*Original Article*

# Sequential changes of postoperative condylar position in patients with facial asymmetry

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**ABSTRACT**

**Objective:** To evaluate sequential images of the condylar position in relation to the glenoid fossa after orthognathic surgery in patients with facial asymmetry using cone beam computed tomography.

**Materials and Methods:** A total of 20 adult patients (11 men and 9 women; mean age, 22.1 ± 4.02 years) with facial asymmetry who underwent sagittal split ramus osteotomy with rigid fixation were involved. Cone beam computed tomography scans were obtained before treatment (T0), 1 month before the surgery (T1), and 1 day (T2), 3 months (T3), 6 months (T4), and 12 months (T5) after the surgery. The condyle position was evaluated.

**Results:** At 1 day after surgery (T2), the condylar position on both sides significantly changed posteriorly, inferiorly, and laterally, but no significant difference was observed between the nonaffected and affected sides. The condyle on the nonaffected side had a tendency to recover its preoperative position at 3 months after surgery (T3) and inclined slightly laterally up to 1 year after the surgery (T5). The condyle on the affected side returned more closely to the glenoid fossa than to its pretreatment position at 3 months after surgery (T3). Thereafter, it showed a more backward and downward position (T5).

**Conclusions:** The overall condylar position after an orthognathic surgery in patients with facial asymmetry was relatively stable at 1 year after surgery. However, the condyle on the affected side during the first 3 months after surgery should be carefully monitored for surgical stability. (*Angle Orthod.* 2017;87:260–268)

**KEY WORDS:** Condylar position; Mandibular asymmetry; Orthognathic surgery; Affected side; Nonaffected side

## INTRODUCTION

Symmetry is a major concern in facial esthetics. Facial asymmetry is the result of unbalanced growth of the maxillofacial structures and mostly occurs as a mandibular deviation to either the right or left sides. Mandibular asymmetry consists of not only differences in body or ramus between the left and right jaws but also morphological and positional differences in the temporomandibular joints (TMJs).[1,2] The condyle on the affected side adjusts and rotates to maintain the same condyle–fossa relationship with similar bilateral joint spaces.[3] Such compensatory adaptation can cause stress loading on the articular surface of the condyle.[1,4–6]

To correct the underlying skeletal discrepancy, orthognathic surgery is considered as the gold standard for the treatment of facial asymmetry. It usually requires complex movement of the mandibular segments, and such a complicated surgical technique affects the position of the TMJ and increases the risk of relapse tendency. The difficulty of an asymmetrical mandibular movement can differ according to the position, distance, and angulation of proximal segments, rotational movement of the distal segment, and tensional balance of the surrounding muscles, fixation method, and surgeon experience.[7–9]

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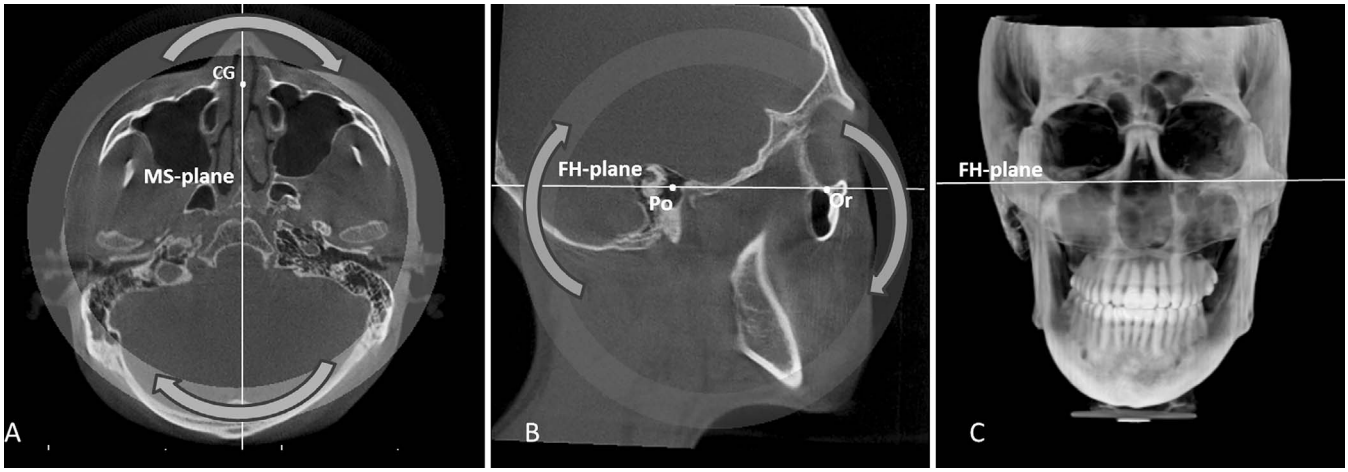


**Figure 1.** Cone beam computed tomography orientation: (A) axial view, (B) sagittal view; (C) coronal view in three-dimensional image. MS-plane indicates midsagittal plane; CG, Crista Galli; FH-plane, Frankfurt horizontal plane; Po, porion; Or, orbitale.

The postoperative condylar position should be carefully monitored for surgical stability.[8,10,11] There is a higher possibility of positional changes of condyles in asymmetry patients because of the difference between affected and nonaffected side. There have been a few reports related to the postoperative condylar position in patients with facial asymmetry. Lee et al.[12] found that the deviated condyle rotated inward and returned to the preoperative position 3 months after surgery. However, they were based on two-dimensional X-rays, which have inherent limitations of magnification and inaccuracy because of superimposed structures. Baek et al.[13] evaluated class III patients with asymmetry using cone beam computed tomography (CBCT) and reported that the condyle significantly rotated inward and backward on the nonaffected side and backward on the affected side 6 months after surgery.

