

Three-dimensional printer-assisted reduction genioplasty; surgical guide fabrication

[Seied Omid Keyhan](#),^{1,2} [Alireza Jahangirnia](#),³ [Hamid Reza Fallahi](#),⁴ [Alireza Navabazam](#),¹ and [Sina Ghanean](#)¹

¹Department of Oral and Maxillofacial Surgery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

²Cranio Maxillofacial Research Center, Tehran Dental Branch, Islamic Azad University, Tehran, Iran

³Oral and Maxillofacial Surgeon, Private Practice, Tehran, Iran

⁴Department of Oral and Maxillofacial Surgery, Jondishapour University of Medical Sciences, Ahvaz, Iran

Address for correspondence: Dr. Sina Ghanean, Department of Oral and Maxillofacial Surgery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. E-mail: sinasin@gmail.com

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Abstract

Genioplasty is a common operation to enhance function and appearance of the chin, the most prominent part of the lower third of the face, which has major impact on character impressions and facial beauty. However, since transference of preconfigured accurate treatment plans to patients during operation is difficult, sometimes it can be challenging, especially for inexperienced surgeons. This article represents a simplified technique to perform reduction genioplasty by utilizing a customized genioplasty guide manufactured with three-dimensional printing technology. This approach is helpful to achieve more precise and safer outcomes with fewer complications.

Keywords: Genioplasty, osteotomy, three-dimensional printing

INTRODUCTION

Beauty of the face relies on the outline, topography, harmony, and relationship of its numerous components. The chin is the most prominent structure of the lower third of the face having major impact on facial esthetics and balance in both profile and frontal views. There are two main corrective methods to resolve chin abnormalities, alloplastic implants, and osseous genioplasty.[1,2] Such operations are challenging considering the three-dimensional (3D) irregularities of the impaired chin. Imprecise transference of proper treatment plans to patients during operation can affect the results leading to unfavorable complications such as hemorrhage, chin hypoesthesia or dysesthesia, lip ptosis, root injury, mobile segments resorption, mandibular fracture, and failing to stabilize bony segment.[1,3]

Today, maxillofacial surgery can benefit from additive manufacturing in various aspects and different clinical cases.[4] This article represents a simplified technique to perform reduction genioplasty using rapid prototyping technology to aid executing this procedure safely with better outcomes.

TECHNICAL NOTE

First, 3D computed tomography scan of the face was acquired with 1.25 mm slices and the data conversion was performed using Mimics Innovation Suite software (Materialise®) to fabricate the model. After fabricating 3D model of the jaw and radiographic evaluations on panoramic and lateral cephalometric radiographs, the amount of reduction in different aspects and appropriate techniques are determined.[2,5,6] According to data obtained from analysis of X-rays, designed osteotomy lines are drawn on 3D model. Next, a surgical guide is manufactured extending to areas beyond the osteotomy lines using transparent

acrylic resin and carefully constructed to adapt to the anatomy of the bone [Figure 1].

Then, the splint is placed on the 3D model and two holes are drilled in the upper left and right corners to stabilize position of the splint on the model or jaw bone during surgery using screws. The holes also expand into the model. Respectively, two holes are drilled in the bony pieces that must be relocated during surgery. Next, the surgical splint is removed from the model, and using saw or piezosurgery, osteotomy is performed on 3D model. After removing the intended parts, the segments are fixed in place using sticky wax [Figure 2].

Next, acrylic surgical splint is again fixed in place through the preconfigured upper holes on the intact parts of the jaw before. After stabilization of the splint, predrilled holes that were created on the model will be easily visible through the transparent acrylic splint. Using fissure bur and in order that the bur penetrates into the shifted hole from the acryl, two other holes are created in surgical splint in the location of shifted segments. These second holes are drilled to specify the amount of movement toward midline in cases of width reduction and the amount of cephalic movement of the segments during chin height reduction. If the patient requires chin advancement and vertical or transverse reduction at the same time (rarely), at this stage, we can add another piece of acrylic resin to the inner surface of the splint using a separating material indicating the amount of advancement (splint within splint).

