Original Article

Disk Position and Temporomandibular Joint Structure Associated with Mandibular Setback in Mandibular Asymmetry Patients

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ABSTRACT

Objective: To determine the changes in articular disk position and the temporomandibular joint (TMJ) structure in patients who had an asymmetric setback of the mandible performed by a bilateral sagittal split ramus osteotomy with manual positioning of the condyle.

Materials and Methods: Twenty-two patients with skeletal Class III malocclusion being treated at Nara Medical University Hospital were evaluated using clinical examination and pre- and postoperative magnetic resonance images of their TMJs.

Results: Changes in articular disk position after asymmetric setback surgery were not statistically significant, although a tendency of anterior displacement in the fossa was noted. The anterior and posterior joint spaces did not show significant changes, whereas the condyle head of the deviated or contralateral side tended to be positioned downward.

Conclusion: The asymmetric setback of the mandible with intraoperative manual positioning of the condyle does not significantly change the disk position in the fossa. (*Angle Orthod.* 2009;79: 521–527.)

KEY WORDS: Articular disk; MRI; Mandibular asymmetry; Mandibular setback; Temporomandibular joint

INTRODUCTION

Patients with mandibular prognathism have an asymmetric face with a jaw deviation to either the left or right side. The asymmetry is the result of not only mandibular rotation but also significant structural differences between the right and left temporomandibular joints (TMJs) that include unilateral condylar hyperplasia.[1–3] The TMJ on the deviated side of the mandible is characterized by a smaller condyle and a higher incidence of disk displacement compared with the nondeviated side.[2]

Differences between the left and right TMJs may represent anatomic disorders that dispose affected individuals to joint sounds and TMJ symptoms. Internal derangement of the TMJ is a relatively common problem in patients with mandibular lateral displacement or rotation, and facial asymmetry in adults can often be corrected with asymmetric mandibular setback performed with a bilateral mandibular osteotomy or two-jaw surgery.[4] Because of the structural differences of bilateral TMJs, it is likely that the asymmetric setback causes a different change in condylar position and angulation because of rotation of the mandible.[5,6]

A few studies address changes in the temporomandibular joint after a bilateral sagittal split ramus osteotomy (BSSO) of the mandible and the influence of the condylar position. These studies reported that radiographic and computed tomography (CT) images showed significant changes in the position of the condyle after forward or backward movement of the mandible related to BSSO.[7,8] The disk position in the fossa was independent of the condylar position, and radiographs and CT images do not provide any information regarding that position. When performing an asym-

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metric setback of the mandible in a patient with jaw deviation, little is known regarding changes of the disk position in the articular fossa. The purpose of the present study was to evaluate the effects of asymmetric setback of the mandible on articular disk position using magnetic resonance (MR) images of the TMJ, as an MRI examination of the articular disk and surrounding soft tissues of the TMJ is a routine diagnostic method for temporomandibular disorders.

MATERIALS AND METHODS

Twenty-two Japanese patients (5 men, 17 women; mean age = 24 years 1 month; range = 17 years 5 months to 38 years 9 month) who had received orthognathic surgery between 2001 and 2007 were enlisted as subjects. All had been diagnosed with mandibular prognathism and needed combined surgical orthodontic treatment. None of the subjects had congenital craniofacial anomalies. TMJ function was clinically evaluated in each subject in terms of TMJ pain, joint sounds, and limitation of mouth opening.

All subjects received preoperative orthodontic treatment and asymmetric setback of the mandible with a BSSO procedure. No subject underwent two-jaw surgery or rotation of the mandible in the frontal plane. In all cases osteosynthesis of the mandibular segment was performed by bicortical semirigid fixation with two screws on each side after manual intraoperative positioning of the condylar process. The proximal segment was set and fixed to maintain the preoperative distance between the anterior ridge of the mandibular ramus and the orthodontic bracket hook of the upper canine on the right and left sides. Intermaxillary fixation (IMF) was maintained for about 1 week, and postoperative orthodontic treatment using intermaxillary elastics was done after IMF removal.

An anteroposterior cephalogram of each patient was obtained before surgery in centric occlusion and traced twice by one of the authors. The jaw deviation of each patient was analyzed on the traces using a method described previously.[1] Deviation of the menton (Me) from the facial midline on the frontal plane of more than 3 mm was considered to indicate an asymmetric condition. Based on the results, all subjects were assigned to one of two asymmetry groups (left deviation n = 8; right deviation n = 7) or the symmetry group (no deviation n = 7). Table 1 presents the amounts of jaw deviation from the facial midline at Me and the setbacks of the mandible on the right and left sides in the subjects.

