Effects of single- or double-jaw surgery on vertical dimension in skeletal Class III patients

The vertical facial proportions resulting from bimaxillary surgery (maxillary advancement and mandibular setback) and mandibular setback alone were evaluated. The measurements were evaluated on the preoperative and postoperative cephalometric radiographs of 20 skeletal Class III patients. The results showed that sagittal correction of the jaws caused no change in the vertical relationship of the jaws. The only significant change was an increase in occlusal plane inclination in bimaxillary surgical patients. (Int J Adult Orthod Orthognath Surg 2001;16:30–35)

Skeletal Class III patients characterize a dentofacial deformity group who frequently seek orthognathic therapy. Orthognathic surgery is the most frequently preferred treatment alternative in these patients because of the difficulty in controlling mandibular growth with extraoral devices and the limited stability of treated patients due to late mandibular growth. A Class III incisor relationship may be associated with a wide variety of skeletal patterns. The size and relative positions of the cranial base, maxilla, and mandible and any displacement of the mandible will affect both the sagittal and vertical relationship of the teeth. In most of the patients studied, the maxilla was shorter and more retrusive, while the mandible was longer and more prominent. Simultaneous maxillary advancement and mandibular setback was the preferred type of surgery in these cases. Of particular importance is the vertical relationship, ie, whether the individual is long-faced or short-faced. In Class III patients with vertical excess, the recommended procedure was maxillary intrusion and mandibular autorotation.

Occlusal plane inclination should also be considered in deciding the type of surgery. Changes to the occlusal plane were described in terms of rotation of the mandible in an upward and forward manner secondary to superior movement of the maxilla. The coupling of maxillary and mandibular surgery to change occlusal plane inclination was presented by Sarver et al. Surgical impaction of the posterior maxilla produced a clockwise rotation of the occlusal plane inclination in their cases.

On the other hand, setting the mandible backward may require a rotational movement to accommodate the complex structure of the craniofacial skeleton, which may then affect the vertical relationship of the jaws. Maxillary advancement without intrusion would carry the fulcrum point forward, which may also cause a change in the vertical relationship of the jaws. It is important to verify this change in orthognathic treatment planning, particularly in mesofacial Class III patients, to obtain more harmonious and esthetically pleasing facial proportions.

The purpose of this study was to examine the effects of single-jaw (mandibular setback) and bimaxillary (simultaneous maxillary advancement and mandibular setback) surgeries on the vertical relationships of skeletal Class III patients.
Materials and methods

The sample used in this study consisted of 20 patients. Ten patients (6 female and 4 male, mean age 22.4 ± 2.1 years) had been diagnosed with mandibular prognathism and formed the first group in this study. Their surgical treatment consisted of sagittal split osteotomy to set back the mandible. Maxillary development was within the normal range, and an average of -6 mm of convexity was measured in these patients, resulting from excessive mandibular development.

The second group (7 female and 3 male, mean age 21.3 ± 1.2 years) had a diagnosis of maxillary retrusion and mandibular prognathism, and surgical treatment consisted of simultaneous Le Fort I osteotomy to advance the maxilla and bilateral sagittal split osteotomy to set back the mandible. The maxilla was moved into its correct relationship by a conventional Le Fort I osteotomy, as described by Bell,9 whereby ANS was retained. Excessive maxillary deficiency and mandibular prognathism were observed in these patients. The amount of maxillary retrusion was -4 mm and mandibular prognathism was over -8 mm according to the McNamara evaluation.10

Both groups included patients with no vertical discrepancy. No additional surgical procedures such as genioplasty, rhinoplasty, or infraorbital augmentations were performed in conjunction with the osteotomies or postoperatively. Patients with cleft lip and palate were excluded from the study. All patients underwent preoperative orthodontic treatment, and only those who remained stable 1 year postoperatively were included.

