



# Effects of the changes in the condylar long axis angle and condylar position on temporomandibular symptoms after intraoral vertical ramus osteotomy: a preliminary study

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**Objective.** This study was conducted to characterize the effects of the changes in the condylar long axis and position on temporomandibular symptoms with respect proximal segment position after intraoral vertical ramus osteotomy (IVRO).

**Study Design.** Twenty Japanese patients with diagnosed jaw deformity underwent IVRO without internal fixation. Long-term changes in condylar long axis and position were assessed during postoperative follow-up examinations by using computed tomography, and *t* tests were performed for comparison. In addition, changes in temporomandibular symptoms were examined.

**Results.** The degree of axial rotation of the proximal segment changed significantly when the proximal segment was located laterally. Downward changes in condylar position significantly differed when the proximal segment was located posterolaterally. Forward changes in condylar position significantly differed when the proximal segment was located laterally; moreover, when the proximal segment was located laterally, temporomandibular symptoms disappeared.

**Conclusions.** Lateral location of the proximal segment may be an important factor in the positive effects of IVRO, with respect to temporomandibular symptoms. (Oral Surg Oral Med Oral Pathol Oral Radiol 2019;128:597–605)

Intraoral vertical ramus osteotomy (IVRO) and sagittal splitting ramus osteotomy are common forms of orthognathic surgery used to treat patients with mandibular prognathism. Notably, IVRO has been shown to alleviate certain symptoms, including temporomandibular pain<sup>1–11</sup>; therefore, this procedure is often used to treat patients with temporomandibular symptoms. IVRO is suspected to cause downward movement of the proximal segment, which reduces stress on the temporomandibular joint (TMJ).<sup>9–11</sup>

After IVRO, the proximal segment is guided to the lateral side of the distal segment. This creates an overlapping shape, which deviates laterally and changes the degree of axial rotation of the proximal segment and the position of the mandibular condyle; these modifications contribute to changes in temporomandibular symptoms. However, in IVRO, the proximal segments may not be located laterally to the distal segment after

surgery, and there are no clear criteria regarding reoperation. The purpose of the present study was to evaluate the effects of changes in the condylar long axis and position on temporomandibular symptoms with respect proximal segment position after IVRO.

## PATIENTS AND METHODS

### Patients

This retrospective study was approved by the authors' institutional review board (approval No. 16020826), in line with the medical and ethical protocols of the Helsinki Declaration, and all participants provided written informed consent. The study included Japanese patients who were diagnosed with skeletal mandibular prognathism and underwent mandibular setback with IVRO, during the period October 2012 to August 2016, at the Department of Clinical Oral Oncology, Unit of Translational Medicine, Nagasaki University Graduate School of Biomedical Sciences (Nagasaki, Japan). During the study period, IVRO was applied for all patients who required setback and who were assigned to a particular operator. Patient allocation was performed in a

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## Statement of Clinical Relevance

In intraoral vertical ramus osteotomy, it is important and effective to locate the proximal segment laterally; this may maximize alleviation of temporomandibular symptoms. If the proximal segment is located posteriorly, satisfactory results may be achieved through reoperation.

random manner. This study investigated 40 sides of 20 patients (11 women, 9 men) who underwent follow-up examination with postoperative computed tomography (CT) (Aquilion 64; Canon Medical Systems Corporation, Tochigi, Japan). Although bone milling may be performed on proximal and distal segments—that is, the surgical margins around the mandibular notch—to reduce protrusion of the angle of the mandible after IVRO, this treatment was not performed on any of the patients in the present study. In the surgical procedure performed in this study, the medial pterygoid muscle was nearly stripped. A *t* test was then performed by using SPSS software, version 24.0 (SPSS Inc., Chicago, IL).

Inclusion criteria for this study were as follows:

1. No previous orthognathic or maxillary surgery
2. Availability of patients for all evaluation time frames

Exclusion criteria were as follows:

1. Lack of agreement to participate
2. Previous treatment with bimaxillary surgery
3. Loss to follow-up at specific time intervals (1 week before and after the designated follow-up date)

### Assessment methods

Axial and 3-dimensional (3-D) CT images were used to examine the TMJ. CT was performed for surgical planning approximately 1 month before the operation and immediately postoperatively to check for complications; the patients were then examined at 1 month, 3 months, 6 months, and 1 year postoperatively. Comparison with subsequent CT scans was performed by using the CT scan obtained immediately after surgery as the control. In CT imaging, the head position was set such that the Frankfurt plane was perpendicular to the floor. CT images were obtained in the closed-mouth position to ensure that the TMJ was in a consistent position in all images. Measurements were obtained by 2 independent investigators, and more than 1 measurement was obtained at different time intervals by 2 investigators. Positional relationships between the proximal and distal segments after IVRO were examined. The proximal segment was classified as the segment located laterally, posteriorly, and medially to the distal segment. Data were recorded as mean  $\pm$  standard deviation, and *t* tests were performed.

