Bilateral Sagittal Split Osteotomy for Correction of Mandibular Prognathism: Long-Term Results

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Purpose: To identify the long-term maxillomandibular changes after surgical correction of mandibular prognathism using bilateral sagittal split osteotomy (BSSO).

Patients and Methods: Twenty patients who underwent BSSO to setback the mandible and had cephalometric radiographs taken preoperatively and postoperatively at 6 weeks, 1 year, and long-term follow-up (mean, 28 months). The cephalograms were traced and measured to determine the operative and postoperative changes. Correlation analyses were performed to see the relationship between the magnitude of setback and the amount of long-term postsurgical change at B point and pogonion.

Results: The mean surgical setback was 8.2 mm at B point and 8.8 mm at pogonion. The mean long-term horizontal relapse was 2.3 mm (28.0%) at B point and 3.0 mm (34.1%) at pogonion. Out of 20 patients, 12 (60.0%) relapsed horizontally greater than 2 mm at B point and 13 (65.0%) at pogonion. The mean vertical surgical changes showed downward displacement of B point (2.3 mm) and pogonion (2.0 mm). The mean long-term vertical relapse was 1.6 mm (69.6%) at B point and 1.7 mm (85.0%) at pogonion.

Conclusion: There was no correlation between the magnitude of setback and the amount of relapse at B point and pogonion. However, there was significant correlation between the magnitude of vertical, downward surgical displacement and the amount of vertical relapse at B point and pogonion. The majority of the maxillofacial changes occurred within 1 year postoperatively.

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Bilateral sagittal split osteotomy (BSSO) is commonly applied to correct mandibular prognathism. Despite the long experience with this procedure, relapse or movement of an anatomic point toward the presurgical position is always encountered. In a report on the hierarchy of stability of orthognathic surgery, Proffit et al[1] ranked isolated mandibular setback as the third least stable orthognathic surgical movement after maxillary inferior repositioning and transverse maxillary expansion. Komori et al[2] pointed out that early relapse may be because of the surgical technique, whereas later true relapse is multifactorial in nature and could be caused by, or obscured by, removal of the interocclusal wafer, possible mandibular growth, bone remodeling, postoperative orthodontic treatment, and/or differences in follow-up duration.

The reported horizontal relapse rates for isolated mandibular setback show a great variation from 0.2 mm to 4.2 mm (2.3% to 91.3%) as shown in Table 1. However, with regard to the vertical relapse most authors uniformly reported minimal values (Table 2). The reasons given to explain the horizontal relapse are still speculative and include the magnitude of setback,[3-7] the method of fixation,[1,8] remodeling or repositioning of the condyle,[9,10] and forward pull of the pterygomassteric sling.[9-11] The explanations given for stability include proper presurgical orthodontics,[5,12] long-term maxillomandibular fixation (MMF) and nonrigid fixation that allowed muscular adaptation,[11,21] minimal muscle alteration,[12,21] good bony contact, and control of the proximal segments.[12]

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Table 1. HORIZONTAL RELAPSE RATES REPORTED IN THE LITERATURE

Study	Rigid Fixation	Sample	Follow-Up (mos)	Landmark	Setback (mm)	Relapse (mm)	Relapse Rate
Franco et al, 1989[3]	2.0 mm screws ≤1 wk MMF	14	6–36 [24.1]	Pogonion	4.87	2.13	43.7%
Krekmanov et al, 1989[20]	Screws Elastics if required	14	12	"Corner fiducials"	6.3	0.8	12.6%
Sorokolit & Nanda, 1990[12]	2.0 mm screws	25	7–42 [15.3]	B Point	5.1	.51	9.8%
Proffit et al, 1991[10]	Screws	11	12	B Point	5.8	3.6	62.1%
				Pogonion	4.6	4.2	91.3%
Ingervall et al, 1995[4]	3.5 screws MMF 4–8 days	29	14	Pogonion	6.0	1.3	21.7%
Schatz & Tsimas, 1995[19]	RIF	13	12	B Point	7.27	2.85	39.2%
				Pogonion	7.13	3.52	49.4%
Ayoub et al, 2000[9]	Screws 2–3 wks elastics	15	12	Gonion	5.7	2.5	43.9%
Mobarak et al, 2000[6]	2.0 mm screws	80	36	B Point	6.93	1.27	18.3%
				Pogonion	6.28	1.63	25.9%
	Nonrigid Fixation						
Kobayashi et al, 1986[5]	7 wks MMF 2–20 wks elastics 6 mos chin cup	44	12	B Point	8.4	0.6	7.1%
				Pogonion	8.4	0.2	2.3%
Michiwaki et al, 1990[11]	5–10 wks MMF	24	12–24 [16]	Gnathion	5.6	1.5	26.8%
Proffit et al, 1991[10]	MMF	29	12	B Point	5.5	2.6	47.3%
				Pogonion	5.1	2.6	51.0%
Park et al, 1994[14]	6 wks MMF	10	7–38 [19.6]	Pogonion	<10	–	27.2%
Rodriguez & Gonzalez, 1996[7]	6 wks MMF	14	6	Pogonion	8.75	2.23	26.0%

Abbreviation: MMF, maxillomandibular fixation.

