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CASE REPORT

THE IMPACT OF IN-HOUSE SURGICAL GUIDES ON GENIOPLASTY PRECISION

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Abstract

Objective: The aspect, volume, shape, and projection of the chin contribute to a "well-balanced and harmonious" face, and good projection influences psychosocial well-being, playing a fundamental role in facial aesthetics. The aim of this paper is to discuss the importance of using surgical guides in genioplasty.

Case Series: Two patients underwent bimaxillary orthognathic surgery with genioplasty using 3D-printed guides were reported.

Case 1 involved posterior impaction and 2mm advancement genioplasty.

Case 2 addressed chin rotation, posterior impaction, and lowering without advancement. The chin's form and projection contribute to facial harmony.

Conclusion: Computer-assisted surgical simulation allows precise guide creation, making genioplasty safer and minimally invasive. Guides reduce complications and offer cost-effective benefits over traditional methods. Genioplasty with in-house 3D-printed guides shows promise in improving predictability, precision, and safety. Further research on printers, materials, sterilization, and open-access software is needed

Keywords: Genioplasty; Printing, three-dimensional; Surgery, computer-assisted; Orthognathic Surgery; Planning Techniques.

INTRODUCTION

Chin plays a fundamental role in facial aesthetics, with the lower third being an important area, even to an untrained eye. It is one of the facial structures that draws the most attention in facial aesthetics, with an impact on social and personal relationships [1]. Considering an aesthetic evaluation, an imbalance in this area in terms of shape, size, and position contributes to the overall disharmony of the face [2]. Genioplasty is a widely used surgical technique to correct chin deformities. Trauner and Obwegeser were the first surgeons to perform chin advancement osteotomy through an intraoral approach, calling it genioplasty [3]. This technique has been modified by several others to move the chin in all three dimensions of space.

High predictability cutting guides are created through preoperative three-dimensional simulation, primarily aiming to preserve critical areas such as nerves and tooth roots, and allowing for repositioning of the chin to the desired position defined in the virtual planning [4].

Alterations in the lower third of the face are sensitive to the amount of advancement or setback, as well as vertical displacement of the bony segment. Virtual genioplasty planning focuses on the horizontal and vertical movements of the segment, rather than the design of the osteotomy itself. It is important to consider the mentolabial fold in the virtual planning for frontal and vertical displacement of the bony segment, as it has a significant effect on the cephalometric points of the soft tissue portion of the segment.

Correcting chin deformities improves facial balance and harmony, and many patients are unaware that there are ways to correct them through chin augmentation or reduction [3]. Chin aesthetic treatments should consider chin height and width, projection, and shape, and should also take into account the adjacent facial structures. Thus, the aim of this work was to report two clinical cases using virtual planning with 3D-printed cutting guides to perform a genioplasty.

Case Series

This is a retrospective single-center consecutive case series according to the recommendations from the Consensus Preferred Reporting Of CasE Series (PROCESS) guideline [5]. Two young patients were submitted to a bimaxillary orthognathic surgery and genioplasty. Some slight differences in virtual surgical planning were discussed. Both patients were submitted to CT scans, intraoral scanning (iTero), Virtual Surgical Planning through Dolphin Imaging ® 11.91 software. The surgical guides were obtained through 3D printing using an Elegoo Mars 2 Pro Teresina printer and Smart Dent - Smart 3D Print Bio Clear Guide resin. The surgeries were performed according to the simulated planning. Both genioplasties were performed with piezosurgery.

Case 1

A 28-year-old female patient underwent bimaxillary orthognathic surgery with genioplasty. The genioplasty was planned with posterior impaction and 2mm advancement, in addition to a 2mm symmetry correction (fig. 1). The decision to create a surgical guide was made due to the intraoperative challenge of accurately removing this bony slice, which could compromise facial aesthetics if not executed precisely (figs. 2 and 3). In this case, removal of adipose tissue on the muscle surface was necessary.

