Transverse stability of the proximal segment after bilateral sagittal split ramus osteotomy for mandibular setback surgery


Abstract. This study aimed to evaluate the correlation between the transverse displacement of the proximal segment after bilateral sagittal osteotomy for mandibular setback and the amount and design of the mandibular setback. Patients who underwent either bilateral sagittal split ramus osteotomy (BSSRO) alone or two-jaw surgery were selected, and cephalographic postero-anterior (PA) measurements were taken pre-operatively (T1), immediately post-operatively (T2), and at follow-up (T3). The inter-gonal (IG) and inter-ramal (IR) width increased immediately after surgery, but decreased to the initial value during follow-up (P = 0.002; IR, P = 0.046). Only the immediate IG changes after surgery correlated with the amount of mandibular setback (P = 0.009). The IG changes were significant in the symmetric group, but not in the asymmetric group. There was no difference in the IG and IR changes between the symmetric group and the asymmetric group. The immediate IG change in two-jaw patients with symmetric setback showed correlation with the setback amount. The gonial width of the deviated group showed more significant changes than that of the non-deviated group. There was no difference in the unilateral gonial width between the deviated and the non-deviated group, but the difference was significant for the unilateral ramal angle between the two groups. These correlations will be helpful in predicting post-surgical results for patients.

Keywords: mandibular setback; mandibular prognathism; facial asymmetry; proximal segment; inter-gonal width.

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Bilateral sagittal split ramus osteotomy (BSSRO) is an effective and widely used method to correct a prognathic or retrognathic mandible. In Asian countries, the majority of patients treated with BSSRO are skeletal Class III. Despite the popularity of this surgical method, many unpredictable results have been described. In particular, changes in the gonial area after mandibular setback BSSRO are not well understood.

Several studies have reported the horizontal expansion of the gonial area following BSSRO or internal vertical ramus osteotomy (IVRO). Despite the various methods to maintain the condyle in its natural position, the setback of the distal segment appears to cause flaring of the proximal segment, leading to discomfort in the temporomandibular joint (TMJ) and a wider gonial width in the frontal view.

Drs. Kwon and Kim contributed equally to this work.
A better understanding of gonial widening would contribute to improved surgical planning, and the surgeon would be able to consider mandibular angle osteotomy or shaving pre-operatively.

Many factors affect the transverse displacement of the proximal segment, requiring different surgical considerations in each case. The condyle must be seated in its fossa with minimal change in the antero-posterior and mesio-distal ramal inclination. Also, the surgeon must decide on the location of the vertical osteotomy at the body of the mandible with prudence, because it determines the size and thickness of the proximal segment as well as affecting the contact area between the proximal and distal segments. Finally, the amount and design of the mandibular setback presents diversely for each individual as the treatment plan differs accordingly. This decides the amount of overlap of the two segments and the kicking out direction and amount of the distal segment. Among the above factors, the last factor mainly requires modifications of the surgical considerations for BSSRO.

The purpose of the present study was to evaluate the correlation between transverse changes in the proximal segment after BSSRO for mandibular setback surgery and the amount and design of the mandibular setback from four perspectives: (1) the inter-gonial distance (IG) and inter-ramal distance (IR) changes in association with the setback amount and difference; (2) the difference in IG and IR related to symmetric or asymmetric setback; (3) IG and IR changes in association with symmetric setback, also in regard to one-jaw and two-jaw surgery; and (4) the unilateral gonial width and the unilateral ramal angle changes related to the deviated or non-deviated side of the mandible.

Materials and methods

This study was conducted as a single-centre, retrospective investigation of 94 skeletal Class III patients who underwent orthognathic surgery; all the information from the patients was anonymized. Patients were selected using the following criteria: (1) patients who received BSSRO and Le Fort I + BSSRO surgery without any combinations; (2) patients fully able to complete the follow-up in accordance with the study protocol and who had complete records including frontal and lateral cephalograms; (3) patients for whom the BSSRO was internally fixated with monocortical miniplates and screws; (4) no craniofacial syndrome, trauma, or prior maxillofacial surgery; (5) no active periodontal disease judged severe by the surgeon; and (6) no severely missing teeth that may affect post-operative occlusion.