For each patient, a preoperative radiograph was taken within 1 month of surgery, and a postoperative radiograph was taken 1 year after surgery. Both the preoperative and postoperative cephalograms were taken either in centric relation or in centric occlusion with the lips in repose and were traced on 0.003-inch acetate tracing paper. Ricketts's cephalometric reference planes (PTV, FH) were used to measure the following variables11 (Fig 1):

1. Lower face height (degrees)
2. Mandibular arch (degrees)
3. Mandibular plane to FH (degrees)
4. Facial axis (degrees)
5. Maxillary height (degrees)
6. Cranial deflection (degrees)
7. Total face height (degrees)
8. Inclination of occlusal plane (degrees)

In Delaire's hard tissue analysis, the reference planes were from FM to Clp. With a line perpendicular to this line, a vertical assessment was made by measuring the upper facial height from N to ANS and the lower facial height from ANS to Me. The distance between ANS and N should be 45% of the total facial height and the measurement from ANS to Me along this line should be 55% of the total facial height (Fig 2).

9. Upper facial height (N-ANS) (mm)
10. Lower facial height (ANS-Me) (mm)

Legan's soft tissue analysis included the ratio of the distances from G to Sn and from Sn to Me according to a reconstructed reference plane 7 degrees above the S-N plane. The ratio of this distance should be 1 to 1 (Fig 3).

11. G-Sn (mm)
12. Sn-Me (mm)

To estimate the error of tracing, location and landmarks, and measurements, 20 radiographs were retraced and remeasured by the primary examiner. The means and standard errors were calculated between the 2 recordings. The mean error was 0.4 degrees and 0.3 mm for the whole sample.

Statistical analysis was performed with SPSS software. Nonparametric tests were used to compare the intragroup and intergroup differences.

Landmarks used

ANS = anterior nasal spine
Clp = posterior clinoid process
FH = Frankfort horizontal
FM = intersection of frontal and maxillary bones
G = glabella
Me = menton
Me' = soft tissue menton
MP = mandibular plane
N = nasion
Ptm = pterygomaxillary fissure
PTV = pterygoid vertical: the line perpendicular to FH at Ptm
Sn = subnasale

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Fig 1  Ricketts analysis. 1 = lower facial height; 2 = mandibular arch; 3 = MP to FH; 4 = facial axis; 5 = maxillary height; 6 = cranial deflection; 7 = total facial height; 8 = inclination of occlusal plane.

Fig 2  Delaire analysis for vertical hard tissue assessment.

Fig 3  Legan analysis for vertical soft tissue assessment.
Results

Tables 1 and 2 show the mean measurements of Ricketts analysis for both surgical groups. Facial axis angle decreased posteriorly an average of 2.7 degrees (P < 0.01) in single-jaw and 3.7 degrees (P < 0.05) degrees in double-jaw surgery patients. The difference between the 2 groups was not significant. Occlusal plane inclination increased an average of 3.7 degrees (P < 0.05) in the bimaxillary surgery group. No significant change in occlusal plane inclination was observed in the mandibular setback patients.

Tables 3 and 4 detail the results of De-laire and Legan analyses in the mandibular setback and bimaxillary surgery groups, respectively. No significant change was observed in these parameters in both groups.

Discussion

Conventional Le Fort I and sagittal split osteotomies were used in this study to advance the maxilla and set back the mandible as described by Bell. Anterior nasal spine was retained, and no modification of the surgical technique was made to alter soft tissue morphology. The amount of required anterior maxillary repositioning was determined according to McNamara analysis.

A vertical discrepancy severely complicates the horizontal discrepancy in
Class III patients. It was shown that anteroposterior chin position could be controlled by selective alteration of the maxillary occlusal plane angulation. On the other hand, it was equally important to predict the effect of mandibular setback and bimaxillary surgeries on the vertical relationship of the jaws. In this regard, patients with mesofacial skeletal patterns were included in the present study group to test the effect of surgery type on vertical proportions. Parts of several analyses taken from several different authors were used to assess the vertical relationship differences following surgery.