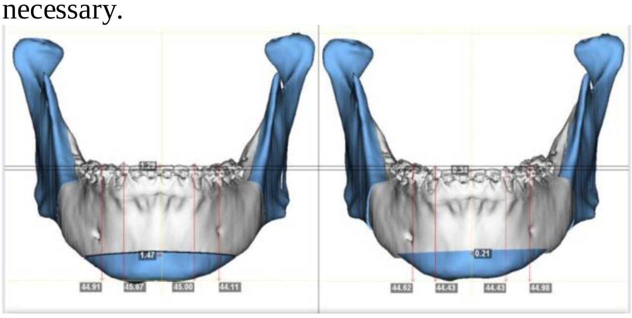

Figure 1. Pre and postoperative Virtual Surgical Planning correcting chin asymmetry.

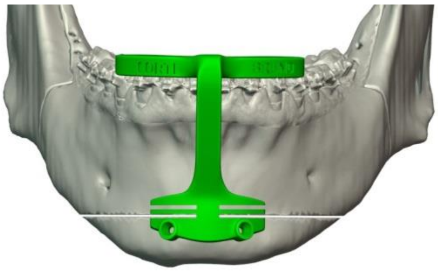

Figure 2.Genioplasty cutting guide.

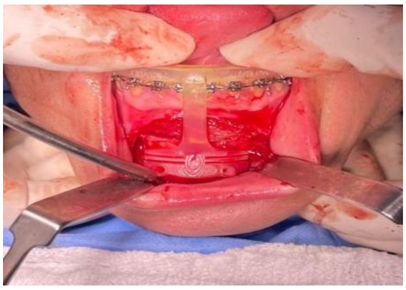

Figure 3. Genioplasty cutting guide.

Case 2

A 24-year-old male patient underwent bimaxillary orthognathic surgery with genioplasty. In this case, there was neither advancement nor setback of the chin. The difficulty in performing the surgery was associated with a clockwise rotation of the chin, a 2mm posterior impaction, and a 3mm advancement of the chin (fig. 4), something quite challenging to execute without surgical guides. A positional guide was crafted and 3D printed (fig. 5).

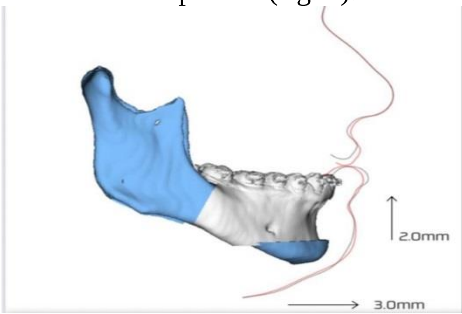

Figure 4. Profile Virtual Surgical Planning demonstrating chin impaction. A very hard to perform surgical step without aid of a cutting guide, notably in posterior region.

Figure 5.3D printed genioplasty positional and cutting guides.

Discussion

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The aspect and volume of the chin are important, and their boundaries are determined by the mentolabial fold, the lip commissures, and the submental cervical fold. The shape and projection of the chin contribute to a "well-balanced and harmonious" face, and good chin projection influences psychosocial well-being.

With the rapid development of computer-assisted surgical simulation (CASS) technology, surgeons are now able to design a surgical guide in the preoperative phase through virtual planning. The printed guide is accurately transferred to the patient in the operating room exactly as planned digitally [6].

Genioplasty is a procedure that has great potential to transform facial profiles, and the technique using customized guides helps mitigate the disadvantages of the procedure, making it safe, precise, and predictable. In the past, the difficulties in performing genioplasty led to the procedure being exclusively performed in a surgical center under general anesthesia, and today it can be performed with local anesthesia on an outpatient basis with sedation [7,8].