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Other reports have shown no relation of the magnitude of setback to the relapse[9,11,12] and no significant difference between groups with and without presurgical orthodontics.[11] Because BSSO is a technique-sensitive procedure from presurgical preparation to the operation itself and the postsurgical management by both the orthodontist and surgeon, many factors such as those mentioned above could indeed affect its outcome.

A recent review by Costa et al[13] mentioned that BSSO fixed with wire osteosynthesis provided greater stability than those that used rigid internal fixation. However, few studies have been published with this technique in comparison to those stabilized with rigid internal fixation. And among these studies few have reported on the long-term results, with the longest follow-up being an average of 19.6 months (range, 7 to 38 months) among 10 patients.[14] Bailey et al[15] studied the long-term results of surgical Class III treatment and reported on different combinations of procedures (1- and 2-jaw). For the isolated mandibular setback cases (mean follow-up, 3.7 years; 18 patients), the results for the rigid internal fixation and wire fixation groups were combined, 3.43 mm of relapse at B point and 3.44 mm at pogonion. Additionally, most of the previous studies have reported only on the anterior changes in the mandible at B point, pogonion, gonion, or gnathion. This article now aims to evaluate the long-term results of BSSO procedures for isolated mandibular setback stabilized with wire osteosynthesis and to describe in detail the horizontal and vertical changes that occur in the anterior and posterior portions of the mandible.

Methods

A total of 20 patients were included in this study based on the following criteria: *1*) mandibular prognathism without or with chin deviation of less than 3 mm; *2*) mandibular setback through a BSSO with or without genioplasty; *3*) no associated maxillary orthognathic procedures; *4*) available preoperative and postoperative radiographs with a follow-up of 12

Table 2. VERTICAL RELAPSE RATES REPORTED IN LITERATURE

Author	Rigid Fixation	Sample	Follow-Up (mos)	Landmark	Movement (mm)	Relapse (mm)	Relapse Rate*
Krekmanov et al, 1989[20]	Screws Elastics if required	14	12	"Corner fiducials"	−1.2	−0.9	75%
Sorokolit & Nanda, 1990[12]	2.0 mm screws	25	7–42 [15.3]	B Point	.77	−.05	6.5%
				Menton	.88	.14	15.9%
Proffit et al, 1991[10]	Screws	11	12	B Point	0.1	1.3	1,300%
				Pogonion	0.0	0.6	–
Ingervall et al, 1995[4]	3.5 screws MMF 4–8 days	29	14	Pogonion	−2.0	−0.2	10%
Schatz & Tsimas, 1995[19]	RIF	13	12	B Point	−0.65	−2.47	380%
				Pogonion	−0.2	−2.08	1,040%
Ayoub et al, 2000[9]	Screws 2–3 wks elastics	15	12	B Point	0.2	0.7	350%
				Gonion	1.1	1.5	136.4%
Mobarak et al, 2000[6]	2.0 mm screws	80	36	B Point	−1.08	−0.51	47.2%
				Pogonion	−1.17	−0.53	45.3%
	Nonrigid Fixation						
Kobayashi et al, 1986[5]	7 wks MMF 2–20 wks elastics 6 months chin cup	44	12	B Point	−3.1	−0.3	9.7%
				Pogonion	−3.0	0.0	0.0%
Michiwaki et al, 1990[11]	5–10 wks MMF	24	12–24 [16]	Gnathion	−2.4	0.0	0.0%
Proffit et al, 1991[10]	MMF	29	12	B Point	0.5	−1.2	240%
				Pogonion	0.3	−1.6	533.3%

NOTE: Negative values mean superior movement.
Abbreviation: MMF, maxillomandibular fixation.
*When converted to percentages of the surgical movement, large numbers are obtained although in actuality the relapse values could be considered clinically insignificant.

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months or longer and; 5) no history of trauma or associated craniofacial anomaly.

There were 15 females (75%) and 5 males (25%) with an average age of 24.1 years (range, 17 to 45 years) at the time of operation. Of the 20 cases, 8 (40%) had mild chin deviation of less than 3 mm. Patients who had asymmetric mandibles were excluded because it had been found that large lateral shifts of the mandible during setback significantly contributed to relapse.[5] Twelve patients (60%) underwent BSSO while 8 patients (40%) underwent BSSO and genioplasty (3 advancements and 5 vertical reductions). Patients who underwent genioplasty were included in the study because this procedure has been found to be stable.[16,17]

Minimal presurgical orthodontics was started 1 to 2 months before surgery with no intention to decompensate the axial inclination of the lower incisors. A single surgeon (Y.R.C.) using the same BSSO technique and type of wire fixation operated on all patients. The entire pterygomasseteric sling was stripped from its attachment at the inferior and posterior borders of the mandible to allow retraction of the soft tissues and visualization of the osteotomy sites. Care was taken to allow the proximal segment to stay passively beside the lateral portion of the distal segment after the MMF was applied. Premature bony contacts were trimmed with a bur. Fixation was achieved using wire osteosynthesis at the superior border of the mandible distal to the last molar. MMF with an acrylic stent was maintained for 6 weeks.