However, this research included samples with severe anteroposterior skeletal dysplasia as well as facial asymmetry, and it is hard to evaluate whether the condylar changes resulted from sagittal correction or asymmetry correction. In addition, previous studies did not provide sequential information about the condylar position, and it was impossible to evaluate the direction of movement. The aim of this study was to evaluate long-term sequential images of the condylar position after orthognathic surgery in facial asymmetry patients using CBCT.

## MATERIALS AND METHODS

### Patients

This study involved 20 adult patients (11 men and 9 women; mean age 22.1 $\pm$ 4.02 years) with facial asymmetry who planned to undergo an orthodontic–orthognathic surgery treatment at Kyung Hee University Dental Hospital within the period from 2009 to 2015. Mandibular surgery included sagittal split ramus osteotomy with rigid fixation. The inclusion criteria were as follows: (1) facial asymmetry (menton deviation $>$ 4 mm), (2) skeletal class i or mild class III relationship ($-3° < \text{ANB} < 3°$), and (3) successfully treated with normal occlusion at debonding. The exclusion criteria were as follows: (1) severe class ii or class III skeletal relationship (ANB $< -3°$, or A point-nasion-B point angle (ANB) $> 3°$), which showed the same direction of distal segment; (2) progressive TMJ lesions; 3) numerous missing teeth; and 4) systematic disease or congenital syndromes.

Patients who had TMJ pain or limitations of mouth opening before surgery received TMJ stabilization treatment and underwent an orthognathic surgical procedure after the symptoms were resolved. This retrospective study was performed with approval from the institutional review board of Kyung Hee University Dental Hospital (1509-3).

### CBCT Assessment

*Data acquisition*. For this retrospective study, CBCT scans were obtained at a 0.2-mm voxel size level (PSR 9000N, Asahi Roentgen, Kyoto, Japan; 10 mA, 80 kV, and 30-second scan time) before treatment (T0), 1 month before the surgery (T1), and 1 day (T2), 3 months (T3), 6 months (T4), and 12 months (T5) after the surgery. Bite jigs were not used during CBCT. For the mandibular skeletal changes and TMJ evaluation, Digital Imaging and Communications in Medicine (DICOM) raw data were imported to the InVivoDental 5 software (Anatomage Inc., San Jose, Calif).

*Reorientation and landmark*. CBCT images were oriented according to the Frankfurt horizontal plane on the sagittal view and the midsagittal plane, passing from the midpoint of the base of the crista galli on the