### Postoperative changes in the degree of axial rotation of the proximal segment

On the CT images, we measured the angle formed by the intersection of a line connecting the left and right anterosuperior alveolar arteries and a line passing



Fig. 1. Measurements of postoperative change in the condylar long axis.

through the center of the mandibular condyle, where the buccolingual width is greatest. For the right mandibular condyle, a counterclockwise change in the angle on CT images was considered positive; for the left mandibular condyle, a clockwise change was considered positive (Figure 1).

### Postoperative changes in the position of the mandibular condyle

The positional movement of the mandibular condyle was measured on 3-D CT images. In the measurement, a straight line was drawn on the upper edge of the zygomatic arch, and a straight line drawn parallel to it passed through the deepest point of the mandibular fossa and the upper edge of the articular tubercle of the temporal bone. The intermediate line between the 2 lines was designated as the horizontal reference line. Furthermore, a line perpendicular to the horizontal reference line was drawn at the deepest point of the mandibular fossa; this was used as a vertical reference line. For measurement purposes, the point of intersection of the horizontal and vertical reference lines represented the position of the mandibular condyle (Figure 2). The measurement was performed twice by 3 oral surgeons. Two or more oral surgeons were present at the work to ensure the accuracy of the measurements.

*Postoperative changes in temporomandibular symptoms.* Temporomandibular symptoms before and after surgery were assessed by using the Research Diagnostic Criteria for Temporomandibular Disorders (RDC-TMD) at the initiation and completion of orthodontic treatment (Table I). Questionnaire items regarding race and sex life were excluded.

### Detailed analysis of cases in which TMJ symptoms did not disappear after IVRO

We compared changes in the degree of axial rotation of the proximal segment, as well as the positional change

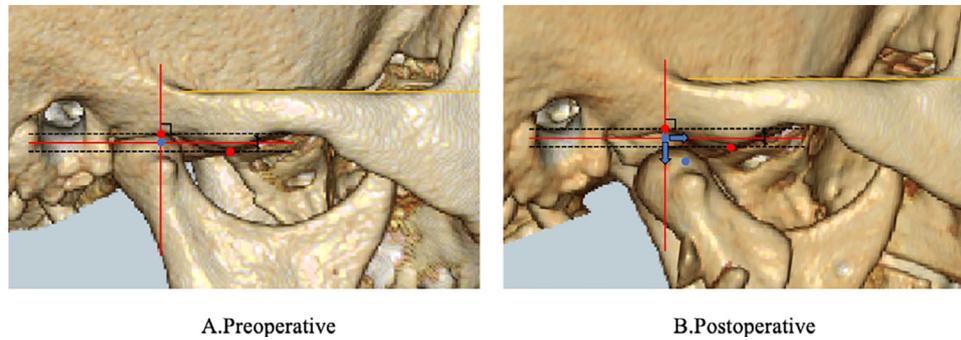


Fig. 2. Changes in the position of the sagittal mandibular condyle after osteotomy: **A**, Preoperative. **B**, Postoperative.