Two lateral cephalometric radiographs (1 in centric occlusion and 1 in maximum open-mouth) were obtained preoperatively (T1), at the time of release of the MMF (T2), 1 year postoperatively (T3), and at longest follow-up (T4) with an average of 28 months (range, 12 to 53 months). Radiographs were traced by the same investigator (G.H.V.) and verified for accuracy by another investigator (C.S.H.). A special technique of tracing the condyles correctly, as described by Huang and Ross,[18] was performed on a cephalometric radiograph taken while the patient was in a maximum open-mouth position to reveal both condyles. An x-y coordinate was constructed on the tracings using a line drawn from the sella point and 6° downward from the sella-nasion line to approximate

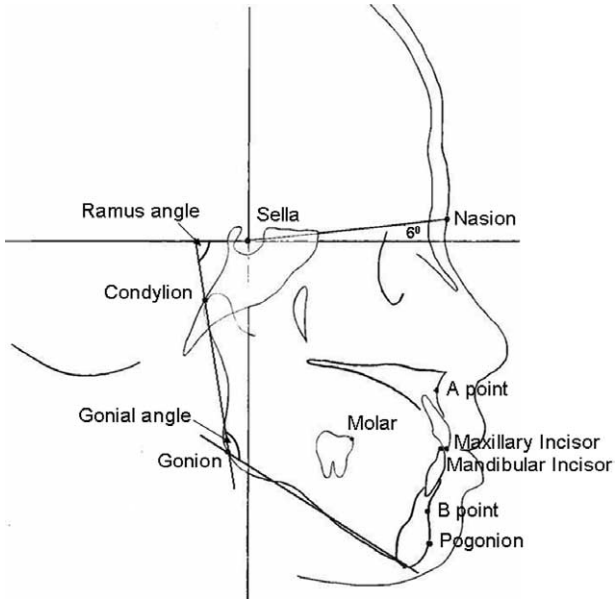

FIGURE 1. Reference points and cephalometric landmarks used in the study.

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the true horizontal axis, and a vertical line perpendicular to this through the point in sella.[10] Cephalometric landmarks were chosen similar to those in the study by Proffit et al.[10] These were marked and analyzed in relation to the x-y coordinates (Fig 1).

To evaluate the error of method, 10 randomly selected cephalometric radiographs were retraced and remeasured. No systematic errors were detected on the measurements as determined by paired *t* tests. Random errors were calculated using the formula $s = \sqrt{\sum(d)^2/2n}$, (where d is the difference between the 2 measurements and n is the number of pairs).[4] The results are shown in Table 3.

Results

Mean surgical movements and long-term horizontal and vertical changes in the landmarks are shown in Table 4. The mean surgical setback at B point was 8.2 mm with an average forward horizontal displacement of 2.3 mm (or 28.0%). The mean surgical setback at pogonion was 8.8 mm with an average forward horizontal displacement of 3.0 mm (or 34.1%). The mean surgical setback at gonion was 6.4 mm with an average forward horizontal displacement of 3.1 mm (or 48.4%). All 3 points moved forward after surgery. The overall direction of the vertical surgical movement was downward for B point (2.3 mm) and pogonion (2.0 mm), and upward for gonion (2.3 mm). The overall long-term postsurgical change was upward for all 3 points, 1.6 mm (69.6%), 1.7 mm (85.0%), and 0.8 mm (34.8%), respectively.

The mandibular incisors moved posteriorly an average of 6.8 mm and remained in relatively the same horizontal position postsurgically. Their overall vertical surgical movement was 1.2 mm downward and the overall postsurgical change was 1.1 mm or 91.7% upward. The condyle, A point, and maxillary incisors had very little (<1 mm) mean horizontal and vertical movements after surgery although when presented in terms of percentages of the surgical movement, large values are obtained in some instances.

The mean mandibular plane angle increased an average of 3.5° with surgery and remained in relatively the same position. The mean ramus angle increased an average of 5.2° with surgery and decreased an average of 3.3° or 63.5% postsurgically. Figure 2 shows the surgical movement (increase of 1.0 to 11.0°) and the long-term changes (decrease of 0 to 6.5°) of the ramus angle of each individual subject. The gonial angle decreased 1.7° at surgery and increased an average of 2.8° or 164.7% postsurgically.