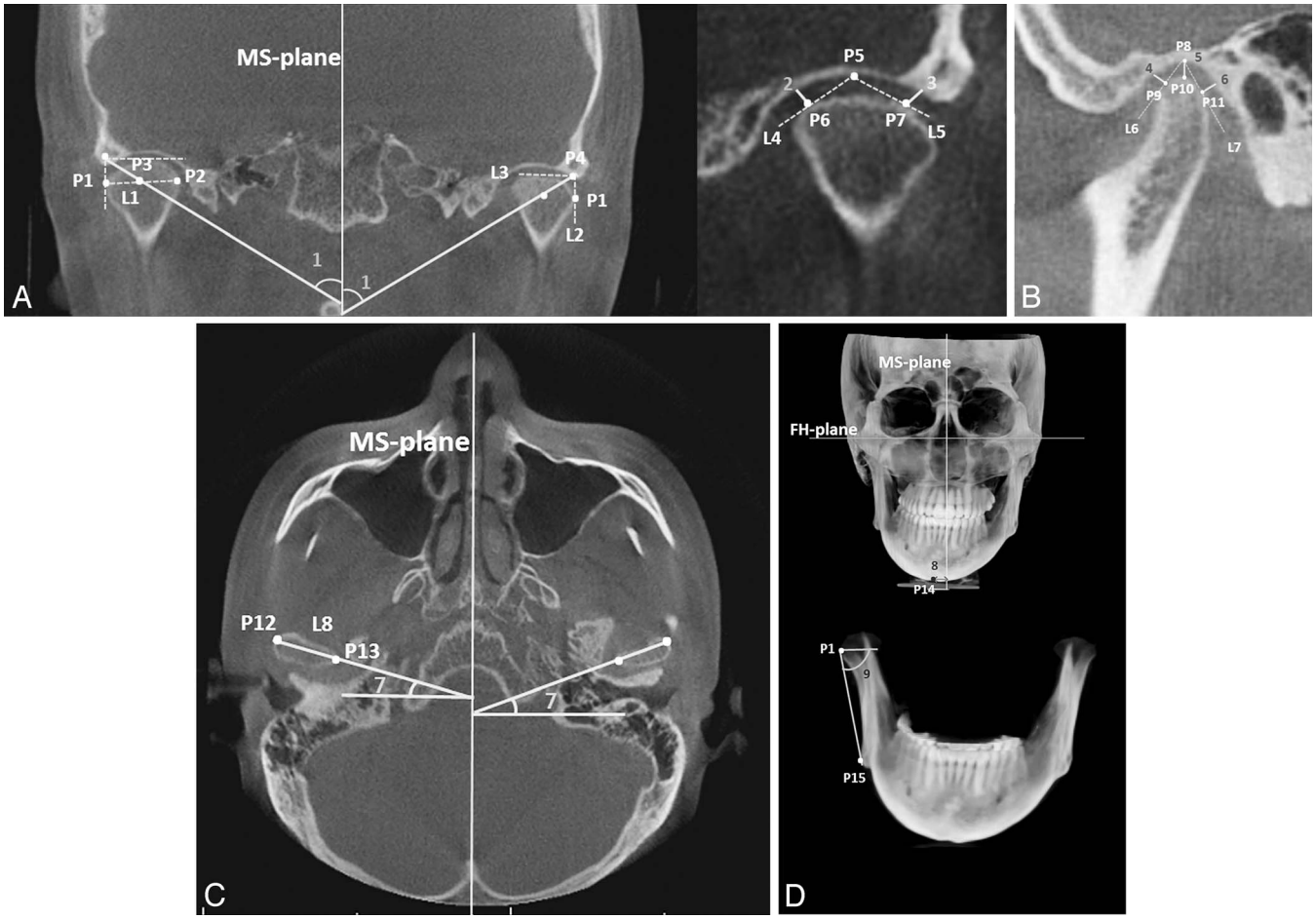


**Figure 2.** Landmarks and measurements. (A) Coronal view. P1, lateral pole; P2, medial pole; L1, line drawing through P1 and P2; P3, center of the condyle; L2, tangent line drawing through P1 and parallel MS-plane; L3, tangent line to the most superior border of the condyle and perpendicular to L2; P4, point obtained by intersection L2 and L3; 1, coronal condylar angle (CCA); P5, the deepest point of the condylar fossa; L4, line beginning from P5 and tangent to medial surface of the condyle; P6, contact point on the medial surface of the condyle with L4; L5, line beginning from P5 and tangent to lateral surface of the condyle; P7, contact point on the lateral surface of the condyle with L5; 2, medial joint space (MJS); 3, lateral joint space (LJS). (B) Sagittal view. P8, the deepest point of the condylar fossa; P9, the most anterior point of the condylar head; P10, the most superior point of the condylar head; P11, the most posterior point of the condylar head; L6, line drawing through P8 and P9; L7, line drawing through P8 and P11; 4, anterior joint space (AJS); 5, superior joint space (SJS); 6, posterior joint space (PJS). (C) Axial view. P12, lateral pole; P13, medial pole; L8, line drawing through P12 and P13; 7, axial condylar angle (ACA). (D) Skeletal landmarks and measurements. P14, menton; P15, lateral Gonion; 8, menton deviation (MD); 9, frontal ramal inclination (FRI).

axial view (Figure 1). For TMJ evaluation, the slices that showed the greatest mediolateral dimension of the condylar head were selected on the coronal and sagittal views. The reference points and lines are illustrated in Figure 2 and defined in Table 1.

*Measurements*. The TMJ measurements on the coronal view included the coronal condylar angle (CCA), medial joint space (MJS), and lateral joint space (LJS). On the sagittal view, the anterior joint space (AJS), superior joint space (SJS), and posterior joint space (PJS) were defined. The axial condylar angle (ACA) was measured on the axial view. The skeletal measurements for asymmetry evaluation were the menton deviation and frontal ramal inclination (FRI; Table 2, Figure 2). The affected side was defined as the location of the menton deviation relative to the midsagittal plane and the nonaffected side as the opposite side.

## Statistical Analysis

Normality of the data distribution was confirmed by using the Shapiro-Wilk test. All measurements were repeated by the same operator after 1 month. The mean of the two measurements was used for this study. Repeated-measures analysis of variance was performed for comparison of the condylar position and asymmetry at the different time points. The Bonferroni correction sets the significance cut-off at .003 (.05 per 15) and .006 (.1 per 15), respectively. Paired *t*-test was used to compare the degree of condylar changes between the affected and nonaffected sides. A

**Table 1.** Definition of Reference Points and Lines

| Reference | Definition |
|---|---|
| Temporomandibular joint | Coronal view |
| P1 | Lateral pole on the coronal view |
| P2 | Medial pole on the coronal view |
| L1 | Line drawing through P1 and P2 |
| P3 | Center of the L1-center of the condyle |
| L2 | Tangent line drawing through P1 and parallel MS-plane |
| L3 | Tangent line to the most superior border of the condyle and perpendicular L2 |
| P4 | Point obtained by intersection L2 and L3 |
| P5 | The deepest point of the condylar fossa on the coronal view |
| L4 | Line beginning from P5 and tangent to medial surface of the condyle |
| P6 | Contact point on the medial surface of the condyle with L4 |
| L5 | Line beginning from P5 and tangent to lateral surface of the condyle |
| P7 | Contact point on the lateral surface of the condyle with L5 |
| | Sagittal view |
| P8 | The deepest point of the condylar fossa on the sagittal view |
| P9 | The most anterior point of the condylar head |
| P10 | The most superior point of the condylar head |
| P11 | The most posterior point of the condylar head |
| L6 | Line drawing through P8 and P9 |
| L7 | Line drawing through P8 and P11 |
| | Axial view |
| P12 | Lateral pole |
| P13 | Medial pole |
| L8 | Line drawing through P12 and P13 |
| Skeletal | |
| P14 | Menton |
| P15 | Lateral go-point |

**Table 2.** Temporomandibular joint (TMJ) and Skeletal Measurements

| Measurements | Definition |
|---|---|
| TMJ | Coronal view |
| 1. Coronal condylar angle | The angle formed by the intersection of the line connecting the center of the condyle and the latero-superior condyle point (P6) with the midsagittal plane |
| 2. Medial joint space | The distance drawing from P8 and perpendicular L5 to the wall of the glenoid fossa |
| 3. Lateral joint space | The distance from P9 and perpendicular L6 to the wall of the glenoid fossa |
| | Sagittal view |
| 4. Anterior joint space | The distance from P11 and perpendicular L7 to the wall of the glenoid fossa |
| 5. Superior joint space | The distance from P12 to the wall of the mandibular fossa |
| 6. Posterior join space | The distance from P13 and perpendicular L8 to the wall of the glenoid fossa |
| | Axial view |
| 7. Axial condylar angle | The angle formed by the intersection of L8 and line perpendicular to MS-plane |
| Skeletal | |
| 8. Menton Deviation | The distance from Menton to the midsagittal plane |
| 9. Frontal ramal inclination | The angle between plane parallel fronto-zygomaticus plane and line from lateral pole (P3) of the condyle and lateral go-point |

difference was considered statistically significant when the $P$ value was $< .05$.