A total of 94 patients (49 females and 45 males) were selected. The mean age of the patients was 24 years (standard deviation 4.6 years). Forty-two patients received BSSRO and 52 patients received Le Fort I and BSSRO surgery. All patients received BSSRO for mandibular setback as described by Obwegeser and modified by Dal Ponte. The desired occlusion was designed into a prefabricated splint. The proximal segment was manually guided into its original position by measuring the distance of a certain point in the ascending ramus to two or more points in the maxillary archwire. The cephalometric radiographs were all taken using a CX 90SP instrument (Asahi, Japan). The same equipment, same film, and same focus distance were used to examine the patients. All radiographs were taken at optimal exposure; the anatomic landmarks were clearly visualized and were hand-traced for examination. The cephalograms were taken after the pre-surgical orthodontic treatment (T1), within 1 week after orthognathic surgery with intermaxillary fixation in the desired occlusion (T2), and at least 2 months post-operatively (T3), to analyse the skeletal movements.

Postero-anterior (PA) cephalometric radiographs were used to evaluate the angulation of the proximal segment and the mandibular width at the same time-points (Fig. 1). The reference points and planes were as follows: (1) ramus point (RP): the intersection of the mastoid process and the lateral border of the ramus (i.e., the most superior visible part on the lateral border of the ramus); (2) gonion (GO): most infero-lateral visible part of the ramal outline at the mandibular angle; (3) upper orbital margin (UOM): the most superior visible margin of the orbit.

Reference lines were designed to pass through GO and RP, and a tangent line to the UOMs was used as a horizontal reference plane. A true vertical line passing through the crista galli was used. Points GO and RP were identified on both sides and were then marked on the T1 to the T2 and T3 radiographs so that the anatomic landmark was best superimposed on the proximal segment cortical outline.

The measurements recorded were as follows: (1) medial ramus angles between UOMs and GO–RP lines (right and left); (2) distance between the left GO and the right GO (inter-gonial width); (3) distance between the left RP and the right RP (inter-ramal width); (4) perpendicular distance from GO to the true vertical line (right and left).

This study had four aims and patients were grouped accordingly: (1) To determine the association between the IG and IR changes and the setback amount and difference (n = 94). (2) The difference of IG and IR related to symmetric or asymmetric setback was analysed by grouping the patients into a symmetric setback group (n = 60) and an asymmetric setback group (n = 34). Asymmetric setback was defined as a setback difference of 2 mm or greater. (3) To determine the IG and IR changes in association with symmetric
setback, symmetric setback was defined as a setback difference of less than 2 mm, giving a total of 60 patients. To examine the association in more detail, the patients were divided into a one-jaw symmetric setback group (n = 24) and a two-jaw symmetric setback group (n = 36). (4) To analyse the unilateral gonial width and the unilateral ramal angle changes related to the deviated or non-deviated side of the mandible, the deviated side of the mandible was identified on the cephalometric PA film by the position of the menton point to the true vertical line. Patients who had the menton point along the true vertical line were excluded from this analysis (n = 86).

The differences in IG and IR values at T1, T2, and T3 were analysed by one-way analysis of variance (ANOVA), and the difference of IG and IR values at T1, T2, and T3 according to the particular study groups (symmetric/asymmetric setback, deviated/non-deviated side) was analysed by repeated measures ANOVA. The correlations between the setback amount and the respective groups were analysed by Spearman’s correlation method.

To test method error, 10 cases were selected at random, and all tracings and measurements were re-done by the same investigator (JY). Measurement errors were determined using the Dahlberg formula:

$$\sqrt{\frac{\sum D^2}{2N}}$$

where $D$ is the difference between re-measured values and $N$ is the number of double measurements ($n = 10$). Measurement errors for IG, IR, gonial width, and ramal angle were obtained, and the values were considered clinically insignificant.

Results

Table 1 shows the values of IG and IR before surgery (T1), within 2 days after surgery (T2), and at least 2 months post-surgery (T3). The transverse change in the proximal segment was clearly observed in the significant changes of IG and IR values. The IG and IR values increased from T1 to T2, with a mean of 2.72 mm and 2.49 mm, respectively ($P = 0.005$ and $P = 0.050$), but decreased in the follow-up radiograph (T3) ($P = 0.002$ and $P = 0.046$, Table 2), almost corresponding to the pre-surgical values (Table 1).

