A Study on the Influence of the Osteotomy Slope on Bony Changes after Advancement Genioplasty

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Abstract

Introduction The slope of the osteotomy used for the genioplasty dictates the vertical change. The horizontal bony changes after advancement genioplasty are not identical to the intercortical bony changes, because the variety of osteotomy slopes result in different vertical changes.

Material and Methodology Ten of these patients had additional osteotomies as follows: five maxillary, three mandibular and two both maxillary and mandibular. Pre-operative and post-operative (at least 6 months) lateral cephalograms were retrospectively analyzed to assess horizontal and vertical movements of the chin. The following landmarks were used, Hard tissue pogonion (Pog), Occlusal plane (OPL), Menton (Me), Menton plane (MePL). The following parameters were calculated: $\Delta H = H-H$, $\Delta V = V-V$, The ratio between ΔH and ΔV equals tangent α , Calculated $\alpha = \text{inverse tangent } \alpha$.

Results The Mean Horizontal bony movements was 3.75 mm (SD 1.4 mm, range –6 to 15 mm). The Mean Vertical bony movements was 1.4 mm (SD 0.8 mm, range 0.5–2 mm). The Mean Measured Osteotomy slope angle was 82.2 (SD 7.4, range 75–91). The Calculated Mean Slope Angle based on the $\Delta H/\Delta V$ ratio was 82.3 (SD 7.0, range 74–95).

Discussion The slope of the osteotomy used for the genioplasty dictates the vertical change. The osteotomy slope angle was defined as the angle between the osteotomy and a line perpendicular to the occlusal plane. The measured angle was compared with the calculated angle deduced from the horizontal and vertical genial post-operative changes.

Keywords Osteotomy · Genioplasty · Soft tissue changes

Introduction

Horizontal bony changes of the chin after advancement genioplasty and their influence on the overall soft tissue have been well documented, however little attention has been given to the vertical bony changes in the facial lower third and their influence on the soft tissue [1, 2].

The slope of the osteotomy used for the genioplasty dictates the vertical change. The horizontal bony changes after advancement genioplasty are not identical to the intercortical bony changes, because the variety of osteotomy slopes result in different vertical changes. The cephalometric prediction methods that are being used do not take into consideration the slope of the osteotomy [3, 4]. Moreover, there are no means to allow precise transfer cephalometric prediction of advancement genioplasty to the patient [2].

Treatment planning for patients with vertical or horizontal divergence of the lower third of the face begins with systematic evaluation of facial esthetics. The morphology of the anterior mandibular contour may differ in postero-anterior, vertical and transverse directions [5].

The aim of the study was to describe a prediction method that allows accurate cephalometric planning of the osteotomy slope that can be transferred to the patient during the surgical procedure.

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Materials and Methods

The study was conducted in the Department of Oral and Maxillofacial Surgery, Saveetha Dental College and Hospitals, Chennai.

The study group comprised of ten patients who needed to undergo advancement genioplasty. Out of the ten patients, six were females and four were males. The mean age of this group was 21 ± 5 years.

Ten of these patients had additional osteotomies as follows: five maxillary and three mandibular and two both maxillary and mandibular. Patients who were treated by vertical reduction genioplasty or straightening genioplasty were not included in the study.

Same surgical technique was followed in all patients. Soft tissue dissection was minimal to preserve the pedicle as much as possible. Anterior movement of the genial segment was carried out and stabilized with 26 gauge stainless steel trans-osseous wiring.

Retrospective analysis of pre-operative and post-operative (at least 6 months) lateral cephalograms to assess horizontal and vertical movements of the chin was done. All radiographs were taken by the same standard technique and using the same X-ray machine and cephalometric tracing was done by a single investigator on standard acetate tracing paper. Successive mandibular tracings were superimposed on a best fit of the mandibular structures.

The following landmarks were used: (1) Occlusal plane (OPL): A horizontal plane tangent to the uppermost definite area of the first molar and the most anterior tooth of the mandible, (2) Menton (Me): The most inferior point on the mandibular symphysis, (3) Menton plane (MePL): A horizontal plane parallel to OPL and tangent to Me, (4) Hard tissue pogonion (Pog): The most anterior point of the mandibular symphysis.

The following parameters were measured same as used by Yitzhak Shoshani et al.: (1) H: The pre-operative horizontal distance between pogonion and a perpendicular line to OPL tangent to the incisal edge of the mandibular incisor, measured parallel to OPL, (2) H': The post-operative horizontal distance between pogonion and a perpendicular line to OPL tangent to the incisal edge of the mandibular incisor measured parallel to OPL, (3) V: The pre-operative vertical distance between the OPL and MePL measured on a perpendicular line to OPL, (4) V': The post-operative vertical distance between the OPL and MePL measured on a perpendicular line to OPL, (5) Measured Osteotomy slope angle (α): The angle between the osteotomy and a perpendicular line to OPL.

The movement of the genial segment along the osteotomy was divided into a horizontal vector (ΔH) and a vertical vector (ΔV), creating a right angle triangle. The angle between ΔV and the osteotomy is α .

Fig. 1 Pre-operative landmarks and measurements

Fig. 2 Post operative landmarks and measurements

Fig. 3 Calculated parameters the ratio $\Delta H/\Delta V$ equals tangent α

The following parameters were calculated: (Figs. 1, 2, 3).

1. $\Delta H = H' - H$
2. $\Delta V = V - V'$
3. The ratio between ΔH and ΔV (equals tangent α)
4. Calculated $\alpha = \text{inverse tangent } \alpha$

The OPL was chosen as substitute for the standard Frankfort horizontal plane, as the reference line for this study to neutralize other changes in the mandible resulting from additional mandibular or maxillary osteotomies.