During surgery after the osteotomy lines are drawn on the bone with pencil, the splint is placed on the jaw and two holes are drilled on the bone using predrilled holes on superior corners of the splint [Figure 3 - A]. The splint is then fixed in place using screws. Next, two holes are drilled in the bone using second hole which are indicators of the location of segments before movement [Figure 3 - B].

After that, the acrylic splint is removed from the bone and the osteotomy is performed using saw or bur following treatment plan and the splint is fixed in place again. Traction screws are inserted through the third holes [Figure 3 - C] on the splint and are screwed into the existing holes on mobile segments leading by the opposite hand. This way segments will be fixed in the new position [Figures 3 and 4].

To stabilize the relocated segments, a lag screw is used passing through the splint and mobile bony segments. Furthermore, grooves can be drilled on both sides of the splint using a bur with the same width of the plate to stabilize the bones. It is worth mentioning the possibility of using this method using simulation software and printing the splint.

DISCUSSION

The expression and contour of the chin are related to character impressions and facial beauty. Genioplasty is a conventional operation to enhance function and appearance of the chin.[1,7]

Genioplasty was introduced initially by Aufrecht in 1934 and modified by Obwegeser and Trauner in 1957. Genioplasty is indicated to repair facial contours during orthognathic surgery, posttraumatic facial reconstruction, pathologic defects, and cosmetic surgeries.[1,3]

At present, surgeons experience and optical evaluation are the only tool to transfer designed treatment plans to patients during operation. Any inaccurate measurement during genioplasty can affect the outcome causing undesirables events including lip ptosis due to muscles dysfunction, paresthesia, bony segments absorption, root damage, and infection. In addition, the thickness and types of the instruments utilized during surgery can negatively affect the treatment plan and cause deviation from favorable osteotomy.[2,7]

Since its introduction in 1986, 3D printing technology has been utilized in different fields of medicine and surgery. Nowadays, craniofacial surgery can hugely profit from rapid prototyping in various aspects. Some known advantages of 3D printers are reduced surgical time, prebending plates, easier treatment planning, and education.[8]

Researches have shown that 3D printers are able to manufacture models with great accuracy. 3D-printed models can be precise and advantageous in genioplasty. By simulating surgery and preoperative plate bending novice surgeons will be able to perform genioplasty more simply and precisely.[9]

The surgical splint has the ability to relocate segments to their preconfigured final position.[10]

CONCLUSION

We recommend utilization of 3D printing technology in genioplasty to achieve more accurate and safer results with less complication. Furthermore, it is advised to execute clinical trial experiments based on this article.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Figures and Tables

