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PRE-SURGICAL PLANNING USING Virtual And 3D Printing Model as Guidance for SECONDARY Mandible Reconstruction with Bone Graft: A Case Report

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ABSTRACT

Reconstruction of mandibular defects due to trauma or tumor resection is a significant challenge for surgeons, given the unique and variable shape of the mandible in terms of curvature, length, and height. Numerous techniques have been developed to achieve both aesthetic and functional outcomes. This case report presents a 28-year-old patient with mandibular irregularity following ameloblastoma dissection, which was reconstructed with non-vascularized bone grafts (NBGs) from the left iliac crest approximately 10 years ago. Prior to our procedure, virtual planning and 3D modeling were employed to accurately assess the bone defect. After debridement, a 5 cm defect was identified, and NBGs were harvested from the right iliac crest for reconstruction. NBGs are commonly used for small mandibular defects (<6 cm), non-continuity defects, and benign pathologies, and they can be performed in centers without microsurgical expertise. The use of virtual planning and 3D printing enables the surgical team to thoroughly study the case, anticipate potential issues, and improve precision, resulting in better outcomes and reduced operative time. NBGs, guided by virtual planning and 3D modeling, prove to be an effective technique in reducing surgical time and minimizing the risk of failure during the postoperative recovery period.

Keywords: *Mandible, non-vascularized bone grafts, 3D model, ameloblastoma*

INTRODUCTION

Mandible reconstruction is a challenge due to the complexity of its 3-dimensional structure and its involvement with facial aesthetics and function of the stomatognathic system. Currently, several reconstructive techniques are available, and the individualization of choice for each patient leads to better results and quality of life for the individual(Güngör & Doğan, 2017).

Segmental defects of the mandible secondary to tumour therapy may result from the management of aggressive benign tumours arising within the mandible such as ameloblastoma or myxoma or from malignancies (carcinomas/sarcomas) arising in the associated soft tissue envelope that invade or extend to the mandible(Huotilainen et al., 2014).

Ameloblastoma is a benign epithelial odontogenic tumour that often shows aggressive growth and high recurrence rate following conservative surgical treatment. It is the most controversial tumour of the mandible because a greater diversity of opinion has existed concerning the clinical behaviour, treatment, and malignant potential of this tumour than perhaps any other neoplasms found elsewhere in the body (Ackermann et al., 1988). The tumour has been aptly described by Robinson as a tumour that is usually "unicentric, non-functional, intermittent in growth, anatomically benign, and clinically persistent." Several treatment modalities have been used to eradicate the ameloblastoma. One of those treatment is radical resection of tumour (segmental resection of the mandible) (Atkinson et al., 1984).

In the management of bony defects, autologous bone grafts can be used as the mechanical structure for reconstruction. Both vascularized and non-vascularized techniques are well-accepted treatment strategies for reconstruction of the jaws (Sachs, 2006). Several criteria to help identify the type of bone graft reconstruction that is optimal for mandibular reconstruction. Several criteria to help identify the type of bone graft reconstruction that is optimal for mandibular reconstruction. In cases of shorter defects (<6 cm), non-continuity defects, defects with no soft tissue requirement, and ability for secondary reconstruction, many defects are amenable to reconstruction with non-vascularized bone grafts (NBGs). These procedures are shorter, allow for faster recovery, and better facilitate reconstruction with dental implants (van Gemert et al., 2009). The anterior and/or posterior iliac crest is a commonly used donor site as it offers a large amount of bone and high concentration of osteocompetent cells to be transferred(Carlson & Marx, 1996).

The mandible reconstruction procedure needs a proper preoperative planning to minimize the risk of failure. To accommodate the need for precision preoperative planning, surgeons frequently need guidance such as a 3-dimentional (3D) model to display complex cranial structures (Varga Jr et al., 2013). Using computer imaging software will able to process CT Scan or CBCT Data to be 3D imaging and convert it to be another data format, these kind of format then ready to be printed into 3D model as surgical guidance (Reinbacher et al., 2012). The advance technic in fabrication of 3D object has risen the ability to create an accurate geometrical structure of a replication object that very similar with the original object itself.

METHOD

Case Report

A 28-year-old patient came to the plastic reconstructive and aesthetic surgery outpatient clinic, with a chief complaint of mandible irregularity. History revealed that 10 years ago, she was diagnosed with an Ameloblastoma on her left lateral mandible. She had undergone a mandible reconstruction with her left iliac bone graft within the same year. A few months later, an abscess was found in her left lateral mandible. The debridement and removal of reconstruction plates were done. 4 years ago, the braces were placed into her teeth, and she was referred to our outpatient clinic, by her dentist. The orthopantomogram shows lateral mandible defects with remaining bone graft fragments from the previous procedure. (Figure 1)

Figure 1 Pre-operative orthopantomogram

A mandible reconstruction using bone graft was planned with the help of virtual planning (Figure 2) and patient-specific 3D model (Figure 3) as guidance to get a good measurement of the bone defect and a precise measurement of the right iliac bone crest that will be harvested.