Table 1. Setback

	Asymmetry (N = 15)		
	Left deviation (N = 8)	Right deviation (N = 7)	Symmetry (N = 7)
Midline deviation at L1 (mm)	5.5 ± 2.4L	7.0 ± 3.2R	0.3 ± 0.7R
Setback (mm)			
Left	5.4 ± 2.3	10.4 ± 2.0	6.4 ± 3.2
Right	9.4 ± 1.9	6.9 ± 3.0	6.9 ± 2.0

MR Imaging

MR sagittal and coronal images taken with GE Signa MR/I scanner (GE Medical Systems, Milwaukee, WI) 1.5T (repetition time = 600 millisecond and echo time = 10.5 millisecond) were used to evaluate the morphology of the TMJ, including displacement of the articular disk in a closed mouth as described previously.[1] Briefly, axial scout images were first obtained to identify exact mid-condylar sections. The head of the patient was positioned so that the Frankfurt plane was perpendicular to the floor, in order to get a consistent orientation of sagittal images. Six contiguous 3-mm thick parasagittal images were obtained. The scans were obtained at least 1 month before and more than 1 year after surgery.

Measurements were made on the sagittal MR images using a line that passed through the center of the condyle, as described previously, though the lateral MR image was often so impeded that it could not be evaluated (Figure 1).[1] Briefly, using the method of Gökalp,[9] the eminence slope was defined as the angle between the horizontal plane and a tangent drawn from the deepest point of the glenoid fossa (Gf) to the slope of the anterior eminence (a). Next, the angle was measured between the lines drawn from the geometrical center of the condyle head (Cc) to Gf and from the Cc to the posterior margin of the posterior band of the disk (b). A positive value indicated that the disk was in an anterior position in the glenoid fossa, and a negative value indicated that it was in a posterior position. The narrowest anterior (c) and posterior (d) distances between the surface of the condyle and the inner face of the glenoid fossa were also measured.

Statistical Analysis

All the measurements were performed twice with a minimum interval of 1 month by the same investigator (MK). The angular and linear variables showed a coefficient of reliability as previously described.[1] Right and left TMJ variables were compared using a paired *t*-test or the Wilcoxon signed-rank test using Microsoft Excel for Windows XP (Microsoft, Redmond, Wash). A level of $P < .05$ was considered to be significant.

RESULTS

The distribution of TMJ symptoms in all subjects before and after surgery is shown in Table 2. Of the 15