**Table 1.** Inter-gonial (IG) and inter-ramal (IR) measurements, before surgery (T1), within 2 days after surgery (T2), and at least 2 months post-surgery (T3) ($n = 94$).

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T1–T2</th>
<th>T2–T3</th>
<th>T1–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>IG</td>
<td>105.8</td>
<td>6.81</td>
<td>108.5</td>
<td>6.55</td>
<td>105.5</td>
<td>6.54</td>
</tr>
<tr>
<td>IR</td>
<td>116.3</td>
<td>12.37</td>
<td>118.7</td>
<td>6.29</td>
<td>116.2</td>
<td>5.72</td>
</tr>
</tbody>
</table>

SD, standard deviation.

**IG and IR changes in association with the setback amount and difference**

Tables 3 and 4 show the significance in the correlation of the IG and IR changes according to setback amount and difference. Only the IG value change from T1 to T2 was significantly associated with the setback amount ($P = 0.009$). There was no significant correlation with either the setback amount or the setback difference in IG and IR values at other T1, T2, and T3.

**Differences in IG and IR related to symmetric or asymmetric setback**

Table 5 shows the IG and IR values in symmetric ($n = 60$) and asymmetric ($n = 34$) setback groups at T1, T2, and T3.

**Table 2.** Significance of inter-gonial (IG) and inter-ramal (IR) value changes between T1, T2, and T3.

<table>
<thead>
<tr>
<th></th>
<th>T1–T2</th>
<th>T2–T3</th>
<th>T1–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IG</td>
<td>$P = 0.005$</td>
<td>$P = 0.002$</td>
<td>$P = 0.733$</td>
</tr>
<tr>
<td>IR</td>
<td>$P = 0.050$</td>
<td>$P = 0.046$</td>
<td>$P = 0.970$</td>
</tr>
</tbody>
</table>

T1, before surgery; T2, within 2 days after surgery; T3, at least 2 months post-surgery.

**Table 3.** Correlation of inter-gonial (IG) and inter-ramal (IR) changes in association with the setback amount.

<table>
<thead>
<tr>
<th>Setback amount</th>
<th>T1–T2</th>
<th>T2–T3</th>
<th>T1–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IG</td>
<td>P-value</td>
<td>r-value</td>
<td>P-value</td>
</tr>
<tr>
<td></td>
<td>0.009</td>
<td>−0.267</td>
<td>0.116</td>
</tr>
<tr>
<td>IR</td>
<td>0.225</td>
<td>−0.126</td>
<td>0.536</td>
</tr>
</tbody>
</table>

T1, before surgery; T2, within 2 days after surgery; T3, at least 2 months post-surgery.

**Table 4.** Correlation of inter-gonial (IG) and inter-ramal (IR) changes in association with the setback difference.

<table>
<thead>
<tr>
<th>Setback difference</th>
<th>T1–T2</th>
<th>T2–T3</th>
<th>T1–T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IG</td>
<td>P-value</td>
<td>r-value</td>
<td>P-value</td>
</tr>
<tr>
<td></td>
<td>0.917</td>
<td>−0.011</td>
<td>0.702</td>
</tr>
<tr>
<td>IR</td>
<td>0.068</td>
<td>0.189</td>
<td>0.867</td>
</tr>
</tbody>
</table>

T1, before surgery; T2, within 2 days after surgery; T3, at least 2 months post-surgery.
Table 5. Inter-gonial (IG) and inter-ramal (IR) changes in symmetric\(^a\) and asymmetric\(^b\) setback patients.