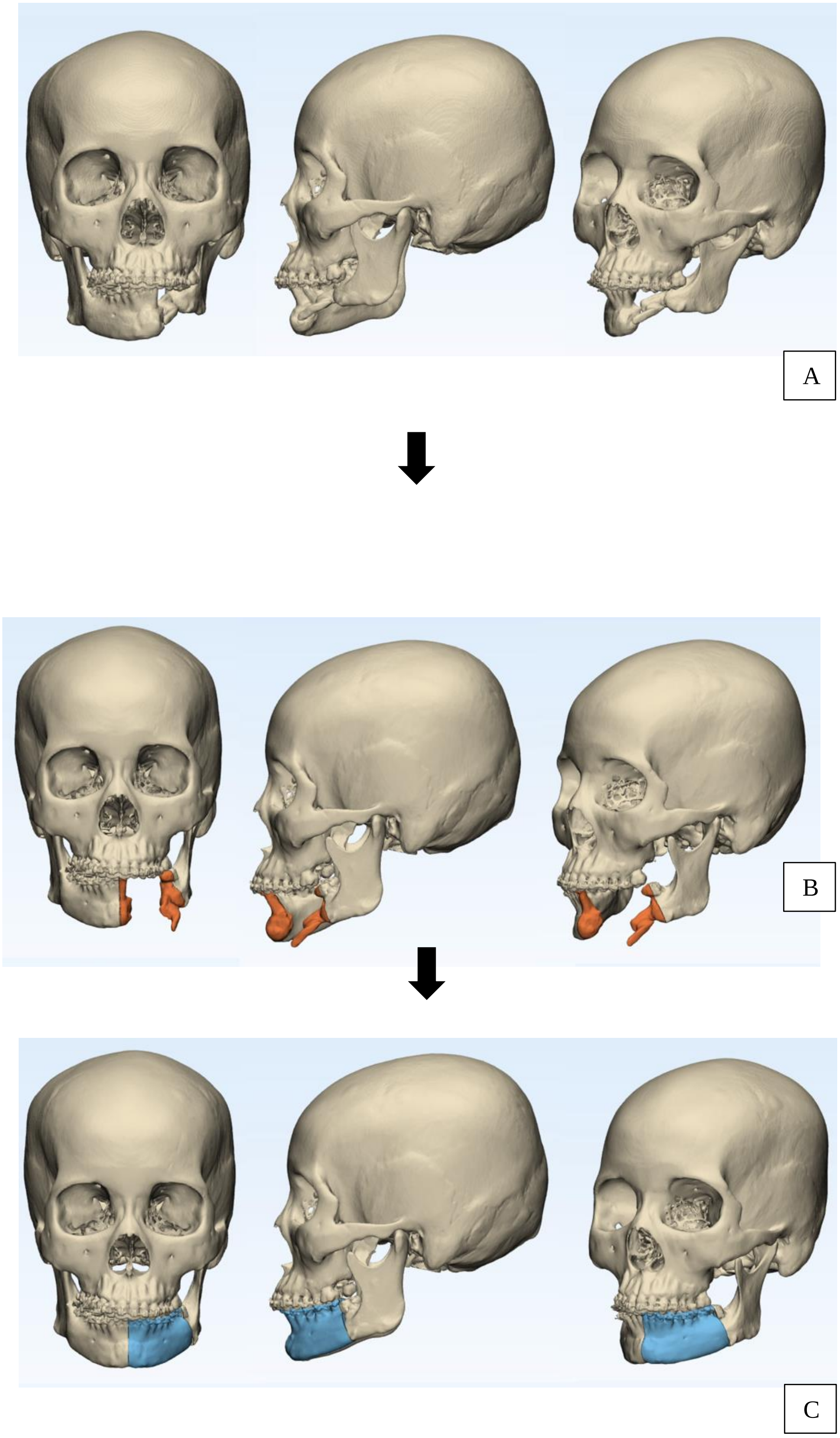

Figure 2 (A) Preoperative 3D reconstruction view. (B) Mandible cutting guides planning (C) Virtual planning for mandible reconstruction with iliac crest.

