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Achieved chin position after genioplasty follows the planned horizontal change better than the planned vertical change

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ABSTRACT

Purpose: The soft-tissue pogonion closely follows changes of the bony pogonion, but it is unknown how often an augmented bony pogonion reaches the intended position. Here we assessed the agreement between planned surgical changes and achieved results in chin surgery.
Materials and methods: Surgical treatment was planned based on clinical examination, cast model analysis, and cephalometric image analysis. The mobile chin segment was stabilized using one chin plate. Preoperative and postoperative cephalometric X-ray images were digitized, and cephalometric tracing was performed. We calculated and analyzed the changes between the preoperative and postoperative images as well as between planned genioplasty movements and actual surgical changes in the horizontal and vertical directions.
Results: This study included 36 patients. In 34 patients, the absolute mean horizontal difference was less than 2 mm. We found a higher range of absolute error in vertical (0.00–5.60) compared to horizontal (0.01–3.64) movement. There was no significant difference between the mean planned chin movement and the mean achieved position with regard to the horizontal and vertical movement ($p = 0.97$ and 0.79, respectively).
Conclusions: The mean values for linear difference in both the horizontal and vertical directions were in line with the acceptable mean of ≤2 mm proposed in the literature.

1. Introduction

Excessive protrusion or retrusion of the chin can occur alone or with co-existing maxillofacial deformities (Arnett and Bergman, 1993), potentially leading to functional difficulties (such as obstructive sleep apnea) and esthetic problems (Agbaje et al., 2016). Abnormal chin position can often be surgically corrected, either alone or with correction of associated maxillofacial deformities (Park et al., 1989). The literature describes many surgical options for reducing a prominent chin or augmenting a poorly projected chin. The surgical goals in such cases include the establishment of a proportionate facial height and creation of an aesthetically pleasing facial contour (Athanasiou et al., 1989; Ostler and Kiyak, 1991; Rivera et al., 2000; Williams et al., 2009).

Genioplasty with or without BSSO is the most common surgical procedure for chin correction in all planes, i.e., anteroposterior, sagittal, and vertical deficiencies (Kolokitha and Topouzelis, 2011). In addition to esthetic changes, genioplasty combined with BSSO can improve associated functional problems, such as obstructive sleep apnea, by increasing posterior airspace (Agbaje et al., 2016). Osseous genioplasty produces stable results, and reliably and consistently improves chin projection (Chan and Ducic, 2016). Although alloplastic chin implantation is a faster and easier method of augmenting a retruded chin, its use is limited by disadvantages

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that include infections, extrusion of alloplastic material, and variable bone resorption (Stalder and St, 2012; Bain and Odili, 2012; Bertossi et al., 2015). Genioplasty carries more profound predictability and better stability, ensuring a better long-term postoperative outcome (Bertossi et al., 2015).

Good postoperative results depend on the preoperative workup, including tissue analyses and surgical planning (Kusnoto, 2007). Facial harmony and symmetry are strongly influenced by the size, shape, and position of soft and hard tissues. It is critical to be able to accurately and consistently predict postoperative outcomes. At our center, we apply both Legan-Burstone analysis and the Arnett approach. To evaluate the desired vertical chin dimension, we calculate the following proportion: soft tissue subnasale—soft tissue nasion/lower incisor incisal edge—soft tissue menton. To judge the sagittal chin projection, we use the angle of facial convexity according to Legan (Powell and Humphreys, 1984; Athanasiou, 1995; Arnett and Gunson, 2004). However, the amount of vertical and sagittal change achieved through genioplasty is ultimately determined based on the surgeon's clinical judgment.

In the present study, we aimed to assess the agreement between preoperative surgical plans and the results achieved by chin surgery. To this end, we performed quantitative comparison of preoperative and postoperative cephalometric X-ray images.

2. Materials and methods

2.1. Patients

This study included patients who underwent genioplasty, with or without BSSO, or bimaxillary surgery at the Leuven University Hospital, Department of Oral and Maxillofacial Surgery, between January 2013 and December 2015. Exclusion criteria were history of syndromes or craniofacial defects, history of previous orthognathic surgery, or the use of alloplastic materials for chin augmentation. All included patients had preoperative cephalometric X-rays taken using ProMax (Planmeca, Helsinki, Finland) 3 weeks before their operation. The preoperative surgical treatment plan was determined based on clinical examination, analysis of cast models, and cephalometric image analysis (Fig. 1). This retrospective study was approved by the Medical Ethical Committee of Leuven University Hospitals (number S57587).