## RESULTS

### Sequential Postoperative Changes in Condylar Position and Skeletal Asymmetry (Table 3)

On the coronal view, the MJS and LJS were significantly increased at T2 on both sides. Afterward, they tended to recover to their preoperative values on the nonaffected side (MJS, $P = .001$; LJS, $P < .05$). On the affected side, they decreased at T3, but more so at T1 and slightly increased again during 9 months after the surgery (MJS, $P < .001$; LJS, $P = .01$; Figure 3). The CCA on the affected side was unchanged, but that on the nonaffected side was significantly increased at T5 ($P < .01$; Figure 4A).

On the sagittal view, the AJS and SJS significantly increased at T2 on both sides. Thereafter, the AJS and SJS on the nonaffected side decreased at T3 and T4 and stayed relatively stable at T5 (AJS, $P < .001$; SJS, $P < .01$). On the affected side, the AJS and SJS decreased at T3, but more so at T1, and were slightly increased again at T4 and T5 (AJS, $P < .01$; SJS, $P < .001$; Figure 5A,B). Although the PJS on both sides remained almost unchanged at T2, that on the nonaffected side remained relatively stable and that on the affected side significantly decreased thereafter ($P < .001$; Figure 5C). On the axial view, the ACA on both sides was slightly increased and rotated inward at T2, although the difference was not significant (Figure 4B).

The FRI on the affected side was significantly decreased at T2 ($P < .001$), whereas that on the nonaffected side was relatively stable. Up to 12 months, the FRI on nonaffected side was slightly

**Table 3**. Changes in Condylar Position and Skeletal Asymmetry Between the Different Time Points

| | Initial (T0) | | Before Surgery (T1) | | 1 Day After Surgery (T2) | | After 3 Months (T3) | | After 6 Months (T4) | | After 12 Months (T5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variables[a] | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | *P* Value[b] |
| Temporomandibular joint | | | | | | | | | | | | | |
| Coronal condylar angle | | | | | | | | | | | | | |
| Nonaffected | 48.82 | 4.48 | 48.95 | 3.04 | 49.24 | 4.22 | 49.62 | 3.57 | 49.91 | 3.59 | 51.21 | 3.74 | .003*<br>T5 > (T0, T1)†<br>T5 > T2 ‡ |
| Affected | 49.62 | 5.15 | 50.43 | 4.36 | 49.29 | 5.24 | 50.41 | 4.93 | 50.76 | 5.54 | 50.1 | 4.99 | 0.357 |
| Medial joint space | | | | | | | | | | | | | |
| Nonaffected | 2.07 | 0.64 | 2.17 | 0.59 | 2.93 | 1.25 | 2.16 | 0.90 | 2.09 | 0.87 | 2.22 | 0.81 | .001**<br>T2 > (T3, T4, T0)†<br>T2 > T1 ‡ |
| Affected | 2.38 | 0.94 | 2.51 | 0.98 | 2.90 | 1.02 | 1.96 | 0.77 | 2.03 | 0.82 | 2.18 | 0.72 | .000**<br>T2 > (T5, T4, T3)†<br>T2 > T0 ‡ |
| Lateral joint space | | | | | | | | | | | | | |
| Nonaffected | 1.83 | 0.85 | 1.90 | 0.93 | 2.36 | 1.10 | 1.92 | 0.92 | 1.83 | 0.82 | 1.82 | 0.80 | .014* |
| Affected | 2.50 | 1.47 | 2.53 | 1.13 | 2.94 | 1.15 | 2.09 | 0.68 | 2.18 | 0.77 | 2.30 | 0.66 | .010*<br>T2 > (T5, T4)†<br>T2 > T3‡ |
| Anterior joint space | | | | | | | | | | | | | |
| Nonaffected | 1.70 | 0.50 | 1.85 | 0.55 | 2.38 | 0.72 | 1.78 | 0.40 | 1.81 | 0.43 | 1.91 | 0.60 | .000**<br>T2 > (T4, T3, T0)† |
| Affected | 2.32 | 1.08 | 2.25 | 1.04 | 3.47 | 1.76 | 2.20 | 0.95 | 2.30 | 1.18 | 2.51 | 1.45 | .004*<br>T2 > (T5, T0, T4, T1, T3)† |
| Superior joint space | | | | | | | | | | | | | |
| Nonaffected | 2.19 | 0.98 | 2.43 | 0.80 | 2.95 | 1.01 | 2.31 | 0.84 | 2.30 | 0.85 | 2.43 | 0.91 | .003*<br>T2 > T0†<br>T2 > T3‡ |
| Affected | 2.41 | 0.69 | 2.65 | 0.76 | 3.37 | 1.01 | 1.98 | 0.61 | 2.21 | 0.69 | 2.46 | 0.91 | .000**<br>T2 > (T5, T0, T4, T3)†<br>T2 > T1‡ |
| Posreior joint space | | | | | | | | | | | | | |
| Nonaffected | 1.87 | 0.51 | 2.01 | 0.47 | 2.10 | 0.60 | 1.80 | 0.52 | 1.89 | 0.72 | 1.76 | 0.51 | .051 |
| Affected | 1.96 | 0.71 | 2.00 | 0.62 | 1.97 | 0.76 | 1.62 | 0.38 | 1.58 | 0.54 | 1.72 | 0.56 | .000** |
| Axial condylar angle | | | | | | | | | | | | | |
| Nonaffected | 15.61 | 8.98 | 15.62 | 8.34 | 15.63 | 7.99 | 14.51 | 7.33 | 15.26 | 8.05 | 14.76 | 7.95 | .213 |
| Affected | 20.46 | 9.51 | 20.62 | 9.46 | 21.54 | 9.27 | 20.26 | 9.12 | 20.40 | 9.58 | 20.51 | 9.51 | .192 |
| Skeletal | | | | | | | | | | | | | |
| Frontal ramal inclination | | | | | | | | | | | | | |
| Nonaffected | 74.77 | 5.15 | 74.86 | 5.34 | 74.89 | 4.46 | 73.57 | 4.45 | 73.34 | 4.79 | 73.06 | 4.97 | .001*<br>T2 > (T4,T5)†<br>(T2, T1, T0) > (T4, T5)‡ |
| Affected | 81.00 | 4.63 | 81.05 | 4.39 | 78.48 | 4.64 | 77.58 | 3.77 | 77.00 | 3.52 | 77.12 | 3.75 | .000**<br>(T1, T0) > (T3, T5, T4)†<br>T0 > T2‡ |
| Menton deviation | 8.43 | 3.72 | 8.75 | 3.79 | 1.76 | 2.28 | 1.96 | 2.36 | 2.16 | 2.21 | 2.34 | 2.30 | .000**<br>(T1, T0) > (T5, T4, T3, T2)† |