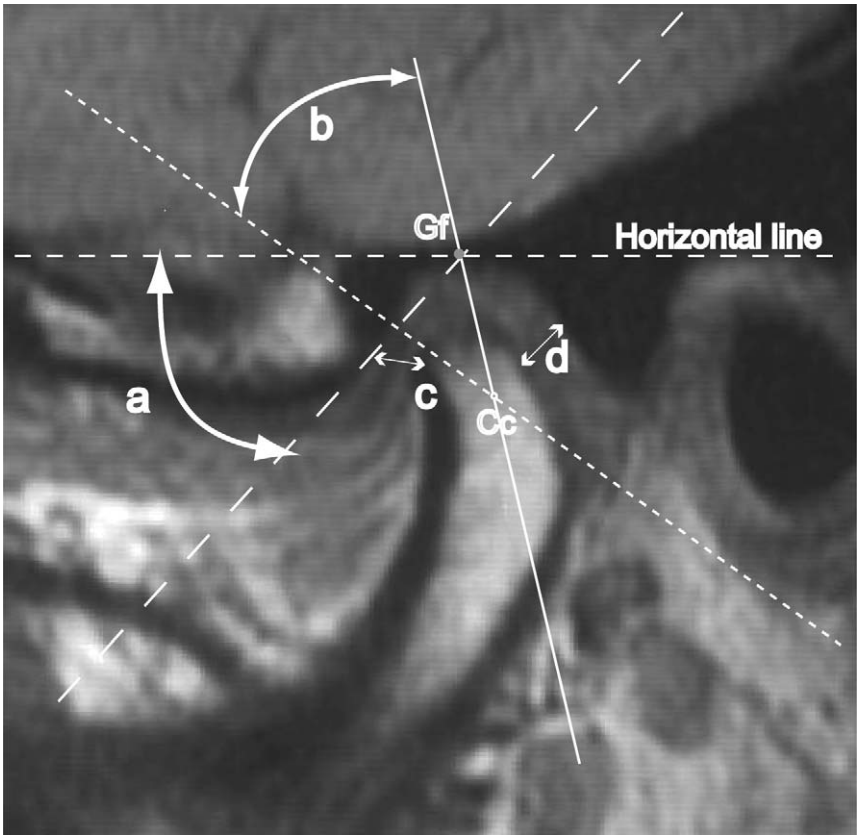

Figure 1. Measurements of the temporomandibular joint on MR images. (Gf) Uppermost point of the roof of the glenoid fossa. (Cc) Center of the condylar head. (a) Eminence slope angle between the horizontal reference line and a line from the Gf to the anterior slope of the glenoid fossa. (b) Disk position angle between the line from the Gf to the Cc and the line from the posterior edge of the disk to the Cc. (c) Anterior joint space. (d) Posterior joint space.

Table 2. TMJ Symptoms

Asymmetry (N = 15)	Deviation Side		Nondeviation Side		Symmetry (N = 7)		
	Pretreatment	Posttreatment	Pretreatment	Posttreatment		Pretreatment	Posttreatment
Clicking	3	2	4	5	Clicking	3	4
Crepitus	0	0	0	1	Crepitus	1	0
Pain	0	0	0	0	Pain	0	1

subjects in the two asymmetry groups, 7 (3 on the deviated side and 4 on the nondeviated side) reported preoperative TMJ clicking. After setback of the mandible, 5 reported improved TMJ clicking, 2 were unchanged, and another 5 had postoperative clicking. In the symmetry group (n = 7), three subjects had preoperative TMJ clicking on the right side; after surgery those symptoms were unchanged and one patient had new TMJ clicking on the left side. Crepitus in the TMJ was reported on the nondeviated side by one subject with asymmetry and on the right side by one subject with symmetry, which disappeared after the surgery in both. In addition, one subject in the symmetry group had reported postoperative TMJ pain. None of the subjects had mouth opening limitations before and after the surgery.

In our previous study, we found that the eminence slope angle of the deviated side was steeper than that of the contralateral side before performing mandibular setback.[1] In all of the present subjects, the steepness of the articular eminence was maintained after the mandibular surgery for both the right and left TMJs (Figure 2). The value of the disk position angle to the condylar axis (Cc-Gf) was positive on the deviated side before surgery, which indicated that the articular disk was in an anterior position in the fossa. After the setback, the disk position angle showed no significant change, and the disk was maintained in its preopera-