<table>
<thead>
<tr>
<th></th>
<th>IG</th>
<th></th>
<th>IR</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Symmetric((n = 60))</td>
<td>106.14</td>
<td>6.80</td>
<td>108.83</td>
<td>6.41</td>
</tr>
<tr>
<td>Asymmetric((n = 34))</td>
<td>105.17</td>
<td>6.90</td>
<td>107.95</td>
<td>6.86</td>
</tr>
<tr>
<td>Symmetric((n = 60))</td>
<td>117.53</td>
<td>6.26</td>
<td>118.71</td>
<td>6.59</td>
</tr>
<tr>
<td>Asymmetric((n = 34))</td>
<td>114.01</td>
<td>18.80</td>
<td>118.81</td>
<td>5.83</td>
</tr>
</tbody>
</table>

SD, standard deviation; T1, before surgery; T2, within 2 days after surgery; T3, at least 2 months post-surgery.
\(^a\) Symmetric = setback difference less than 2 mm.
\(^b\) Asymmetric = setback difference with 2 mm or greater.

Significant correlation for the other intervals for the one-jaw or two-jaw patient groups.

Unilateral gonial width and unilateral ramal angle changes related to the deviated or non-deviated side of the mandible

Table 9 shows the unilateral gonial width and unilateral ramal angle values of the deviated and non-deviated sides at T1, T2, and T3. The unilateral gonial width increased at T2 and decreased again at T3 with statistical significance on the deviated side \((P\)-values T1–T2: 0.013, T2–T3: 0.012, T1–T3: 0.995\). The non-deviated side showed the same pattern, but the change between the intervals was not statistically significant \((P\)-values T1–T2: 0.085, T2–T3: 0.053, T1–T3: 0.829\). There was no statistical difference between the deviated group and the non-deviated group concerning the gonial width \((P = 0.400)\). There were no significant unilateral ramal angle changes throughout the intervals for both groups \((deviated T1–T2–T3: P = 0.172, non-deviated T1–T2–T3: P = 0.406)\), however the difference between the deviated group and the non-deviated group concerning the ramal angle was significant \((P = 0.002)\).

Discussion

Transverse displacements have been studied in various methods along with many factors affecting the skeletal stability after orthognathic surgery. Most of the previous studies have focused on the stability in the sagittal dimension, as the main treatment objective was based on the prognathism or retrognathism.\(^1,6\) The position of the proximal segment after surgery led to many horizontal and vertical changes of the mandible in both coronal and sagittal view. These changes were suggested as influential sources of skeletal relapse post-operatively. Kwon et al.\(^7\) studied the three-dimensional stability of simultaneous...
Table 9. Unilateral gonial width and ramal angle values in deviated and non-deviated sides.\textsuperscript{a}

<table>
<thead>
<tr>
<th></th>
<th>T1 Mean</th>
<th>SD</th>
<th>T2 Mean</th>
<th>SD</th>
<th>T3 Mean</th>
<th>SD</th>
<th>T1–T2 P-value</th>
<th>T2–T3 P-value</th>
<th>T1–T3 P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gonial width</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviated (n = 86)</td>
<td>52.92</td>
<td>4.22</td>
<td>54.85</td>
<td>5.83</td>
<td>52.91</td>
<td>4.92</td>
<td>0.013</td>
<td>0.012</td>
<td>0.995</td>
</tr>
<tr>
<td>Non-deviated (n = 86)</td>
<td>52.72</td>
<td>4.37</td>
<td>53.83</td>
<td>4.22</td>
<td>52.58</td>
<td>4.02</td>
<td>0.085</td>
<td>0.053</td>
<td>0.829</td>
</tr>
<tr>
<td><strong>Ramal angle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviated (n = 86)</td>
<td>83.56</td>
<td>3.45</td>
<td>84.43</td>
<td>3.81</td>
<td>83.42</td>
<td>3.69</td>
<td>0.137</td>
<td>0.083</td>
<td>0.805</td>
</tr>
<tr>
<td>Non-deviated (n = 86)</td>
<td>81.90</td>
<td>3.95</td>
<td>82.43</td>
<td>3.87</td>
<td>81.58</td>
<td>4.18</td>
<td>0.406</td>
<td>0.184</td>
<td>0.617</td>
</tr>
</tbody>
</table>

SD, standard deviation; T1, before surgery; T2, within 2 days after surgery; T3, at least 2 months post-surgery.