[a] Nonaffected indicates nonaffected side; affected, affected side; SD, standard deviation.
[b] Repeated-measures analysis of variance test was performed: *$P < .01$, **$P < .001$. The Bonferroni correction sets the significance cut-off at .003 (.05/15)† and .006 (.1/15)‡, respectively.

increased ($P = .001$). The menton deviation was corrected by the surgery ($P < .001$) and remained stable up to 1 years.

### Comparison of the Condylar Position Between the Nonaffected and Affected Sides (Table 4)

Before surgery (T1), LJS and ACA showed significant differences between the nonaffected and affected sides (both $P < .05$). The condyle had a more central position at the coronal view and rotated inward more on the affected side than on the nonaffected side. During surgery (T2–T1), no significant difference in the changes of condylar position was observed between the two sides. Up to 3 months after the surgery (T3–T1), the MJS and SJS decreased more on the affected side; that is, they moved closer to glenoid fossa (MJS, $P <$

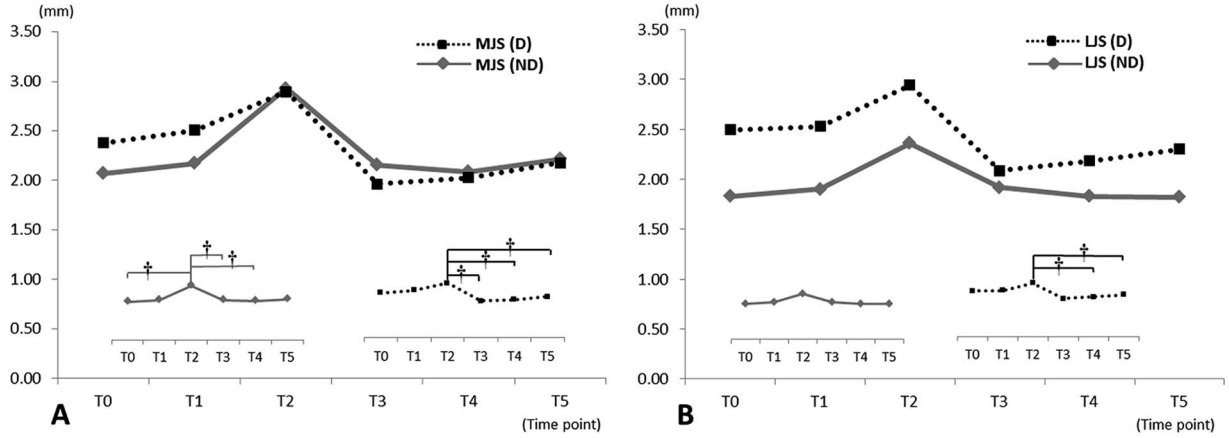


**Figure 3.** Changes of the (A) medial joint space (MJS) and (B) lateral joint space (LJS) on the nonaffected (ND) and affected sides (D) at before treatment (T0), before surgery (T1) and 1 day (T2), 3 months (T3), 6 months (T4) and 1 year (T5) after surgery. †Repeated-measures analysis of variance was performed and the Bonferroni correction sets the significance cut-off at .003 (.05/15).

.01; SJS, $P < .01$; Figure 6). Up to 12 months after the surgery (T5–T1), only the changes of MJS and CCA showed significant differences between two sides ($P < .05$, and $P < .01$, respectively). The CCA significantly inclined more laterally on the nonaffected side.

## DISCUSSION

The condylar position of asymmetry patients showed a characteristic difference between the affected and nonaffected sides before treatment to compensate for their skeletal discrepancy, and it maintained during presurgical orthodontic treatment. The condyle was positioned almost centrally in the coronal view and superiorly in the sagittal view on the nonaffected side and more posteriorly, inferiorly, and medially on the affected side. In accordance with our results, Kim et al.[3] also reported that the condyle on the affected side had to rotate with the increase in the ACA.