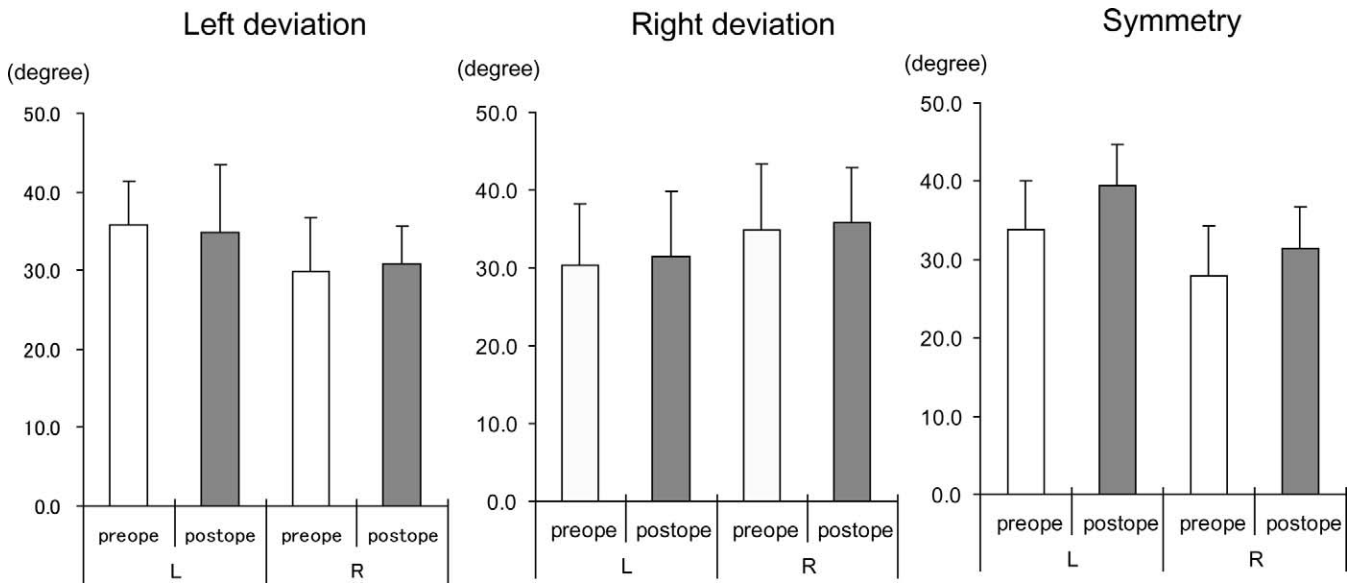

Figure 2. Change of eminence slope angle.

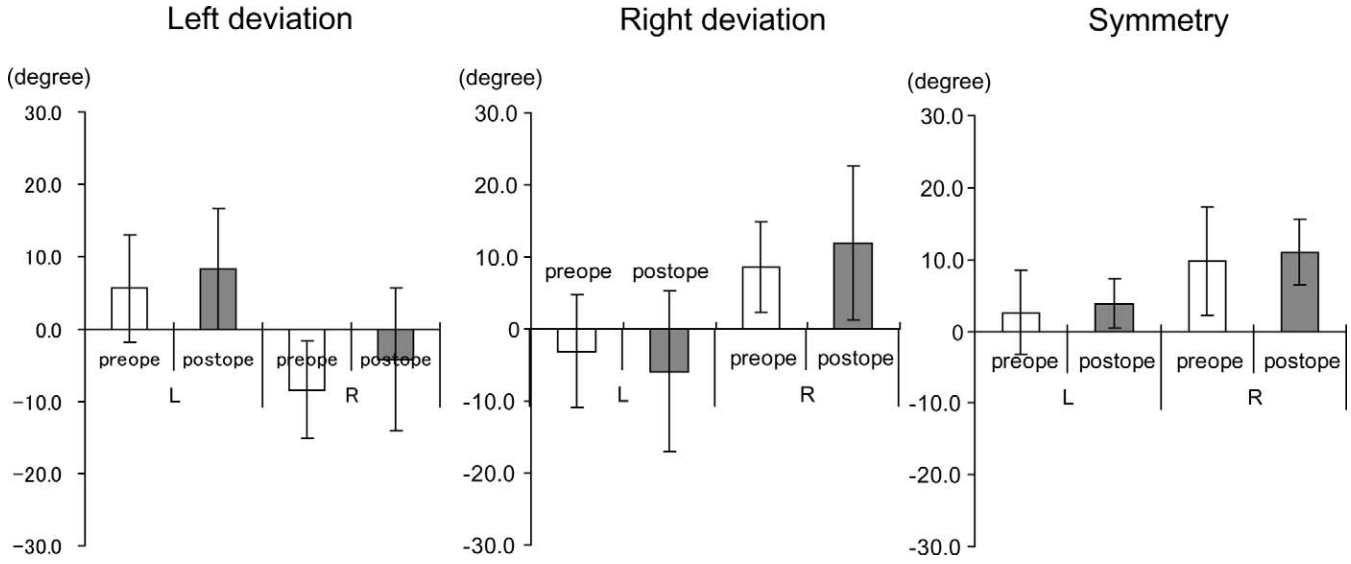

Figure 3. Change of disk position angle. Positive values show the anterior position of the disk to the Gf-Cc line and negative values indicate the posterior position of the disk.

tive position on the deviated side (left deviation group, $P = .576$; right deviation group, $P = .820$). Similarly, the negative value for the disk position on the nondeviated side was maintained after surgery (left deviation group, $P = .129$; right deviation group, $P = .741$). In the symmetry group, there were no significant differences in the right and left sides after surgery (left side, $P = .869$; right side, $P = .845$) (Figure 3). The anterior joint space was narrower on the deviated side than on the nondeviated side of the asymmetry group preoperatively. However, neither side showed changes in the anterior space after surgery (Figure 4). Furthermore, the posterior joint space was not significantly different between the deviated and nondeviated side in the two asymmetry groups or the symmetry group after undergoing the setback (Figure 5).