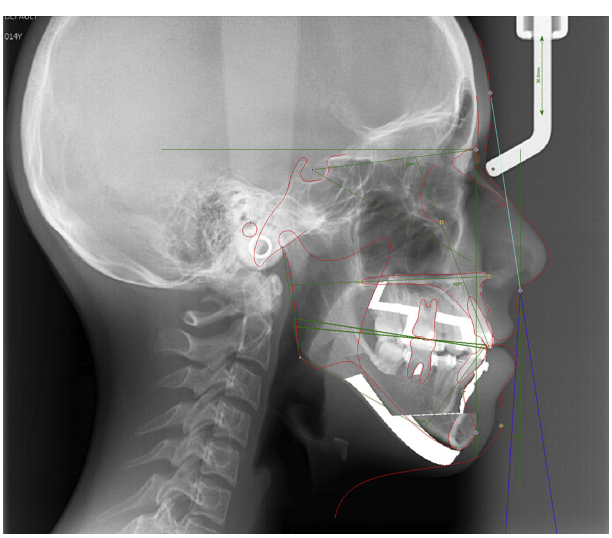

Fig. 1. Cephalometric image analysis and surgical simulation in Onyx software.

2.2. Surgery

All surgical procedures were performed by the same surgeon, and using the same surgical technique regardless of whether chin advancement or setback was required. The mobile chin segment was stabilized using a chin plate (KLS Martin GmbH, Freiburg, Germany) of 2, 3, 4, 6, 8, or 10 mm, according to the preoperative surgical treatment plan. These available chin plate sizes were considered when planning horizontal chin movement. The amount of vertical movement was determined based on the slope of the oblique osteotomy line and the amount of advancement (Fig. 2). There were three categories of planned vertical movements: 0.00 mm (no vertical movement); an intrusion of ≤4 mm, which was realized via sliding genioplasty during an advancement procedure over an oblique osteotomy line; or an intrusion of <4 mm, which was performed via wedge-excision genioplasty with or without advancement.

The operative procedure began with soft tissue dissection up to the bone, followed by the drawing of three vertical reference lines using the piezzotome. Then a horizontal or triangular line was drawn with the piezzotome, defining the osteotomy lines. Symmetry was checked clinically and using calipers. Osteotomy cuts were performed using the piezzotome. The cant of the osteotomy cut was selected based on the desired vertical movement. A straight horizontal cut was made in cases of straight advancement, whereas an oblique cut was made in cases of intrusions. For an intrusion of ≤4 mm, a sliding osteotomy design was chosen. For intrusion of >4 mm, a wedge excision was performed, together with reinsertion of the genioglossus muscle. After mobilization with a wedge osteotome, the mobile fragment was stabilized with a chin plate.

Six weeks after the operation, a second cephalometric X-ray was taken using ProMax. All cephalometric radiographs were taken by specially trained radiology technicians to ensure error-free positioning of the patient's head in the natural position, and occlusion when acquiring the lateral cephalometric X-ray image.

2.3. Data collection and analysis

Each cephalometric X-ray image was analyzed for hard tissue following the method of Burstone et al. (1978). Table 1 lists the cephalometric landmarks. The preoperative and postoperative cephalometric X-ray images were digitized, and cephalometric tracing was performed in Onyx software (Image Instruments, Chemnitz, Germany). The software automatically registered the postoperative cephalometric X-ray image to the preoperative cephalometric X-ray image, using an algorithm based on the correlation of image density in the unchanged part of the skull (Fig. 3).

After registration, the postoperative cephalometric X-ray image had the same coordinates as the preoperative cephalometric X-ray image (Fig. 4). In the Onyx software, a line passing through the sella and nasion points at 7° clockwise rotation was defined as the X-axis, and a line perpendicular to the X-axis and passing through the

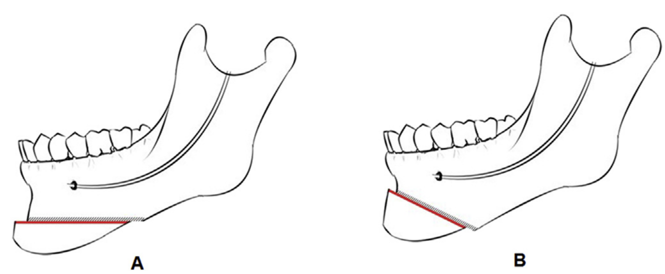

Fig. 2. Chin osteotomy line: (A) horizontal movement, (B) sliding movement.