\textsuperscript{a} n = 86: patients with exact symmetric protrusions were excluded. Significance P = 0.400 gonial width; significance P = 0.002 ramal angle.

maxillary advancement and mandibular setback using rigid fixation and reported that for an average mandibular setback of 5.7 mm, the mean mandibular relapse was 1.1 mm or 19.3% anteriorly. Busby et al.\textsuperscript{8} reported that 85% of the maxillary advancement group and the mandibular setback group showed less than 4 mm of postsurgical change from 1 year to 5 years and beyond.

Another major theme of stability after BSSRO is the position of the condyle after mandibular setback surgery. Mandibular advancement or setback may cause the proximal segment to move horizontally or to rotate three-dimensionally, determining a new ramal angle in the sagittal and coronal dimensions, and thus leading to a new condylar relationship in the glenoid fossa.

When fixing the two segments forcibly, bony interferences may hinder maximum surface contact and cause a rotation at a certain contact point. If the rotating point is anterior–inferior, the condyle will torque medially, and if it posterior–superior, the condyle will torque laterally. Such torque movements may compress the glenoid fossa and cause condylar resorption in the contact area, and furthermore, skeletal and dental relapse.\textsuperscript{9}

Ueki et al.\textsuperscript{10} evaluated the bone formation after sagittal split ramus osteotomy with bent plate fixation using computed tomography and showed an immediate increase in the medio-lateral width of the ramus after surgery and a decrease near to the original value at 1 year follow-up. Maximum approximation of the two segments would rather cause more stress on the TMJ, and the posterior part of the distal segment on the deviated side may interfere with the proximal segment. Maintaining the minimal gap passively by bending the plates will give more stable results, especially in asymmetric mandibles. Many suggestions in trimming the overlapping and hindering areas between the two segments and in preventing the kicking out movements have been considered. Greenstick fractures in the posterior part of the distal segment may reduce the flaring out of the proximal segment and others have designed a modified sagittal split ramus osteotomy to minimize displacement of the proximal segment in asymmetric cases.\textsuperscript{11}

It has been suggested that the fixation method after osteotomy may act as an important factor in causing torque force in the condyle area as well as displacement of the proximal segment. Hackney et al.\textsuperscript{12} suggested that clamp placement and subsequent screw osteosynthesis have more influence on condylar displacement than the direction and amount of surgical advancement. Stroser and Pangrazio-Kulscher\textsuperscript{13} showed that the use of rigid internal fixation following BSSRO resulted in a greater transverse condylar displacement than wire fixation. The method of fixation that best reduces the displacement of the proximal segment is not yet known. Becktor et al.\textsuperscript{14} reported a study comparing the effect of fixation techniques on the transverse displacement of the proximal segment after bilateral sagittal osteotomy. The results showed that there was no statistically significant difference in the amount of transverse displacement of the proximal segment when using titanium miniplates and monocortical screws compared with the lag screw technique.\textsuperscript{14,15}

Some studies have evaluated the skeletal stability of the proximal segment by submentovertex radiography and computed tomography for three-dimensional changes.\textsuperscript{12,13} The measurement methods selected in this study were adapted from the method presented by Becktor et al.\textsuperscript{16} using PA cephalometric radiographs. PA cephalometric radiographs are routinely obtained in BSSRO patients, and the reliability of this method has been demonstrated.\textsuperscript{17} Landmark identification, observer experience, density and sharpness of the image, and position of the head can all contribute to error in evaluation. Identification error can be assessed by double-determination, and Dahlberg’s formula was applied to calculate the method error. The landmark GO (gonion) may be very useful in transverse measurements because the gonion has the smallest intra-examiner errors in the horizontal dimension.\textsuperscript{18} Inter-gonial width and ramal angle measurements were found to have very high inter-examiner reliability, showing almost perfect agreement. Some degrees of up and down tilting of the head are inevitable in patients, especially after surgery, and this could be suggested as a source of error. However, a change of up to 10° of up and down movement or right and left rotation of the head has been shown to be less than the method error and therefore a negligible factor in breadth measurements on PA cephalograms.\textsuperscript{19}