Figure 1



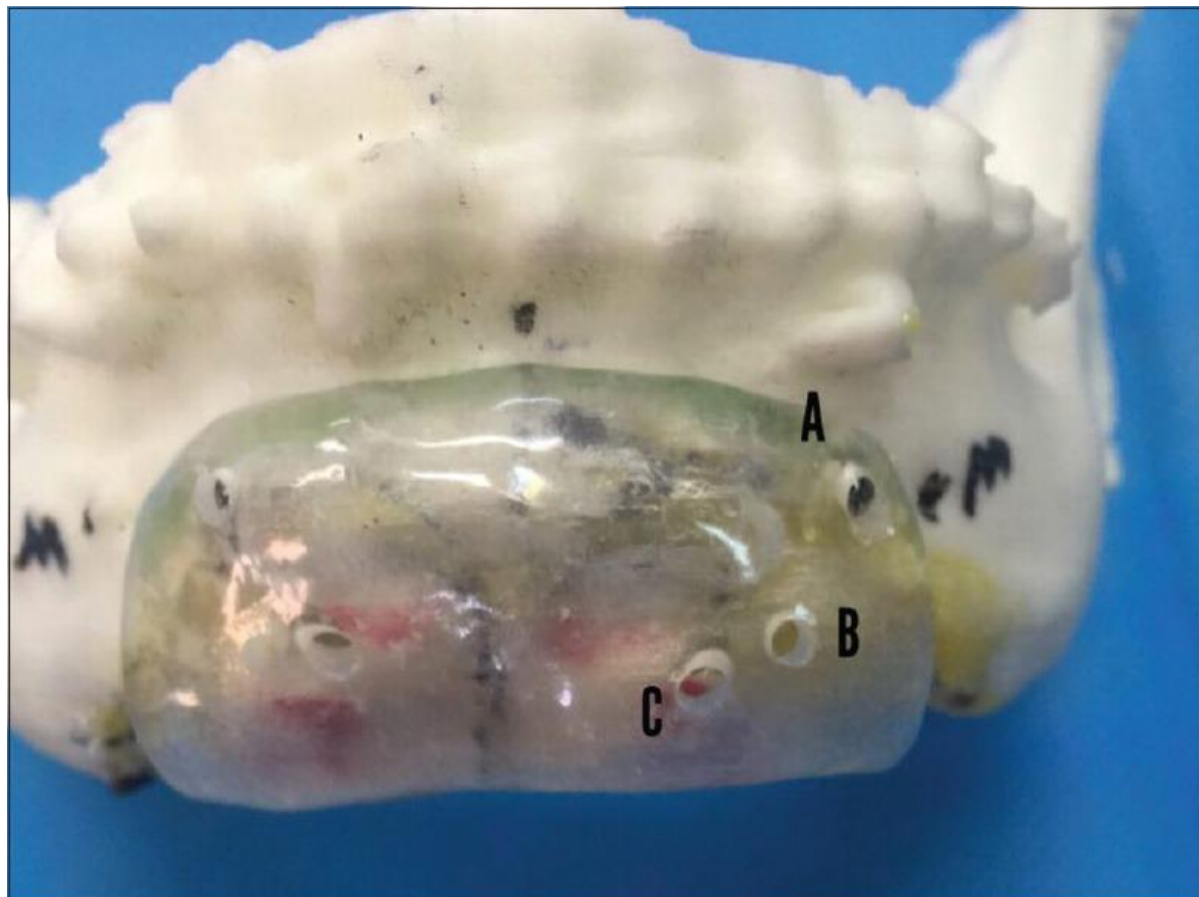
Osteotomy lines are drawn on three-dimensional model and customized surgical guide is adapted to the anatomy of the bone

Figure 2



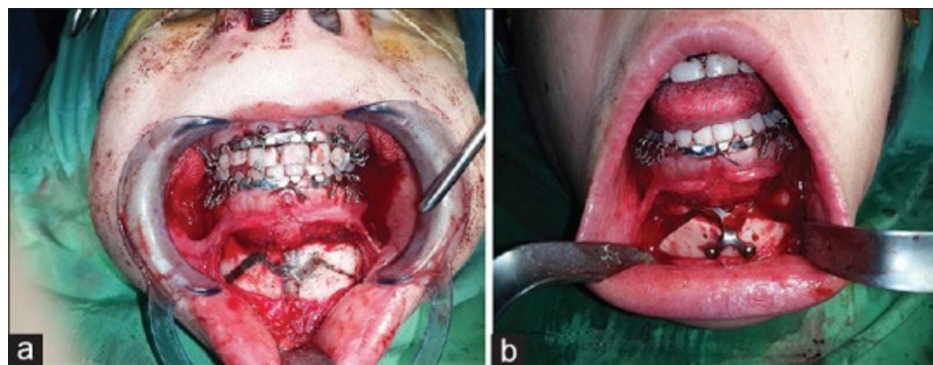
Fixation of mobile segments using sticky wax after performing osteotomy on the model and removing extra parts

Figure 3



Stabilization of mobile segments using predrilled holes

Figure 4



(a) Osteotomy lines design using 3-D technology are drawn on the bone (b) performing reduction genioplasty based on predrawn osteotomy lines

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