors, functional aspects such as articulation, speech, mastication, and swallowing must also be considered [6]. In our case, homogeneous radiopacity between native bone and the graft was observed. The bone volume obtained was 1.24 cm in height, 0.924 cm, and 0.503 cm in the most anterior and posterior portions of the graft, respectively. The smallest width measured was 0.452 cm in the central portion of the graft.

The rib graft demonstrated, in this case and through the cited literature, its feasibility in mandibular reconstructions by providing bone support for masticatory function and aesthetics, as well as allowing for future dental rehabilitations. This case highlights the success of this technique and its ease of execution in centers without specialized teams for harvesting from other donor sites.

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Research Ethics Committee Approval: We declare that the patient approved the study by signing an informed consent form and the study followed the ethical guidelines established by the Declaration of Helsinki.

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Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Hjørting-Hansen E. Bone grafting to the jaws with special reference to reconstructive preprosthetic surgery. A historical review. Mund Kiefer Gesichtschir. 2002 Jan;6(1):6-14. doi: 10.1007/s10006-001-0343-6. PMID: 11974547.
2. Wong RC, Tideman H, Kin L, Merkx MA. Biomechanics of mandibular reconstruction: a review. Int J Oral Maxillofac Surg [Internet]. Abr 2010 [citado 15 nov 2024];39(4):313-9. Disponível em: https://doi.org/10.1016/j.ijom.2009.11.003.
3. Siar CH, Lau SH, Ng KH. Ameloblastoma of the Jaws: A Retrospective Analysis of 340 Cases in a Malaysian Population. J Oral Maxillofac Surg [Internet]. Mar 2012 [citado 21 dez 2024];70(3):608-15. Disponível em: https://doi.org/10.1016/j.joms.2011.02.039.
4. Ruslin M, Hendra FN, Vojdani A, Hardjosantoso D, Gazali M, Tajrin A, Wolff J, Forouzanfar T. The Epidemiology, treatment, and complication of ameloblastoma in East-Indonesia: 6 years retrospective study. Med Oral Patol Oral Cir Bucal. 2018 Jan 1;23(1):e54-e58. Doi: 10.4317/medoral.22185. PMID: 29274152; PMCID: PMC5822540.
5. Moura LB, Carvalho PH, Xavier CB, Post LK, Torriani MA, Santagata M, Chagas Júnior OL. Autogenous non-vascularized bone graft in segmental mandibular reconstruction: a systematic review. Int J Oral Maxillofac Surg [Internet]. Nov 2016 [citado 26 nov 2024];45(11):1388-94. Disponível em: https://doi.org/10.1016/j.ijom.2016.05.004.
6. Ahmad I, Choudhary R. Wide Surgical Excision with Split Rib Graft Reconstruction of Mandible for Ameloblastoma; Our 10 Year Experience. Indian J Otolaryngol Head Amp Neck Surg [Internet]. 28 nov 2012 [citado 12 nov 2024];65(1):40-3. Disponível em: https://doi.org/10.1007/s12070-012-0599-1
7. Tahiri Y, Chang CS, Tuin J, Paliga JT, Lowe KM, Taylor JA, Bartlett SP. Costochondral Grafting in Craniofacial Microsomia. Plast Reconstr Surg [Internet]. Fev 2015 [citado 12 nov 2024];135(2):530-41. Disponível em: https://doi.org/10.1097/prs.0000000000000914.
8. Balaji SM. Mandibular cystic defect: A composite approach with rhBMP-2 and rib graft. J Maxillofac Oral Surg [Internet]. Mar 2009 [citado 21 dez 2024];8(1):27-30. Disponível em: https://doi.org/10.1007/s12663-009-0007-x.
9. Ferreira JJ, Zagalo CM, Oliveira ML, Correia AM, Reis AR. Mandible reconstruction: History, state of the art and persistent problems. Prosthet Orthot Int [Internet]. 25 fev 2014 [citado 12 nov 2024];39(3):182-9. Disponível em: https://doi.org/10.1177/0309364613520032.
10. Akbay E, Aydogan F. Reconstruction of isolated mandibular bone defects with non-vascularized corticocancellous bone autograft and graft viability. Auris Nasus Larynx [Internet]. Fev 2014 [citado 26 nov 2024];41(1):56-62. Disponível em: https://doi.org/10.1016/j.anl.2013.07.002.
11. Hamdy O, Raafat S, Saleh GA, Awny S, Shebl AM, Hegazy MA. Recurrent mandibular ameloblastoma in soft tissue and rib graft 17 years after initial presentation. J Egypt National Cancer Inst [Internet]. 6 jan 2020 [citado 12 nov 2024];32(1). Disponível em: https://doi.org/10.1186/s43046-019-0012-1.
12. Judd, Ryan T., et al. "Pedicled Osteomyocutaneous Pectoralis Major Flap with Osseous Rib Harvest for Salvage Mandibular Reconstruction: Case and Technique." Head & Neck, vol. 46, no. 2, 5 Dec. 2023, pp. 447–451, https://doi.org/10.1002/hed.27586. Accessed 1 Jan. 2025.
13. Marechek A, AlShare A, Pack S, Demko C, Quereshy FA, Baur D. Nonvascularized Bone Grafts for Reconstruction of Segmental Mandibular Defects: Is Length of Graft a Factor of Success? J Oral Maxillofac Surg [Internet]. Dez 2019 [citado 26 dez 2024];77(12):2557-66. Disponível em: https://doi.org/10.1016/j.joms.2019.05.008.
14. Melville JC, Tran HQ, Bhatti AK, Manon V, Young S, Wong ME. Is Reconstruction of Large Mandibular Defects Using Bioengineering Materials Effective? J Oral Maxillofac Surg [Internet]. Abr 2020 [citado 26 dez 2024];78(4):661.e1-661.e29. Disponível em: https://doi.org/10.1016/j.joms.2019.11.024.