Intercondylar width seems to decrease after bilateral sagittal split osteotomy setback and to increase after mandibular advancement.\textsuperscript{15} Choi et al.\textsuperscript{2} reported an immediate increase in the inter-gonial width (mean 3.6 mm) after mandibular setback, and the inter-gonial width and the ramus angle significantly decreased during follow-ups, which may be attributed to the transverse relapse or cortical surface remodelling. Comparisons between the amount of surgical mandibular setback and the transverse displacement of the proximal segments as a result of the surgery showed no statistically significant correlations.\textsuperscript{4}

In the present study, the inter-gonial width and the inter-ramal width increased (mean 2.72 mm and 2.49 mm, respectively) immediately after surgery. There was a significant correlation in the amount of mandibular setback and the immediate change in inter-gonial width after surgery. But there was no other significant correlation in the setback amount and the IG and IR at other time-periods. The mean amount of increase after surgery was smaller than that reported by Choi et al.\textsuperscript{4} Also, the mean decrease from T2 to T3 was greater (mean −3.05 mm), depicting a total decrease in the transverse width (mean −0.33 mm). The correlation of
the proximal segment changes with the setback amount in the sagittal plane is due to the explanation that the further the distal segment is set back, the greater the tendency for the proximal segment to flare out and rotate. Compared with advancement BSSRO, the amount of setback appears to correlate less frequently with the amount of relapse. However this may be because there are fewer studies of setback BSSRO than advancement BSSRO. In a study of sagittal skeletal relapse after BSSRO reported by Mobarak et al.,20 the amount of setback at the pogonion correlated significantly to the relapse at pogonion 3 years postsurgically. Franco et al.21 found that the amount of setback was the only predictor of relapse in their study. However in the coronal plane, this study suggests that the amount of setback only affects the immediate postoperative transverse change and has no significance with the relapse. The setback difference was not a factor in causing significant transverse change of the proximal segment.

As transverse changes of the proximal segments are sensitive to the direction of the mandibular setback, whether it is parallel or rotated, symmetric and asymmetric design setbacks were analysed separately in this present study. Displacement of the proximal segment is more likely expected to occur in patients with mandibular asymmetry than in those with symmetry. Harada et al.22 investigated the postoperative stability of BSSRO of Class III asymmetric patients and compared the results of symmetric versus asymmetric patients. They found a significant increase in the width of the mandible at the gonion points immediately after the operation, but there was no significant difference between the two groups. However the symmetric group showed relatively stable width, whereas the asymmetric group showed stable results only after a certain amount of decrease for 3 months postoperatively. In this study, the symmetric and asymmetric groups were divided according to the suggestion reported in the study of Beyer and Lindauer,23 the mean threshold for acceptable dental midline deviation was 2.2 mm. Unlike the study of Harada et al.,22 the inter-gonial width increased and decreased significantly in the symmetric group, but the asymmetric group only followed the trend with no statistical significance. This can be explained by the surgical considerations involved in treating asymmetric setback to reduce the flaring out movement of the proximal segment. When the groups were further divided into one-jaw and two-jaw groups, the two-jaw group changes were significantly correlated with the setback amount. This correlation in two-jaw patients is probably due to the smaller mean and range of the setback amount, as well as the more three-dimensional setback of the mandible affecting the proximal segment. From these results, a certain increase of the inter-gonial width can be expected from a symmetric setback BSSRO, and the greater the amount of setback, the greater the increase in inter-gonial width in two-jaw patients. Al-Gunaid et al.21 divided patients into bilateral internal vertical ramus osteotomy (BIVRO), BSSRO, and BIVRO + BSSRO groups and reported that there were no differences in the gonial width between the deviated and non-deviated sides in all groups. In this study, the unilateral gonial width of the deviated side increased (mean 1.93 mm) after sagittal split ramus osteotomy surgery with significance, but decreased at follow-up to its previous value. On the non-deviated side, the increase was present (mean 1.11 mm) but was not statistically significant. There was no significant difference between the deviated and the non-deviated group. The ramal angle increased immediately after surgery on both sides, but without significance. However the difference of ramal angle values between the deviated and the non-deviated group was statistically significant. The asymmetric prognathism cases in this study had not been classified in detail, and for more clinically significant results concerning the ramal angle changes, further studies with such classifications of facial asymmetry applied in the selection of patients are required.

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Competing interests
None declared.

Ethical approval
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