A 2-mm change in the position of a landmark was considered clinically significant and beyond the range of cephalometric error.[10] To show the individual alterations among the subjects, the vertical and horizontal surgical movements and long-term postsurgical changes were plotted in bar graphs and are shown in Figures 3-6. This breakdown shows the percentages

Table 3. ERROR OF METHOD OF THE CEPHALOMETRIC TRACINGS

	Random Error (s)	*t* Test (*P* Value)*
Horizontal		
B point	0.92	.166
Pogonion	1.29	.141
Gonion	0.62	.376
Mandibular incisor	0.35	.053
Maxillary incisor	0.56	.252
A point	0.53	.277
Condylion	0.22	.592
Vertical		
B point	0.56	.698
Pogonion	0.59	.587
Gonion	0.29	.458
Mandibular incisor	0.19	.362
Maxillary incisor	0.32	.309
A point	0.26	.653
Condylion	0.26	.481
Angle		
Md plane angle	0.44	.638
Ramus angle	0.22	.319
Gonial angle	0.45	.733

*Significant at $P < .05$.

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Table 4. HORIZONTAL AND VERTICAL CHANGES AT LONG-TERM FOLLOW-UP

	Surgical Movement		Long-Term Change		
	Mean	SD	Mean	SD	Percentile
Horizontal changes					
B Point	−8.2	3.0	2.3	1.6	28.0
Pogonion	−8.8	4.1	3.0	1.8	34.1
Gonion	−6.4	2.9	3.1	1.7	48.4
Md Incisor	−6.8	2.9	0.1	2.3	1.3
Mx Incisor	0.3	1.2	−0.1	1.6	33.3
A Point	−0.2	0.7	−0.2	1.2	100.0
Condylion	−0.3	1.1	−0.3	1.0	100.0
Vertical changes					
B Point	2.3	2.2	−1.6	1.6	69.6
Pogonion	2.0	2.8	−1.7	1.4	85.0
Gonion	−2.3	3.3	−0.8	1.7	34.8
Md Incisor	1.2	2.7	−1.1	1.5	91.7
Mx Incisor	0.9	1.2	−0.3	1.1	33.3
A Point	0.2	0.7	0.0	0.9	0.0
Condylion	0.1	0.9	0.0	0.9	0.0
Angular changes					
Md plane angle	3.5	4.0	−0.5	1.7	14.3
Ramus angle	5.2	2.8	−3.3	1.7	63.5
Gonial angle	−1.7	4.2	2.8	2.1	164.7

NOTE. Linear values are in millimeters and angular values are in degrees.

Horizontal: (−) = posterior movement; vertical: (−) = superior movement; angle: (−) = decrease.

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of patients with the corresponding amounts and directions of movements at the designated points. At surgery (Fig 3) the surgical movement of B point, pogonion, gonion, and the mandibular incisors were all posterior. The condyles, A point, and maxillary incisors moved very little (<2 mm) either anteriorly or posteriorly. In the vertical plane (Fig 4) there was more downward movement of B point, pogonion,

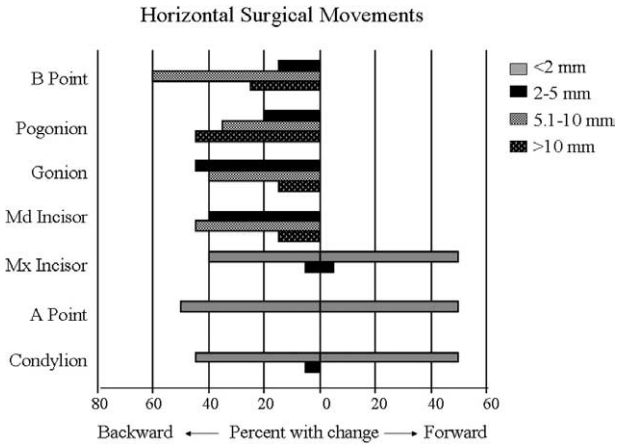

FIGURE 3. Mean horizontal surgical movements of the cephalometric points are divided into clinically insignificant (<2 mm), small (2-5 mm), intermediate (5.1–10 mm), and large movements (>10 mm). The majority of patients (60%) had intermediate setbacks at B point while the majority (45%) had large setbacks at pogonion; only 2 of them belonged to the genioplasty group. The gonion and mandibular incisor moved posteriorly in conjunction with the movement of the chin while the A point, maxillary incisor, and condyle had mostly insignificant movements.

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and maxillary and mandibular incisors. The gonion moved upward more, while the condyle and A point stayed in relatively the same position.