Orthognathic surgery caused significant changes in the condylar position posteriorly, laterally, and inferiorly on both sides. No previous studies have observed the condylar position immediately after a surgery in patients with facial asymmetry. Kim et al.[14] evaluated the postoperative condylar position within 2 weeks after a surgery in class III asymmetry patients and found that the condyles during surgery moved anteriorly on both sides. They suggested that the initial condylar displacement could be related with the occurrence of edema and hemarthrosis after the surgery.

The important factor for the evaluation of the condylar position is the timing of postoperative CBCT. Most studies showed that the condyle had a tendency to return to its preoperative position 3 months after surgery,[11,12] in accordance with the nonaffected side of our patients. Other studies for asymmetry patients also showed no significant difference in condylar position

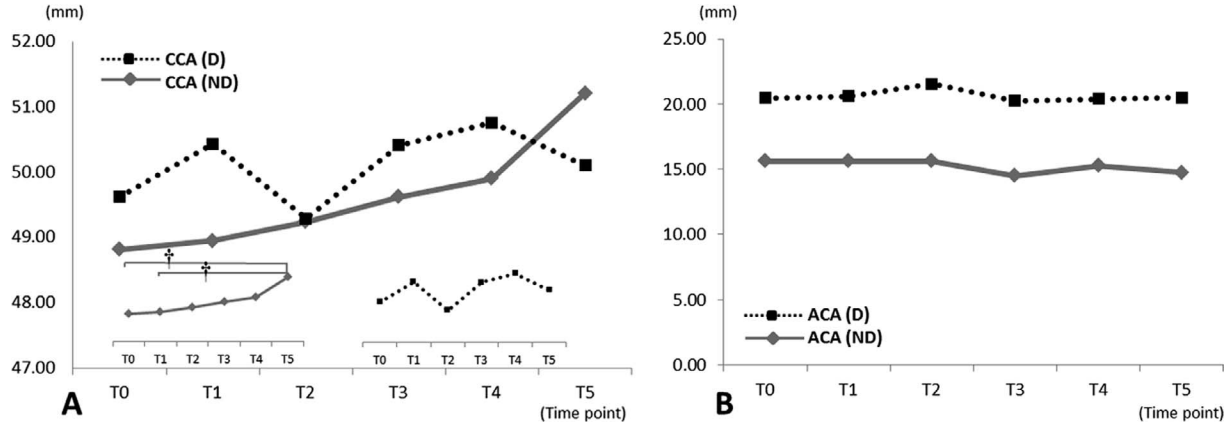


**Figure 4.** Changes of the (A) coronal condylar angle (CCA) and (B) axial condylar angle (ACA) on the nonaffected (ND) and affected sides (D).