**Table I.** Diagnostic Criteria for Temporomandibular Disorders (RDC-TMD)

Group	Criteria
I. Muscle disorders	
I. a. Myofascial pain	<ol style="list-style-type: none"> <li>1. Reported pain in masticatory muscles</li> <li>2. Pain on palpation in at least 3 sites, one of them at least in the same side of the reported pain</li> </ol>
I. b. Myofascial pain with limited opening	<ol style="list-style-type: none"> <li>1. Myofascial pain</li> <li>2. Pain-free unassisted opening &lt;40 mm and passive stretch &gt;5 mm</li> </ol>
II. Disk displacements	
II. a. Disk displacement with reduction	<ol style="list-style-type: none"> <li>1. No pain in the joint</li> <li>2. Reproducible click on excursion with either opening or closing click</li> <li>3. With click on opening and closing (unless excursive click confirmed): Click on opening occurs at <math>\geq 5</math> mm interincisal distance than on closing Clicks eliminated by protrusive opening</li> </ol>
II. b. Disk displacement without reduction with limited opening	<ol style="list-style-type: none"> <li>1. History of locking or catching that interfered with eating</li> <li>2. Absence of temporomandibular joint (TMJ) clicking</li> <li>3. Unassisted opening (even painful) <math>\leq 35</math> mm and passive stretch <math>\leq 4</math> mm</li> <li>4. Contralateral excursion &lt;7 mm or uncorrected ipsilateral deviation on opening</li> </ol>
II. c. Disk displacement without reduction without limited opening	<ol style="list-style-type: none"> <li>1. History of locking or catching that interfered with eating</li> <li>2. Presence of TMJ sounds excluding Disc displacement without reduction clicking</li> <li>3. Unassisted opening (even painful) &gt;35 mm and passive stretch &gt;4 mm</li> <li>4. Contralateral excursion <math>\geq 7</math> mm</li> <li>5. Optional imaging (arthrography or magnetic resonance imaging) to confirm Disc displacements</li> </ol>
III. Other common joint diseases	
III. a. Arthralgia	<ol style="list-style-type: none"> <li>1. Pain on TMJ palpation, either laterally or intra-auricularly</li> <li>2. Self-reported joint pain with or without jaw movement</li> <li>3. Absence of crepitus, and possibility of clicking</li> </ol>
III. b. Osteoarthritis	<ol style="list-style-type: none"> <li>1. Pain as for arthralgia</li> <li>2. Crepitus on any movement or radiographic evidence of joint changes</li> </ol>
III. c. Osteoarthrosis	<ol style="list-style-type: none"> <li>1. Crepitus on any movement or radiographic evidence of joint changes</li> <li>2. No reported joint pain nor pain on any movement</li> </ol>

of the mandibular condyle, for cases in which TMJ symptoms did not disappear after IVRO.

## RESULTS

The total number of patients who underwent IVRO alone during the study period was 33. After excluding the 13 patients who did not undergo consultation at the time of the prescribed follow-up observation, 20 patients were included in the study.

The patients were 17 to 54 years of age (mean 27.3 years) at the time of the surgeries. The amount of setback achieved with IVRO ranged from 1 to 13 mm (mean 7 mm). In 28 of the 40 sides (70%), the segment remained in the lateral position; however, on 9 sides (22.5%), it moved to a posterior position and in 3 sides (7.5%) to a medial position (Table II). Because the proximal segment was located medially in only a few cases, statistical analysis was not performed. It was presumed that during the

**Table II.** Demographic and clinical characteristics of the study patients

Case	Sex	Age at the time of operation	Surgical procedure	Amount of setback (R: mm)	Amount of setback (L: mm)	Proximal segment with respect to distal segment after IVRO	
						Left side	Right side
1	M	45	IVRO	5	5	Lateral	Posterior
2	M	19	IVRO	7.5	9.5	Lateral	Lateral
3	M	23	IVRO	5	5	Posterior	Lateral
4	F	26	IVRO	10.5	6.5	Lateral	Lateral
5	F	24	IVRO	3	3	Medial	Medial
6	F	21	IVRO	7	4	Lateral	Lateral
7	M	21	IVRO	9	6	Posterior	Lateral
8	F	28	IVRO	12	12	Lateral	Lateral
9	M	20	IVRO	11	11	Lateral	Lateral
10	F	20	IVRO	8	8	Medial	Lateral
11	F	17	IVRO	4	3	Lateral	Lateral
12	M	47	IVRO	6.5	6.5	Lateral	Lateral
13	F	18	IVRO	13	13	Posterior	Lateral
14	M	17	IVRO	6	6	Posterior	Lateral
15	M	42	IVRO	1	3	Posterior	Posterior
16	F	19	IVRO	9	9	Lateral	Lateral
17	F	18	IVRO	8	10	Lateral	Lateral
18	M	54	IVRO	6	2	Lateral	Lateral
19	F	18	IVRO	7.5	7.5	Lateral	Lateral
20	F	50	IVRO	7	5	Lateral	Posterior

F, female; IVRO, intraoral vertical ramus osteotomy. M, male.

study period, occlusion remained stable and did not affect the measurement items.

### Postoperative changes in the degree of axial rotation of the proximal segment

When the proximal segment was positioned laterally, the angle increased by  $10.8^\circ \pm 9.4^\circ$  ( $P = 2.46 \times 10^{-6}$ ) immediately postoperatively; it remained elevated by  $5.8^\circ \pm 4.9^\circ$  ( $P = 3.8 \times 10^{-4}$ ) at 1 year postoperatively. A significant difference was observed at all time points.