Postsurgically, (Fig 5) the long-term forward displacements exhibited by B point, pogonion, and gonion generally belonged to the 2–4 mm group and, for these 3 points, more than half of the patients showed alterations that were greater than 2 mm (60%, 65%, and 75%, respectively for B point, pogonion, and gonion). One patient who had the greatest long-term change at pogonion (6.5 mm) was a 17-year-old male. The condyle, A point, and maxillary and mandibular incisors showed

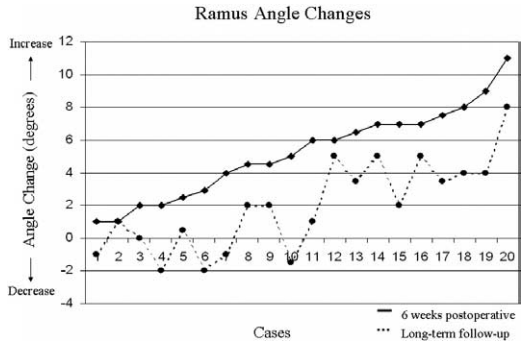

FIGURE 2. Ramus angle surgical and long-term changes for each individual case are plotted to show the increase in the angle measurement with surgical repositioning of the mandible and the decrease in the measurement seen at long-term follow-up.

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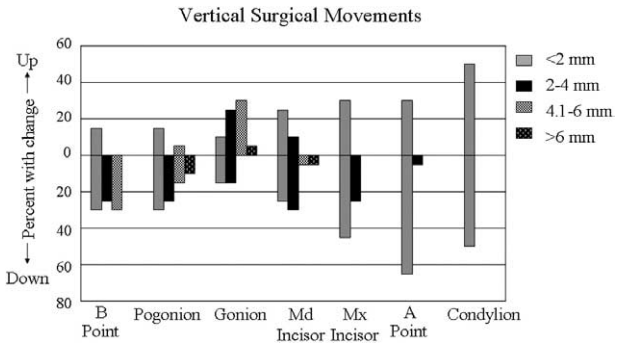

FIGURE 4. Vertical surgical movements of B point, pogonion, and mandibular and maxillary incisors (mostly <2 mm) were generally downward, while the gonion moved upward in more cases; A point and the condyle had mostly clinically insignificant vertical movements in either direction.

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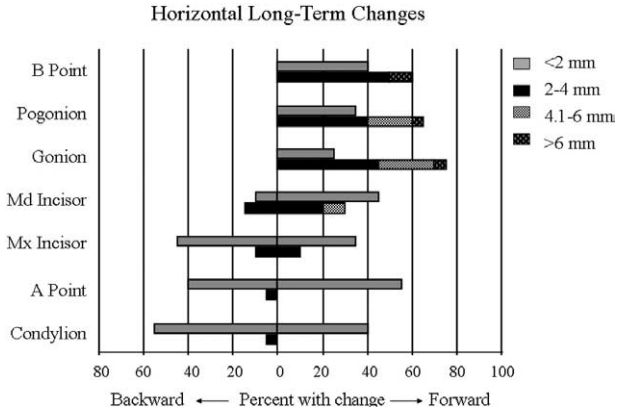

FIGURE 5. Horizontal long-term changes were divided between the clinically insignificant (<2 mm) and significant (≥2 mm). The latter was further divided into 2 mm increments (stacked bars) to show the magnitude of the changes. Results showed that B point, pogonion, and gonion showed more cases with clinically significant relapse (60%, 65%, and 75%, respectively) and most of the values belonged to the 2-4 mm group. The A point, mandibular and maxillary incisors, and condyle had mostly <2 mm long-term postoperative changes in both directions.

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displacements in both directions with more cases belonging in the less than 2 mm group. Generally, all points showed little vertical postsurgical changes (Fig 6), which were mostly in the upward direction for B point, pogonion, and mandibular incisors. The gonion and maxillary incisors moved almost equally in both directions with the gonion showing greater magnitudes in the upward direction. The A point and condyle showed mostly less than 2 mm of upward or downward vertical displacements.

Correlation analyses were performed to see the relationship between the magnitude of setback and the

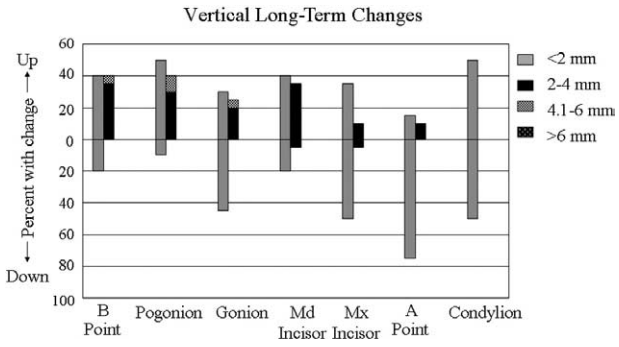

FIGURE 6. Vertical long-term changes were divided similar to that of the horizontal long-term changes. The B point, pogonion, and mandibular incisor moved upward in most cases, while the gonion moved in both directions, with some cases (25%) showing bigger magnitudes upward. Out of 20 patients, 8 (40.0%) relapsed greater than 2 mm at both B point and pogonion. The A point, maxillary incisor, and condyle had mostly clinically insignificant long-term changes.