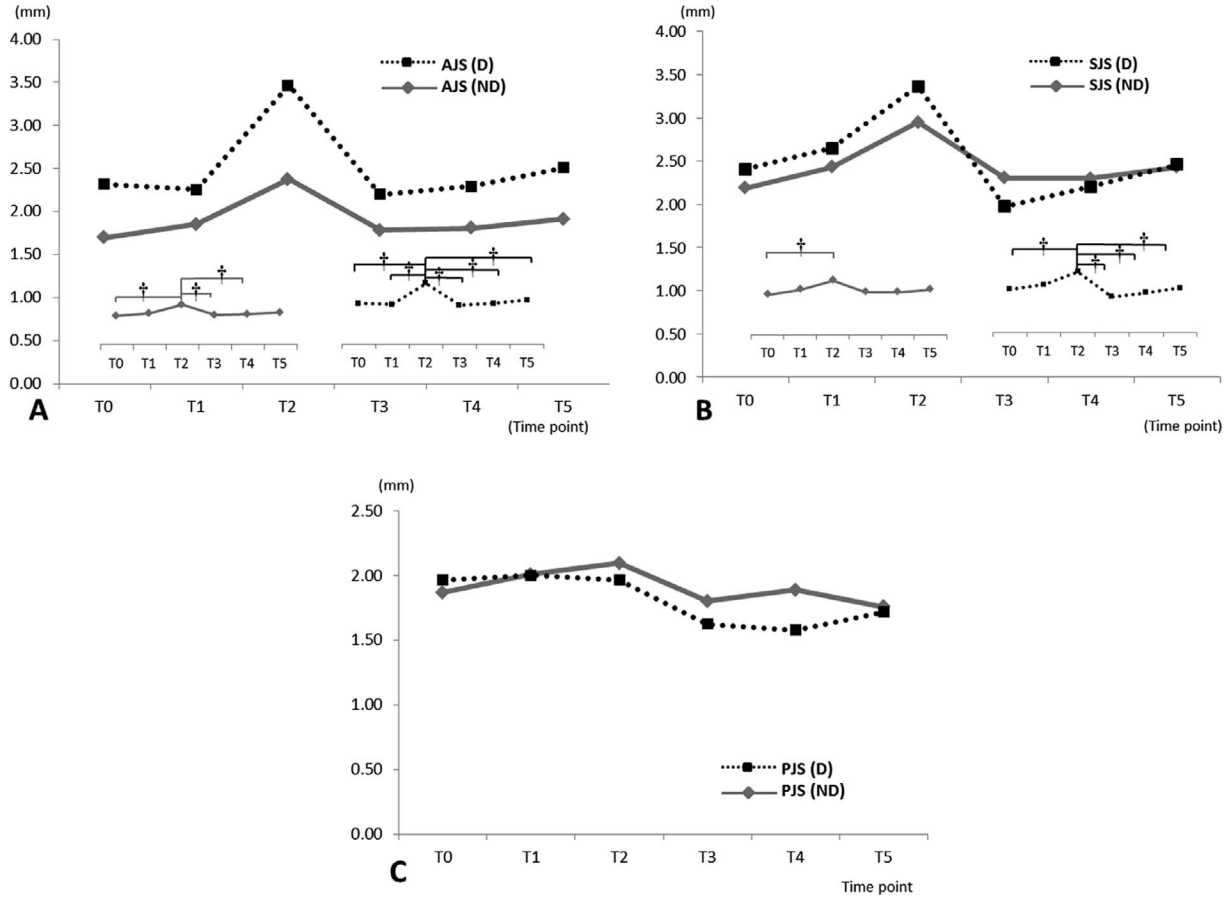


**Figure 5.** Changes of the (A) anterior joint space (AJS), (B) superior joint space (SJS), and (C) posterior joint space (PJS) on the nonaffected (ND) and affected sides (D). †Repeated-measures analysis of variance was performed and the Bonferroni correction sets the significance cut-off at .003 (.05/15). Same abbreviations as referred to in the legend of Figure 3.

between before and 6 months after surgery.[7,13] The major postoperative changes in condylar position occurred within the first 3 months after surgery, therefore it should be included in follow-up protocol. Interestingly, the condyles on the affected side moved closer to the fossa at 3 months after surgery, that is, the articular space was significantly reduced. Up to 1 year follow-up, they slightly moved vertically downward and had a tendency to return to their original pretreatment position. The condyle on the nonaffected side moved laterally on the nonaffected side, which was in accordance with Ueki et al.[15] They explained this phenomenon as the feasible lateral expansion of the proximal segment at the mandibular angle region.

To evaluate TMJs concentrating only on skeletal asymmetry, the sagittal skeletal relationship should be controlled at first. In our study, skeletal class i or mild class III samples were included, which meant that the distal segment moved forward on the deviated side and backward on the nonaffected side.[7,9] There would be no significant differences in condylar positon between two sides in those with severe skeletal class II or III malocclusion and facial asymmetry because the direction of the movement of the distal segment on the affected and nonaffected sides was the same. Kim et al.[7] also reported that the most influential factors with regard to differences between the two sides could be the direction of movement of the distal segment of the mandible rather than its extent.

The postoperative factors that affect the condylar position include the tension of soft tissue and muscles, remaining growth, and remodeling of the TMJ.[16–21] The resorptive remodeling activity on the condyle could be directly related with postoperative relapse. Previous studies found that the condylar head undergoes significant decreases in condylar height and surface changes during remodeling in the anterior and superior areas of the sagittal plane and superior and lateral areas on the coronal plane.[17–20] The condyle on the affected side would be especially vulnerable to condylar resorption because of greater soft tissue tension and structural weakness than the nonaffected

**Table 4.** Comparison of Condylar Changes Between Nonaffected and Affected Sides at Each Time Point

| | Before Surgery (T1) | | | 1 Day After Surgery (T2–T1) | | | After 3 Months (T3–T1) | | | After 6 Months (T4–T1) | | | After 12 Months (T5–T1) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variables[a] | Mean | SD | *P* Value | Mean | SD | *P* Value | Mean | SD | *P* Value | Mean | SD | *P* Value | Mean | SD | *P* Value |
| Coronal condylar angle | | | | | | | | | | | | | | | |
| Nonaffected | 48.95 | 3.04 | .175 | 0.29 | 3.26 | .142 | 0.67 | 2.60 | .485 | 0.95 | 0.54 | .541 | 2.26 | 2.74 | .002** |
| Affected | 50.43 | 4.36 | | −1.14 | 2.85 | | −0.02 | 3.90 | | 0.33 | 0.99 | | −0.33 | 2.74 | |
| Medial joint space | | | | | | | | | | | | | | | |
| Nonaffected | 2.17 | 0.59 | .240 | 0.76 | 1.09 | .164 | −0.02 | 0.57 | .006** | −0.09 | 0.13 | .033* | 0.04 | 0.50 | .017* |
| Affected | 2.51 | 0.98 | | 0.39 | 1.08 | | −0.54 | 0.78 | | −0.48 | 0.14 | | −0.33 | 0.62 | |
| Lateral joint space | | | | | | | | | | | | | | | |
| Nonaffected | 1.90 | 0.93 | .016* | 0.46 | 0.97 | .866 | 0.02 | 0.53 | .100 | −0.07 | 0.12 | .190 | −0.08 | 0.43 | .386 |
| Affected | 2.53 | 1.13 | | 0.41 | 0.99 | | −0.44 | 0.98 | | −0.35 | 0.18 | | −0.22 | 0.69 | |
| Anterior joint space | | | | | | | | | | | | | | | |
| Nonaffected | 1.85 | 0.55 | .066 | 0.53 | 0.81 | .058 | −0.07 | 0.52 | .944 | −0.04 | 0.10 | .694 | 0.06 | 0.79 | .532 |
| Affected | 2.25 | 1.04 | | 1.21 | 1.20 | | −0.06 | 0.51 | | 0.04 | 0.14 | | 0.26 | 0.80 | |
| Superior joint space | | | | | | | | | | | | | | | |
| Nonaffected | 2.43 | 0.80 | .384 | 0.52 | 0.87 | .380 | −0.12 | 0.37 | .012* | −0.13 | 0.10 | .057 | 0.00 | 0.45 | .299 |
| Affected | 2.65 | 0.76 | | 0.72 | 1.00 | | −0.67 | 0.92 | | −0.44 | 0.16 | | −0.19 | 0.70 | |
| Posterior joint space | | | | | | | | | | | | | | | |
| Nonaffected | 2.01 | 0.47 | .960 | 0.09 | 0.51 | .547 | −0.21 | 0.38 | .286 | −0.12 | 0.12 | .172 | −0.25 | 0.43 | .818 |
| Affected | 2.00 | 0.62 | | −0.03 | 0.81 | | −0.38 | 0.71 | | −0.42 | 0.19 | | −0.28 | 0.68 | |
| Axial condylar angle | | | | | | | | | | | | | | | |
| Nonaffected | 15.62 | 8.34 | .018* | 0.01 | 2.44 | .192 | −1.00 | 1.81 | .412 | −0.36 | 0.52 | .773 | −0.86 | 2.78 | .643 |
| Affected | 20.62 | 9.46 | | 0.92 | 3.62 | | −0.36 | 3.67 | | −0.63 | 0.98 | | −0.53 | 3.82 | |