Figure 3 Patient-specific mandible 3D printing models

A debridement procedure was done by cutting the remaining bone graft from the previous procedure and preserving all the healthy tissue, the final defect was measured approximately 5 cm. Thus we decided to use the non-vascularized bone grafts (NBGs) techniques for the mandible reconstruction using the right iliac crest of the patients. The new bone graft was then fixed to the mandible with four reconstructive plates. (Figure 4)

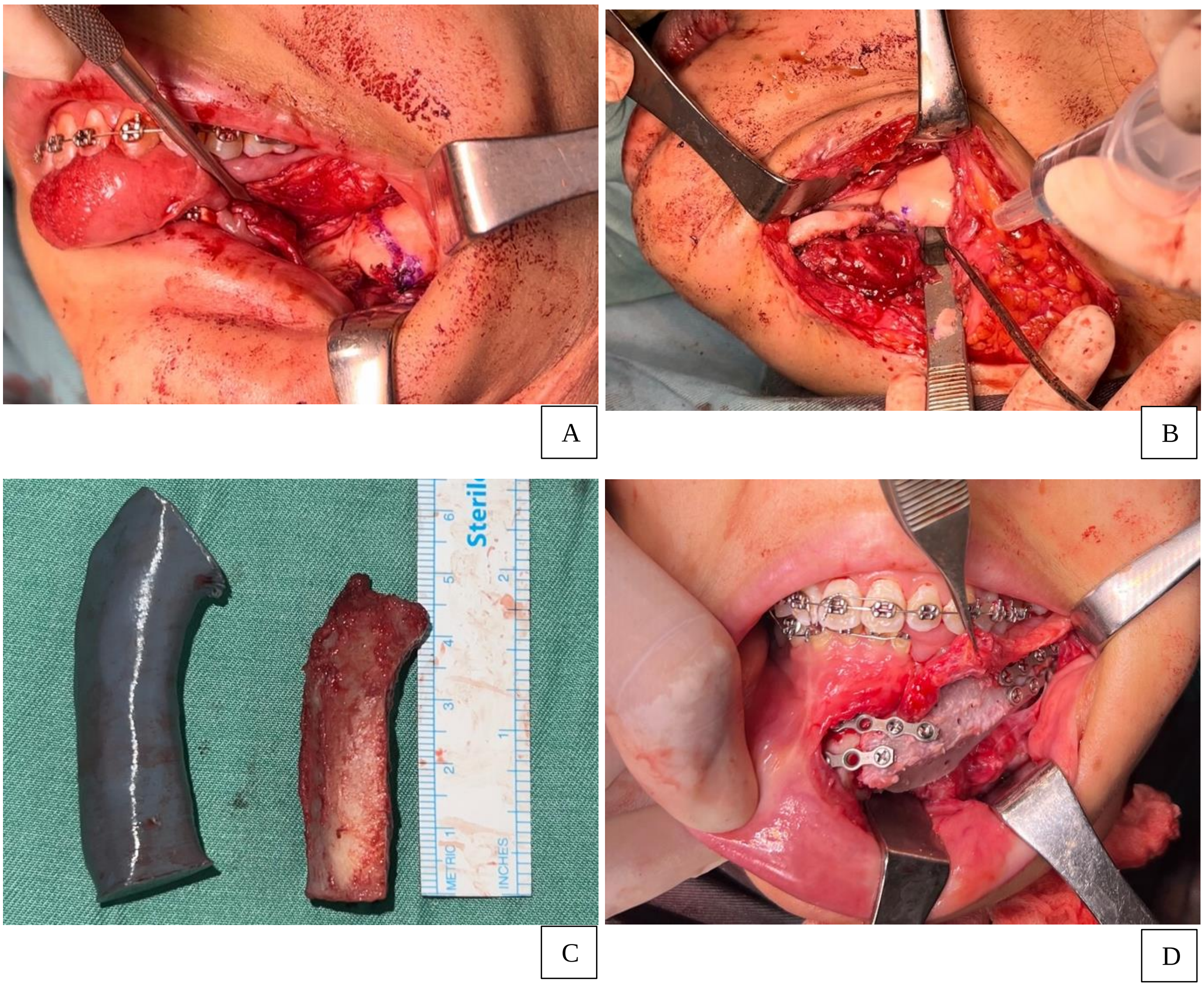

Figure 4 Mandible reconstruction using iliac crest surgery. (A-B) Cutting off the remaining bone graft. (C) Harvested iliac crest bone graft compared with the 3D graft model. (D) Graft fixation with four reconstructive plates.