Facial axis angle decreased significantly in both groups (2.7 degrees in mandibular setback and 3.7 degrees in bimaxillary patients), and no significant change was observed in other Ricketts parameters. The decrease in facial axis angle represented posterior rotation of the mandible. However, since no other changes in the rest of the parameters were determined, we found no increase in the vertical proportions of the face following single- or double-jaw surgery. The decrease in facial axis angle was probably a result of backward movement of the symphysis.

Delaire analysis showed the total hard tissue facial height that is ideal for a patient. The distance between ANS and N should be 45% of the total facial height, and the measurement from ANS to Me along this line should be 55% of the total facial height. The average upper and lower facial height proportions were closer to ideal in the single-jaw surgical patients in this study, but no significant changes were observed in either group following surgery. This was in accordance with Athanasiou, who found that anterior facial height was not altered following mandibular setback surgery.

According to Legan soft tissue analysis, the ratio of the distance from G to Sn and from Sn to Me should be 1 to 1. We could not achieve this objective in either of the surgery groups. Similar results were found with regard to facial proportions in an earlier study. As a consequence, ideal facial proportions could not be achieved only by sagittal correction of the jaws. Genioplasty procedures should also be included in the treatment plan to obtain more harmonious vertical facial proportions.

In contrast with the mandibular setback group, a significant anterior rotation of the occlusal plane was observed in the bimaxillary surgery group. Accordingly, Wolford and Epker also found anterior rotation of the occlusal plane in patients treated by anterior and posterior maxillary osteotomy and stated that this change remained stable. Sarver et al reported on several patients treated with surgical impaction of the posterior maxilla around the incisal tip to produce clockwise rotation of the occlusal plane.

In the present study, sagittal correction of the jaws had no effect on the vertical relationship of the jaws. Anterior rotation of the occlusal plane was observed only in the simultaneous maxillary advancement/mandibular setback surgery group. Therefore, if a change in facial vertical dimensions is planned, an anterior or posterior maxillary osteotomy is recommended.

### Table 3
Delaire and Legan measurements (mean ± SD) in mandibular surgical patients

<table>
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<th></th>
<th>Presurgical</th>
<th>Postsurgical</th>
<th>P</th>
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<tbody>
<tr>
<td>N-ANS (mm)</td>
<td>43.48 ± 2.312</td>
<td>43.19 ± 2.974</td>
<td>0.357</td>
</tr>
<tr>
<td>ANS-Me (mm)</td>
<td>56.52 ± 2.312</td>
<td>56.80 ± 2.974</td>
<td>0.333</td>
</tr>
<tr>
<td>G-Sn (mm)</td>
<td>73.80 ± 3.46</td>
<td>76.75 ± 5.46</td>
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<tr>
<td>Sn-Me' (mm)</td>
<td>70.15 ± 5.75</td>
<td>70.90 ± 4.80</td>
<td>0.594</td>
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</table>

*Significant.

### Table 4
Delaire and Legan measurements (mean ± SD) in bimaxillary surgical patients

<table>
<thead>
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<th></th>
<th>Presurgical</th>
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<th>P</th>
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<tbody>
<tr>
<td>N-ANS (mm)</td>
<td>41.94 ± 3.10</td>
<td>42.49 ± 1.77</td>
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<tr>
<td>ANS-Me (mm)</td>
<td>58.06 ± 3.10</td>
<td>57.43 ± 1.85</td>
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<tr>
<td>G-Sn (mm)</td>
<td>69.60 ± 5.15</td>
<td>71.20 ± 4.12</td>
<td>0.441</td>
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<tr>
<td>Sn-Me' (mm)</td>
<td>73.25 ± 7.18</td>
<td>71.80 ± 7.09</td>
<td>0.208</td>
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</table>

*Significant.
Conclusions

1. In both mandibular setback and simultaneous maxillary advancement/mandibular setback patients, no significant change in the vertical dimension was determined following surgery.
2. Facial axis closure was probably a result of retraction of the tip of the chin in both groups.
3. A counterclockwise rotation of the occlusal plane was observed in the bimaxillary surgery group, in contrast with the mandible-only surgery group.
4. In patients who require a change in the occlusal plane, bimaxillary surgery should be performed.

References