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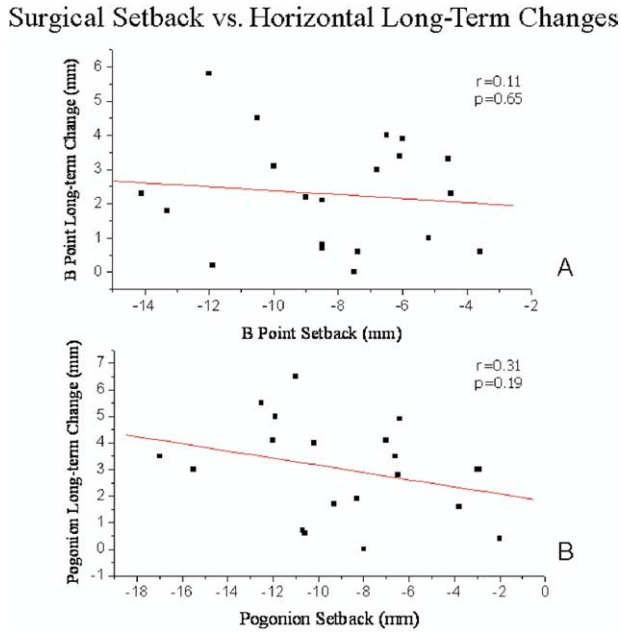

FIGURE 7. Scattergrams show that there is no correlation between the magnitude of setback and the amount of relapse at both B point (*A*) and pogonion (*B*).

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amount of long-term postsurgical change or relapse at B point and pogonion. The results showed no significant correlation in the horizontal direction (Fig 7). On the other hand, significant correlation was seen in the vertical dimension (Fig 8) at B point ($r = 0.78$; $P \leq .0001$) and pogonion ($r = 0.67$; $P = .001$). Other correlation analyses were performed to see the relationship between the magnitude of surgical movement at gonion, condylion, and the ramus angle, and the amount of long-term postsurgical change or relapse at pogonion. The results were not significant (Fig 9).

To find out the changes that occurred from surgery to 1-year follow-up, measurements from the cephalometric radiographs during this period were also taken and recorded (Table 5). Figure 10 shows the mean horizontal changes in landmarks from the surgical movement to 1-year and long-term follow-ups. A great percentage of the relapse was seen at 1-year follow-up for B point (74%), pogonion (80%), and gonion (87%), while the incisors, A point, and condyle showed minimal 1-year and long-term changes. Figure 11 shows the mean vertical surgical, 1-year, and long-term changes of the same points. This graph demonstrates that most of the landmarks were stable after the 1-year follow-up.

Discussion

Mandibular setback osteotomy is commonly used in the Asian patient who has a skeletal Class III maloc-

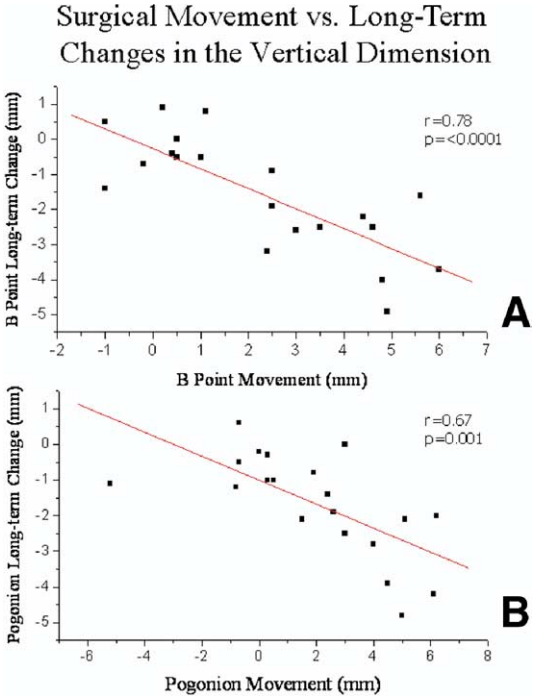

FIGURE 8. Scattergrams show the linear correlation between the amount of surgical (downward) displacement and the amount of (upward) relapse in the vertical dimension at both B point (*A*) and pogonion (*B*).