DISCUSSION

On our previous study, we found that jaw asymmetry is associated with significant differences in TMJ morphology, as there was a steeper slope of eminence and a narrower joint space compared with the contralateral side regardless of right or left deviation.[1] The present results revealed that the TMJ structure and the relationship between the condyle head and the fossa

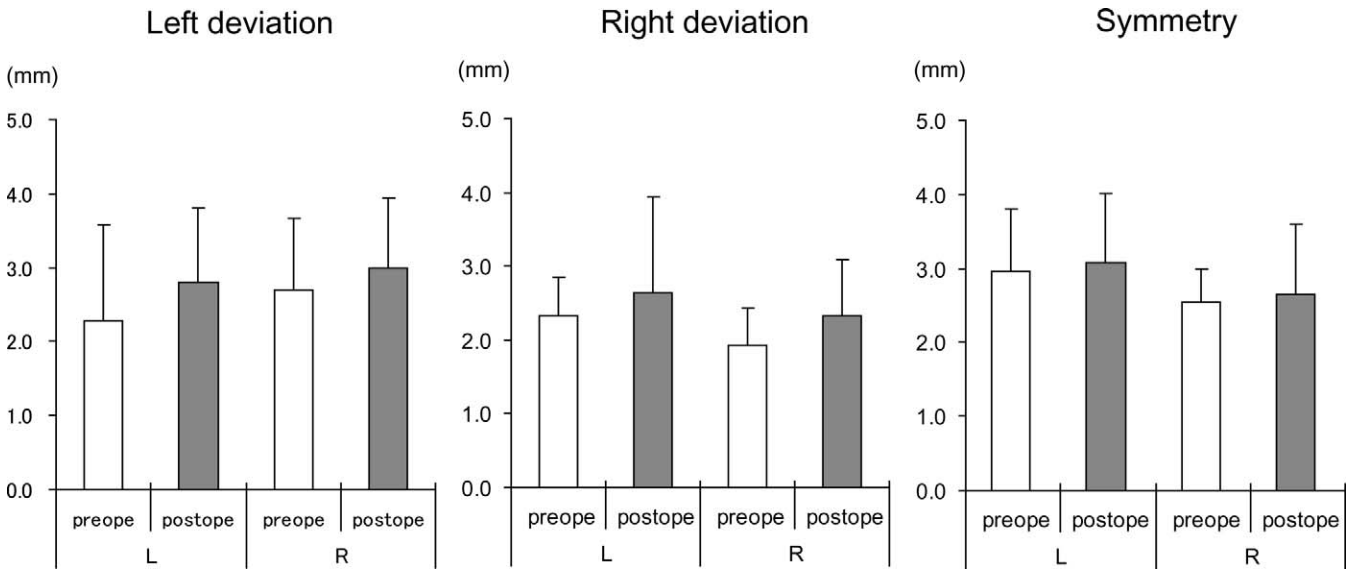

Figure 4. Change of anterior joint space.