When the proximal segment was positioned posteriorly, the angle increased by  $8.1^\circ \pm 5.9^\circ$  ( $P = 4.68 \times 10^{-3}$ ) immediately postoperatively; it remained elevated by  $5.6^\circ \pm 6.5^\circ$  ( $P = 1.6 \times 10^{-1}$ ) at 1 year postoperatively. There were no significant differences at any time point, with the exception of the immediate postoperative period.

When the proximal segment was positioned medially, the angle increased immediately after surgery by  $3^\circ \pm 6.5^\circ$ ; however, it decreased by  $-12^\circ \pm 5.1^\circ$  at 1 year postoperatively. Although statistical analysis was not performed, the angle tended to be lower than that measured before IVRO (Figure 3, Table III).

### Postoperative changes in the position of the mandibular condyle

When the proximal segment was positioned laterally, the mandibular condyle position changed immediately postoperatively by  $1.8 \pm 1.4$  mm ( $P = 7.41 \times 10^{-7}$ )

(downward) and  $1.0 \pm 1.3$  mm ( $P = 5.0 \times 10^{-4}$ ) (forward); these changes persisted 1 year postoperatively:  $0.7 \pm 0.7$  mm ( $P = 4.4 \times 10^{-4}$ ) (downward) and  $0.6 \pm 0.9$  mm ( $P = 1.08 \times 10^{-2}$ ) (forward). A significant difference was observed at all time points.

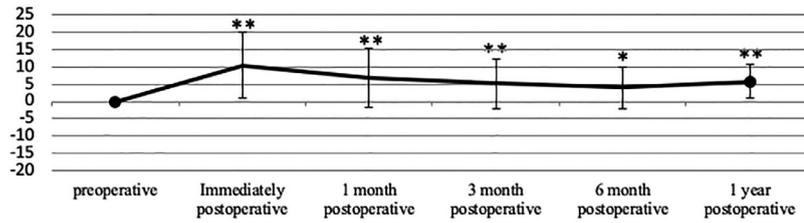
When the proximal segment was positioned posteriorly, the mandibular condyle position changed immediately postoperatively by  $1.7 \pm 0.7$  mm ( $P = 9.56 \times 10^{-5}$ ) (downward) and  $0.5 \pm 0.7$  mm ( $P = 8.06 \times 10^{-2}$ ) (forward); these changes persisted 1 year postoperatively:  $0.9 \pm 0.3$  mm ( $P = 2.92 \times 10^{-3}$ ) (downward) and  $0.5 \pm 0.6$  mm ( $P = 2.24 \times 10^{-1}$ ) (forward). At 1 year postoperatively, the mandibular condyle position change (downward) showed a significant difference; however, there was no significant difference in the mandibular condyle position change (forward).

When the proximal segment was positioned medially, the mandibular condyle position changed immediately postoperatively by  $1.2 \pm 0.5$  mm (downward) and  $0.2 \pm 0.5$  mm (forward); these changes persisted 1 year postoperatively ( $1.0 \pm 0.2$  mm (downward) and  $0.8 \pm 0.1$  mm (forward)). The tendency toward a downward change was not considerably different from that observed in the other 2 groups, but the tendency toward a forward change was more prominent (Figure 4, Table IV).

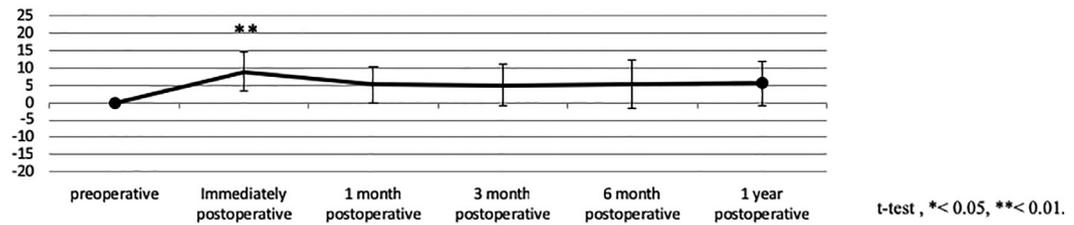
### Postoperative changes in temporomandibular symptoms

Before treatment, diagnostic assessment was performed by using the RDC-TMD. One patient's

A. Change in the degree of axial rotation of the proximal segment with the proximal segment positioned laterally (in units of degrees)



B. Change in the degree of axial rotation of the proximal segment with the proximal segment positioned posteriorly (in units of degrees)