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clusion with a relatively flat midface. It will be noted among the subjects of this study (Fig 3) that 25% had more than 10 mm of horizontal setback at B point and a greater number, 45%, at pogonion (only 2 patients here had had genioplasties). In the analysis between the magnitude of setback and the amount of relapse, both B point (which was not affected by the genioplasty procedure) and pogonion showed no significant correlation. It is not clear why many studies[3-7,9,11,12] disagree on this matter regardless of whether rigid or nonrigid fixation was used. Aside from the differences in sample size and follow-up dates, we speculate that there may be some variations in the surgical technique, in the postoperative management, or measurement procedures in these various studies. In the vertical plane, however, both B point and pogonion showed a significant correlation among our subjects such that downward displacements of the chin area were accompanied by corresponding amounts of upward long-term changes. This observation has not been mentioned in previous studies. One reason for this phenomenon is that our patient group had relatively larger surgical downward movement at the chin point because they had minimal presurgical orthodontics. Recovery for this increased lower facial height was achieved during the postsurgical orthodontic therapy, most of it within the first year after surgery. This shows that there is a great tendency for the chin to regain its vertical position after mandibular setback. It is interesting to note that even if B point and pogonion relapsed forward, there was not a corresponding movement of the mandibular incisors, some of them even moved posteriorly. This most likely shows that postoperative orthodontics played a major role in maintaining the desired position of those teeth.

The gonion point exhibited great amounts of horizontal long-term changes in this study, with most of

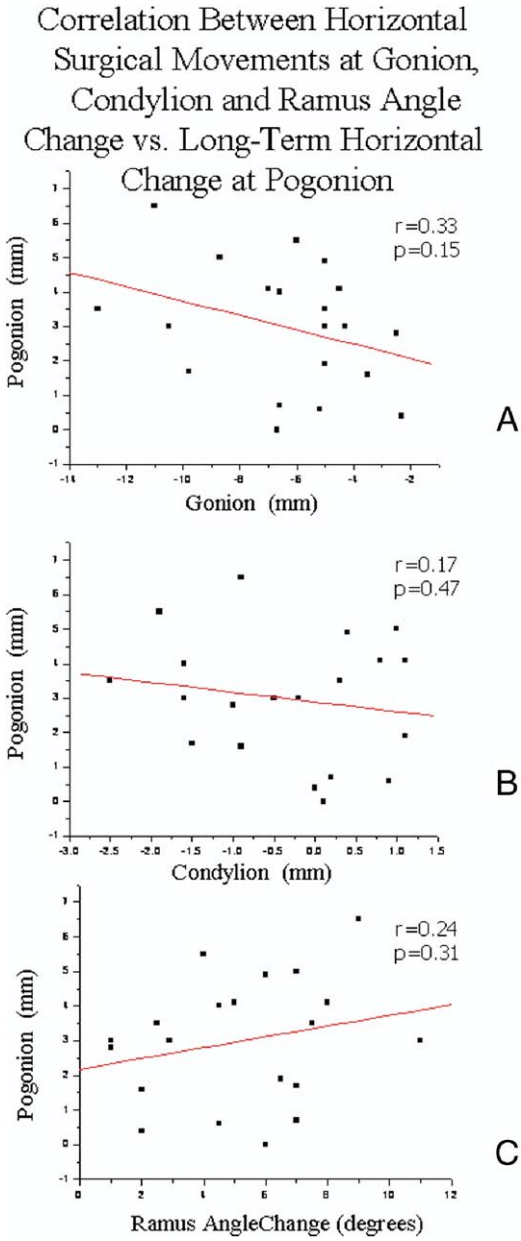

FIGURE 9. Scattergrams show that there is no correlation between the surgical movements at gonion (*A*), condylion (*B*), and ramus angle (*C*) and the amount of long-term change at pogonion.

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Table 5. HORIZONTAL AND VERTICAL CHANGES AT ONE-YEAR FOLLOW-UP

	Surgical Movement		One-Year Change		
	Mean	SD	Mean	SD	Percentile
Horizontal changes					
B Point	−8.2	3.0	1.7	1.5	20.7
Pogonion	−8.8	4.1	2.4	1.5	27.3
Gonion	−6.4	2.9	2.7	1.5	42.2
Md Incisor	−6.8	2.9	0.4	2.5	5.9
Mx Incisor	0.3	1.2	0.1	1.3	33.3
A Point	−0.2	0.7	−0.2	1.2	100.0
Condylion	−0.3	1.1	−0.4	0.1	133.0
Vertical changes					
B Point	2.3	2.2	−1.3	1.5	56.5
Pogonion	2.0	2.8	−1.5	1.4	75.0
Gonion	−2.3	3.3	−0.9	1.6	39.1
Md Incisor	1.2	2.7	−0.9	1.1	75.0
Mx Incisor	0.9	1.2	−0.4	1.0	44.4
A Point	0.2	0.7	0.0	1.0	0.0
Condylion	0.1	0.9	−0.1	1.0	100.0
Angular changes					
Md plane angle	3.5	4.0	−0.2	1.8	5.7
Ramus angle	5.2	2.8	−2.8	1.6	53.8
Gonial angle	−1.7	4.2	1.9	3.5	111.8

NOTE. Linear values are in millimeters and angular values are in degrees.