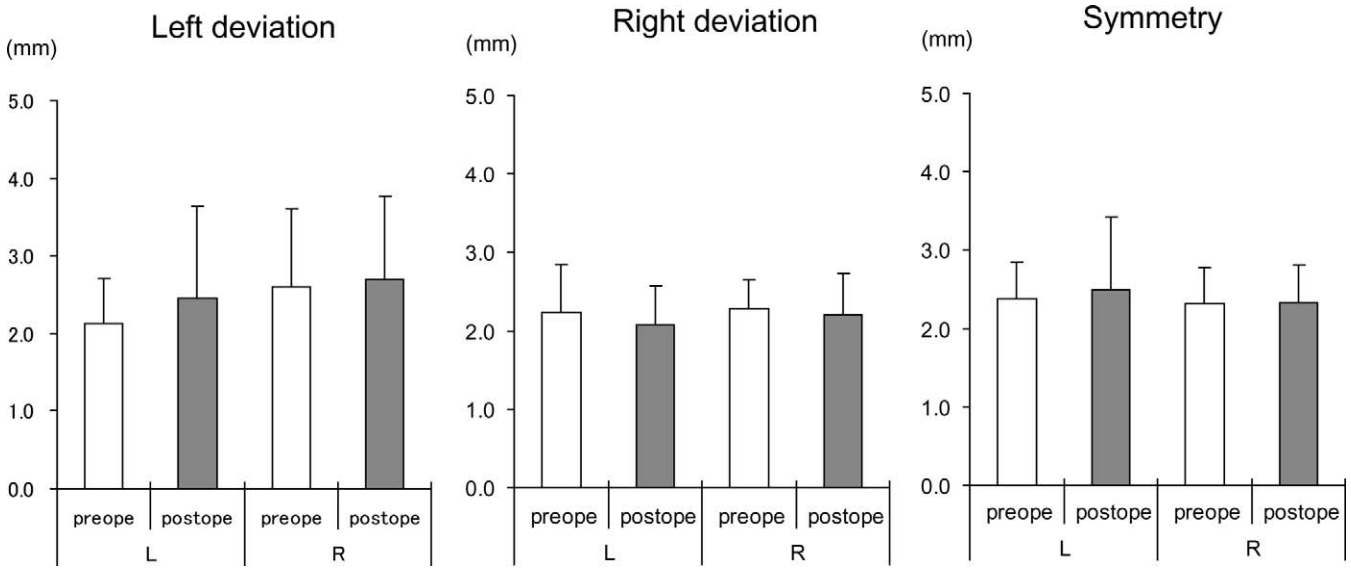

Figure 5. Change of posterior joint space.

were maintained in our subjects after undergoing asymmetric mandibular setback, though there was a slight tendency for forward displacement of the disk with backward movement of the condyle. Overall, there was no significant difference in TMJ signs or symptoms between the subjects with asymmetry and those with symmetry.

It has been reported that the mandibular setback causes slight forward and downward movement of the condylar head. Hu et al[10] showed posterior displacement of the condyle on the sagittal view radiographs of the TMJ after mandibular setback obtained by a muscle pull of the anterior and posterior temporalis and masseter. There is a possibility that changing the condyle influences the disk position after surgery. The mandibular asymmetry may have different influences on the disk position that result from the displacement of the condylar position. On the other hand, another study reported that the amount of the mandibular setback does not correlate statistically with condylar displacement.[11] In addition, Lee et al[12] noted that there was no significant change in the articulate disk position shown in MR images after a simple BSSO in skeletal Class III patients.

In our study, we analyzed the disk displacement after asymmetric setback surgery using MR images and found no significant change of the disk position in the articular fossa after surgery. We also found no signif-

icant changes in the anterior or posterior joint space after surgery, which suggests there were no changes of condylar position in the articular fossa. Although there were slight increases in the anterior joint space and disk position angle after the surgery, likely because of the backward movement of the condyle, they were not significant.

Few studies have examined the influence of mandibular setback on the TMJ postoperatively. Alterations in condylar position by such surgery can lead to an early relapse, and patients may develop signs and symptoms of temporomandibular disorders.[13] Another report stated that the position of the condyle is influenced by the position of the patient during the operation, fixation method, surgical technique, and bony interference between the proximal and distal segments.[14] Increased setback can cause a more backward rotation of the condyle, whereas rigid fixation with screws tends to eliminate the gaps between the proximal and distal segments, which can cause internal rotation of the condylar head.[11]

To prevent postoperative temporomandibular disorders, several positioning devices have been proposed and applied. Intraoperative fixing of the condylar process in the center of the articular fossa with an interpositional splint and titanium miniplates prevented postoperative structural changes in the TMJ.[15] Other surgical techniques include asymmetric setback by intraoral vertical ramus osteotomy on the deviated side during axial movement of the proximal segment and by sagittal split ramus osteotomy on the nondeviated side by sliding the distal segment. However, in case of symmetric mandibular setback or advancement, use of a positioning device does not provide a better functional outcome, and manual positioning results in equally acceptable TMJ function.[13] A variety of transmission errors can occur from recording centric relation to the intraoperative fixation of the fragments. In our department, we do not use positioning devices but simply maintain the preoperative distance between the anterior margin of the mandibular ramus and the upper canine bracket on each side to keep the preoperative relationship of the condylar to the fossa. Baek et al[11] reported that the condylar process did not change its original position in the fossa after asymmetric setback. Our study supported those results and showed that manual positioning of the proximal segment intraoperatively at least maintains the relationship between the disk and the fossa and does not lead to any significant signs or symptoms in the TMJ after the mandibular setback regardless of symmetry or asymmetry. These changes in disk position may be within the range of adaptability for patients. Condylar displacement and changes of muscle tone led to bony apposition of postsuperior areas of the condyle and the temporomandibular fossa,[16] which suggests that some bony remodeling of the TMJ fossa occurs after surgery.

CONCLUSION

- There was no significant change in disk position after differential setback of the mandible. Furthermore, BSSO is effective for preventing the displacement of the disk and condyle during asymmetric setback.

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