[a] Nonaffected indicates nonaffected side; affected, affected side; SD, standard deviation.
[b] Paired *t*-test was performed: *$P < .05$, **$P < .01$.

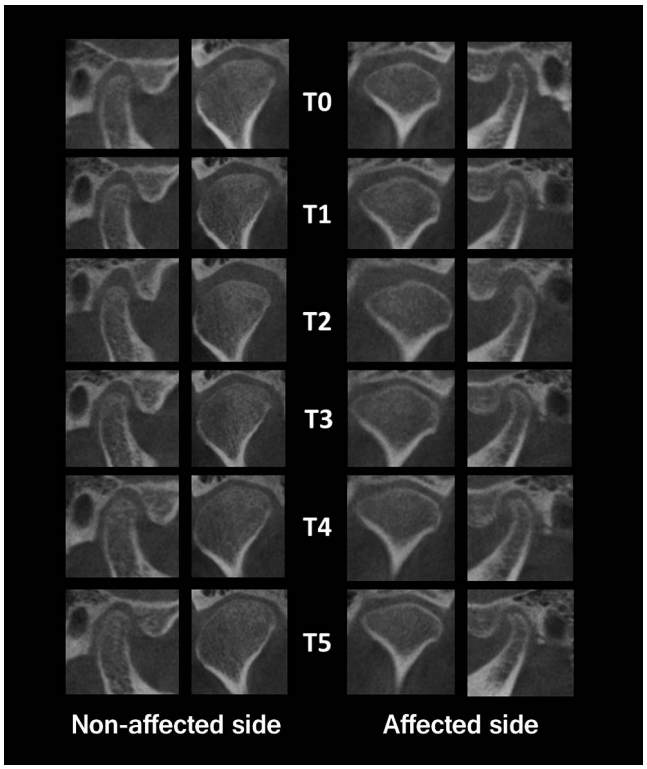


**Figure 6.** Sequential images of the condylar position on the affected and nonaffected side.

side. In some of our cases, the condyle on the affected side showed significant resorption between 3 months after surgery (closer to the fossa) and further follow-up (returned to pretreatment position; Figure 7). Clinicians should pay attention not to overload the condyle on the affected side during early postsurgical orthodontic treatment.

The limitation of this study was that the condylar morphology was not considered. A previous study suggested that the condylar anterior slope on the affected side was flatter and the posterior slope was prominently convex, whereas the anteroposterior slopes on the nonaffected side had a more concave–convex surface, respectively.[1] For further study, the correlation between the changes in condylar position and the skeletal relapse rate would be evaluated with a larger sample size.

## CONCLUSIONS

- The overall condylar position after an orthognathic surgery in patients with facial asymmetry was relatively stable at 1 year after surgery on both sides.
- The condyle on the nonaffected side had a tendency to recover its preoperative position at 3 months after surgery and inclined slightly laterally up to 1 year.
- The condyle on the affected side returned more closely to the glenoid fossa at 3 months after surgery

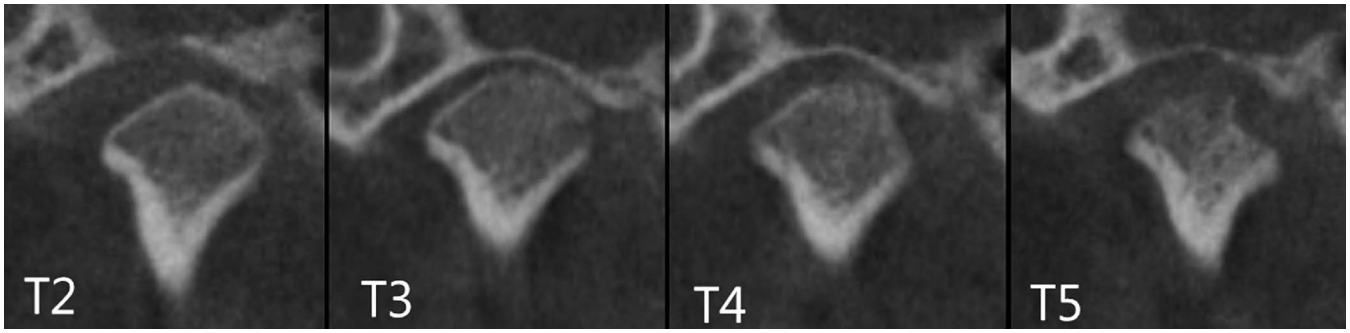


**Figure 7.** The resorptive remodeling of the condyle on the affected side after orthognathic surgery.

and needs careful monitoring during early postsurgical orthodontic treatment.

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