The values of the measured α and calculated α were obtained independently and statistically compared using the χ^2 test.

Results

Horizontal (ΔH) and vertical (ΔV) bony differences together with the measured and calculated osteotomy slope angles are listed in Table 1.

- The Mean Horizontal bony movements was 3.75 mm (SD 1.4 mm, range −6 to 15 mm) (Fig. 4)
- The Mean Vertical bony movements were 1.4 mm (SD 0.8 mm, range 0.5–2 mm) (Fig. 5)
- The Mean Measured Osteotomy slope angle was 82.2° (SD 7.4°, range 75°–91°)
- The Calculated Mean Slope Angle based on the $\Delta H/\Delta V$ ratio was 82.3° (SD 7.0°, range 74°–95°) (Fig. 6)

The difference between the measured α and calculated α was statistically insignificant ($P = 0.93$) (Figs. 7, 8).

Discussion

Horizontal bony changes of the chin after Advancement Genioplasty and their influence on the overall soft-tissue response have been well documented. However, little attention has been paid to the vertical bony changes in the facial lower third and their influence on the soft tissue [6, 7].

The slope of the osteotomy used for the genioplasty dictates the vertical change. The osteotomy slope angle was defined as the angle between the osteotomy and a line perpendicular to the occlusal plane. The measured angle was compared with the calculated angle deduced from the horizontal and vertical genial post-operative changes [2].

Both horizontal and vertical movements occur with Advancement Genioplasty procedure unless the Osteotomy is absolutely parallel to the occlusal plane ($\alpha = 90^\circ$) [8, 9]. This study indicates a mathematical correlation between

Table 1 Horizontal and vertical bony changes after advancement genioplasty using various osteotomy slope angle

Patients' No	ΔH mm	ΔV mm	$\Delta H/\Delta V$ mm	Calculated α	Measured α
1	3.5	1	3.5	74°	75°
2	−6	1	6	95°	94°
3	−2	1.5	−1.03	90°	89°
4	9	2	4.5	77°	78°
5	−4.5	1.5	−3	92°	91°
6	15	2	7.5	83°	84°
7	7	1.5	4.66	78°	77°
8	7.5	2	3.75	75°	76°
9	4	0.5	8	83°	81°
10	4	1	4	76°	77°
Mean	3.75 ± 1.4	1.4 ± 0.5		$82.3^\circ \pm 7.6$	$82.2^\circ \pm 7$

Fig. 4 Horizontal bony changes

Fig. 5 Vertical bony changes **Fig. 6** Vertical & Horizontal bony changes **Fig. 7** Pre-operative analysis & superimposition

the horizontal and vertical bony changes. The movement of the distal chin segment along the Osteotomy can be divided into a major horizontal component and a minor vertical one. The mean ratio between the two components according to measurements was 1:0.16 (range 1:0.08–1:0.38).

Choosing an arbitrary osteotomy slope makes the genioplasty procedure unpredictable and can lead to discrepancies between the planned and the final results [10]. In cases in which large chin advancements (more than 10 mm) are planned, the vertical changes become significant and thus they should not be neglected during prediction.

The close similarity between the calculated (82.3°) and measured (82.2°) slope angles in this study shows that simple mathematical calculations can be applied clinically to aid surgeons in achieving a more predictable result after Advancement Genioplasty.

ΔH and ΔV are first determined according to the cephalometric evaluation of the patient. The ratio between these

Fig. 8 Post-operative analysis & superimposition

two values lead to a calculated slope ($\Delta H/\Delta V = \tan \alpha$). Then the osteotomy is drawn at the desired slope, and two vertical measurements are made on the cephalometric tracing (Fig. 3)—(1) anteriorly the distance between the incisal edge of the mandibular incisor tooth, and the anterior margin of the osteotomy above the hard tissue pogonion. (2) posteriorly, the distance between the lower edge of the mental foramen and posterior margin of the osteotomy. The two values obtained are used in the operating room.

The distance from the incisal edge is marked on the bony chin by the use of a caliper. The mental foramina are identified bilaterally and the posterior values are marked. A line connecting those marks is the desired osteotomy. Although anatomic limitations (the distance between the dental apices and pogonion and the location of the mental foramen) enable only limited spectrum of choices for the planned slope, several possibilities, each with different effects on the facial profile, can be considered in the prediction stage.

Wolfe et al. stated that a minor alteration of vertical dimension of the chin is desired in addition to advancement, the inclination of the osteotomy can be varied slightly. Angling it superiorly gives not only a larger, mobile inferior fragment but also a stable incline favorable to vertically lengthen the chin. Angling it inferiorly achieves the vice versa [9].

Fonseca stressed on the fact that both vertical as well as horizontal changes can be influenced by the angle of the

osteotomy. The more parallel with the occlusal plane and the mandibular plane, the more pure the AP movement. If vertical shortening is desired, the angle of the osteotomy should become more acute compared with the mandibular plane [10].

Conclusion

The close similarity between the calculated and measured osteotomy slope angles in this study shows that simple mathematical calculations can be applied clinically to aid surgeons in achieving a more predictable result. The osteotomy can be determined early in the prediction stage as a calculated figure based on the desired horizontal and vertical movements of the chin and can be transferred to the patient's chin during the surgical stage.

To conclude, this study needs to be undertaken with larger sample and with longer post-operative periods. To predict the long-term result of the effect on osteotomy slope angle on Advancement Genioplasty.

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