The average duration of a genioplasty, from the first incision to the final stitches' ranges from 30 to 90 minutes. The surgeon's experience, the means used to perform the osteotomy (saw, drill, piezo), the technique used for genioplasty, and the bone movements performed should be considered. The development of 3D printing techniques and piezosurgery provided the basis for the establishment of a genioplasty technique that combines both technologies: Minimally Traumatic Guided Genioplasty. A previous study evaluated the profile with correct lip position in women and correct chin position in men, considering cephalometric measurements, and all profiles with deviations from the average obtained lower scores. These findings are important to establish a gold standard and improve awareness during the decision-making process [4,8,9].

Mental nerve injuries, paresthesia, asymmetries, and intraoperative bleeding are the main immediate complications of genioplasty. The literature agrees that operating with guides is much more comfortable as it not only promotes the protection of anatomical structures but also reduces complications. The cost-benefit ratio seems largely in favor of using 3D printing technology during genioplasty compared to traditional techniques. Some advocate for the use of chin implants due to their simplicity and predictability, although the long-term results are unpredictable and unknown in the literature [4,6–9].

The predictability of osteotomy results and osseous repositioning in the soft tissues of the chin is still controversial and requires more specific parameters to predict better results regarding the skin surface response after genioplasty. Result predictions have been made in studies using standard two-dimensional cephalometric analysis or 3D methods, where the latter is the better choice. The finite element method (FEM), already described in the literature, is a viable and accurate method for predicting changes in soft tissues during surgery [8].

The chin is a cortical bone that requires intense and risky osteotomy due to the two cortical plates and the risks and limited visibility in the region where the mental nerve emerges. Osteotomies in the chin are challenging to achieve a perfect level of symmetry, even with guides, and this challenge is greater in cases of asymmetry or secondary genioplasty. Additionally, the positioning of the osteotomized fragment is complex, as it can be placed in different positions in the three planes of space [7].

Financial costs should be considered as they vary according to the printer, the cost of printing materials, and the software used. An European study found that in a dedicated laboratory, the cost of printing a genioplasty guide does not exceed 5 euros after acquiring a 3D printer and utilizing free medical 3D software. They also indicated that the costs of genioplasty guides with external companies range from 400€ to 1000€ on average [9].

Several factors can cause the chosen cutting plan in virtual planning to not correspond exactly to the guide during surgery, including possible software and hardware errors, data loss, 3D printing issues (imprecision of the 3D printer, insufficient rendering quality, quality of the raw material), guide deformation during the process and storage, guide instability when used in the surgical procedure, and sterilization [4,6].

Although several studies have described virtual planning and surgical guides as a precise technique, it still remains a challenge. This protocol reduces the complexity of the procedure and surgical time, guarantees results, minimizes surgical and aesthetic complications, and allows the procedure to be performed with only local anesthesia and oral sedation [7–9].

The complications described in the literature are well-known complications of genioplasty; no new complications due to this new technique and no increase in complication rates have been found [9].

Future research is needed to increase the accuracy of virtual planning and surgical guides in genioplasty, with long-term evaluations, prospective study designs, and control groups. To ensure high-quality and comparable results, future researchers should be encouraged to focus on automatic 3D analysis according to standardized and validated methods [10].

Conclusion

Performing genioplasty with a surgical guide using 3D printing technology is a promising technique that can improve predictability and precision, protect anatomical structures, reduce morbidity, and provide safer results. The type of printer and material used, as well as sterilization techniques, should be further researched. The use of open-access software should also be explored to allow more surgeons to utilize these new technologies. Lastly, prospective multicenter studies with larger samples should be conducted to definitively conclude on the benefits of this new technology and enable its routine use.

DECLARATIONS

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Competing interests

Authors declare that they have no conflicts of interest to disclose.

Clinical trial number

Not applicable.

Ethical approval

This article is exempt of ethical approval since it was performed in our private practice. This study was conducted in accordance with Good Clinical Practice guidelines and the principles of the Declaration of Helsinki.

Patient consentment

The authors certify that they have obtained appropriate patient consent forms.

Authors contribution

All authors contributed equally to this manuscript. All authors participated significantly to the study design and execution, and have read, revised, and approved the final manuscript.

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