Horizontal: (−) = posterior movement; vertical: (−) = superior movement; angle: (−) = decrease.

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them occurring within the first year after surgery. The general direction of this postsurgical movement was forward and slightly upward. This could be a result of both a re-adaptation toward its original position made possible by the nonrigid fixation and bone resorption or remodeling.[16] Instead of the muscle pulling the bone forward, the bone yields and remodels itself to adapt to the muscular force.

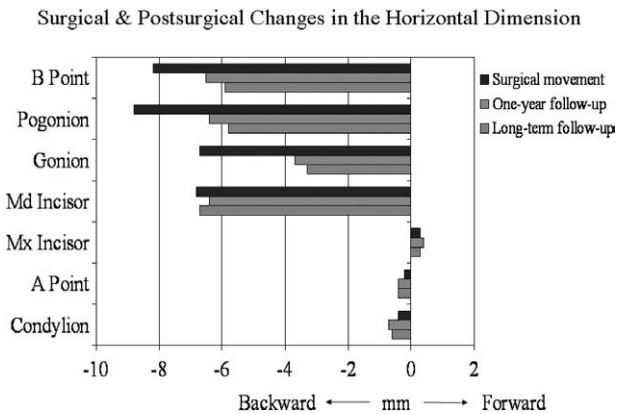

FIGURE 10. Mean horizontal surgical and postoperative changes are plotted in bar graphs to show the magnitude of setback and amount of relapse after 1 year and at long-term follow-up. The graph shows that the majority of postsurgical changes took place within 1 year after surgery at B point, pogonion, and gonion, while the rest of the landmarks had little long-term changes.

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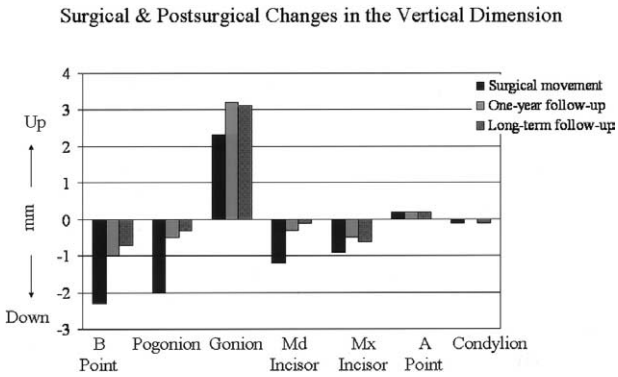

FIGURE 11. Mean surgical and postoperative changes are plotted in bar graphs to show the magnitude of vertical displacement and amount of relapse after 1 year and at long-term follow-up. The graph shows that the majority of postsurgical changes, if any, took place within 1 year after surgery.

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The movement of the proximal segment as represented by changes in the ramus angle manifests the attempt of that segment to regain its preoperative position (Fig 1). Although there was an attempt to return to the original position, this was not achieved in most of the cases (except for 5 cases where the movement went further backward than the preoperative measurement; cases 1, 4, 6, 7, and 10). The measurement of the gonial angle, which decreased with surgery and increased 167.0% at long-term follow-up, also reflects this same movement.

The condyles and A point in this study group had not been significantly altered during surgery and stayed in relatively the same position in relation to the anterior cranial base.

As mentioned before, there are various speculations on why relapse occurs after BSSO for mandibular setback. The authors agree with Komori et al[2] that the reasons could be multifactorial, and that in long-term studies the cephalometric measurements reflecting true surgical relapse could be obscured by factors such as remodeling, mandibular growth, and differences in the time of follow-up. Although the subjects in this study were treated by the same surgeon and orthodontist, we agree with other authors[12,19] that the surgical procedure and follow-up treatment itself can vary significantly among patients and among clinicians. As such, we have only attempted to describe in detail the long-term changes that occur in the maxillomandibular region so that clinicians will be helped in explaining to the patient what to expect in the long run after this type of orthognathic surgery. Two important observations were that

the increase in vertical height can be recovered, and that the majority of the changes in all the points studied occurred within the first year after surgery.

In summary, this study has shown that with a long-term follow-up of about 28 months after BSSO and wire osteosynthesis:

1) The mean horizontal relapse was 28.0% of the surgical movement at point B and 34.1% at pogonion. Out of 20 patients, 12 (60.0%) relapsed greater than 2 mm at B point and 13 (65.0%) at pogonion.
2) The magnitudes of horizontal setback at B point and pogonion were not significantly correlated to their relapse.
3) The mean vertical relapse (upward movement) at B point was 69.6% of the downward displacement at surgery and 85.0% at pogonion. Out of 20 patients, 8 (40.0%) showed greater than 2 mm reduction in the vertical dimension.
4) The magnitudes of downward displacement at B point and pogonion were significantly correlated to their relapse.
5) The majority of the long-term horizontal and vertical changes was already manifest 1 year after surgery.

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