C. Change in the degree of axial rotation of the proximal segment with the proximal segment positioned medially (in units of degrees)

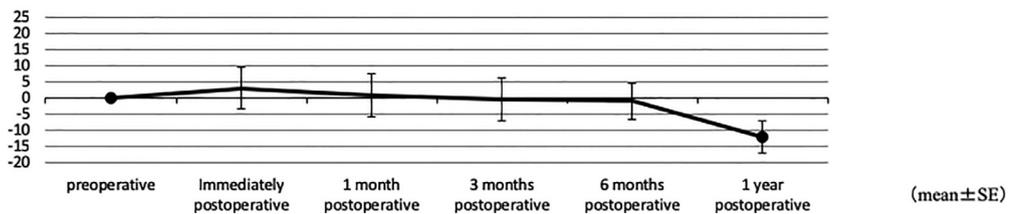


Fig. 3. Changes in the degree of axial rotation of the proximal segment. **A**, Change in the degree of axial rotation of the proximal segment with the proximal segment positioned laterally (in units of degrees). **B**, Change in the degree of axial rotation of the proximal segment with the proximal segment positioned posteriorly (in units of degrees). **C**, Change in the degree of axial rotation of the proximal segment with the proximal segment positioned medially (in units of degrees)

Table III. Changes in the degree of axial rotation

	Preoperative	Immediately postoperative	1 month postoperative	3 month postoperative	6 month postoperative	1 year postoperative
With the proximal segment positioned laterally (in degrees)						
Average	0	10.8	7.1	5.5	4.1	5.8
Standard deviation	0	9.4	8.6	7.1	6.0	4.9
t test		$2.46 \times 10^{-6}$ (†)	$3.7 \times 10^{-4}$ (†)	$7.4 \times 10^{-4}$ (†)	$1.56 \times 10^{-3}$ (†)	$3.8 \times 10^{-4}$ (†)
With the proximal segment positioned posteriorly (in degrees)						
Average	0	8.1	4.4	4.1	4.5	5.6
Standard deviation	0	5.9	5.1	6.2	7.1	6.5
t test		$4.68 \times 10^{-3}$ (†)	$7.6 \times 10^{-2}$	$1.0 \times 10^{-1}$	$1.36 \times 10^{-1}$	$1.60 \times 10^{-1}$
With the proximal segment positioned medially (in degrees)						
Average	0	3	0.7	-0.3	-1	-12
Standard deviation	0	6.5	6.6	6.6	5.7	5.1

t test: \* < 0.05; † < 0.01.  
(mean ± SE)

symptoms were categorized as group Ia, and 3 patients' symptoms were categorized as group Ib. With respect to the left TMJ, one patient's symptoms were categorized as group IIa; two patients' symptoms were categorized as groups IIb, IIc, and IIIa. With respect to

right TMJ, one patient's symptoms were categorized as group IIa; two patients' symptoms were categorized as group IIb, three patients' symptoms were categorized as groups IIc and IIIa. Diagnostic reassessment at the end of treatment showed that no patients' symptoms