Postoperatively the symmetry of the mandible and face projection was corrected as shown in the virtual planning (Figure 5)

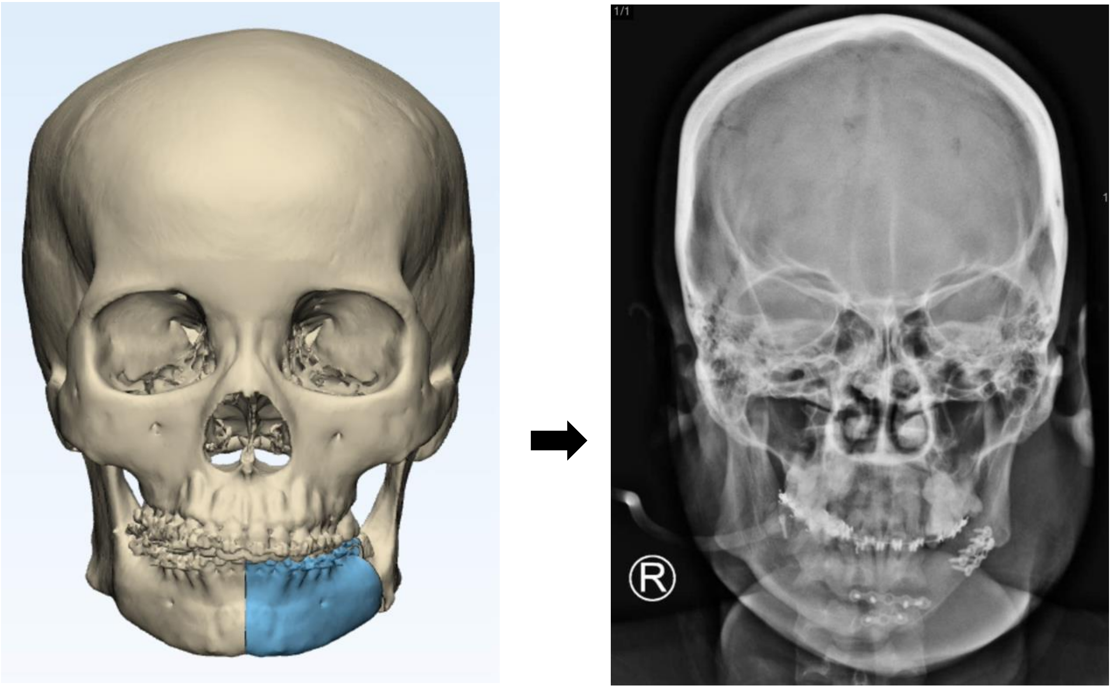

Figure 5 Comparison between virtual planning with the postoperative result.

RESULTS AND DISCUSSION

Discussion

The use of non-vascularized bone grafts (NBGs) in mandibular reconstruction has chosen in some cases, particularly those involving small defects (< 6 cm), non-continuity defects, and defects resulting from benign pathology. [4,5] One of the key advantages of NBGs is their applicability in centers lacking microsurgical expertise, making them accessible in a wider range of clinical settings. However, the complexity of mandibular reconstruction still demands a high degree of precision to achieve optimal functional and aesthetic outcomes.

In this case, virtual surgical planning and 3D printing technology played a crucial role in enhancing the success of the reconstruction. Virtual planning allows for a detailed assessment of the defect and a precise design of the graft, tailored to the unique anatomy of the patient. 3D printing further complements this process by providing a real model of the patient's anatomy, which can be used as a physical guide during surgery (Pogrel et al., 1997). This model help the surgical team in understanding the defect and the required shape and size of the graft, make sure for a more accurate fit. In our case, this approach contributed to the reduction of intraoperative uncertainties and allowed for a more timesaving surgical procedure.

The combination of these technologies not only improves the precision of the reconstruction but also has significant implications for operative time and overall outcomes. By allowing the surgical team to anticipate potential challenges and prevent them, virtual planning and 3D modelling reduce the intraoperative complications and the need for surgical revisions. This is particularly beneficial in centers where surgical expertise may be limited, as it allows for complex procedures to be carried out with greater confidence and success.

Moreover, the use of NBGs in this context aligns with the growing trend towards more conservative and cost-effective approaches to reconstruction, particularly in cases where vascularized grafts may be unnecessary or unavailable . The ability to perform these procedures without the need for advanced microsurgical techniques extends the accessibility of effective mandibular reconstruction to a larger patient population.

CONCLUSION

Non-vascularized bone grafts (NBGs) remain a valuable technique in the reconstruction of mandibular defects, in cases involving small, non-continuity defects and benign pathology. The use of virtual surgical planning and 3D printing models significantly enhances this approach by providing a detailed and precise blueprint for the surgical procedure. In this case, these technologies were beneficial in reducing operative time, minimizing intraoperative uncertainties, and lowering the risk of post-reconstructive complications. The success of this approach highlights the importance of integrating advanced planning tools into reconstructive surgery to improve patient outcomes and efficiency of the complex procedures. As these technologies continue to evolve and become more accessible, their role in mandibular reconstruction is likely to expand, offering new possibilities for precision surgery in wider range of clinical settings.

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