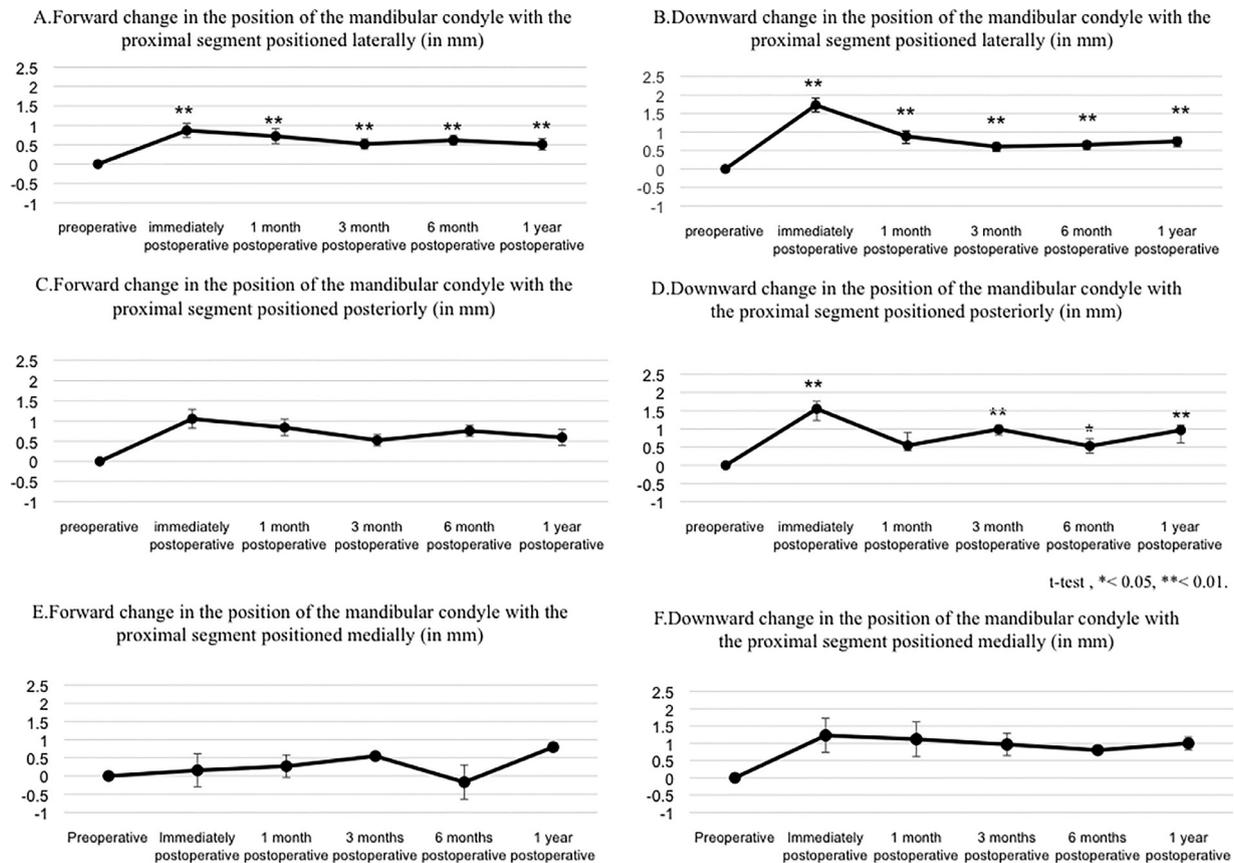


Fig. 4. Forward and downward changes in the position of the mandibular condyle. **A**, Forward change in the position of the mandibular condyle with the proximal segment positioned laterally (in millimeters). **B**, Downward change in the position of the mandibular condyle with the proximal segment positioned laterally (in millimeters). **C**, Forward change in the position of the mandibular condyle with the proximal segment positioned posteriorly (in millimeters). **D**, Downward change in the position of the mandibular condyle with the proximal segment positioned posteriorly (in millimeters). **E**, Forward change in the position of the mandibular condyle with the proximal segment positioned medially (in millimeters). **F**, Downward change in the position of the mandibular condyle with the proximal segment positioned medially (in millimeters).

were classified as group I. With respect to group II, one patient’s symptoms were categorized as IIa in left TMJ; two patients’ symptoms were categorized as IIb and three patients’ symptoms were categorized as IIc in right TMJ. Group III symptoms had disappeared. Regardless of the position of the proximal segment, there were no new temporomandibular symptoms. TMJs that exhibited symptoms before treatment showed improvement of symptoms after treatment in which the proximal segment was located laterally; however, symptoms continued in patients in whom the TMJ was located posteriorly. In cases where the proximal segment was located medially, there were no TMJ symptoms before IVRO, and there were no TMJ symptoms after IVRO (Table V).

**Detailed analysis of cases in which TMJ symptoms did not disappear after IVRO**

Regarding TMJs in which symptoms were present before IVRO, changes in such symptoms after IVRO

were examined. The results revealed that TMJ symptoms did not completely disappear in cases where the proximal segment was located posteriorly to the distal segment after IVRO. Further examination showed that lateral positioning of the proximal segment relative to the distal segment stabilized the change in the degree of axial rotation of the proximal segment, whereas posterior positioning of the proximal bone fragment relative to the distal segment did not (Figure 5).

**DISCUSSION**

With regard to the changes in the angle of the mandibular condyle in patients with class III malocclusion, the condyle has been shown to rotate medially after sagittal splitting ramus osteotomy.<sup>4-6</sup> In contrast, the condyle has been reported to rotate laterally after IVRO.<sup>12,13</sup>

In the present study, when the proximal segment was positioned lateral to the distal segment after IVRO, the degree of axial rotation of the proximal segment increased significantly in the immediate postoperative

**Table IV.** Changes in the position of condyles

	Preoperative	Immediately postoperative	1 month postoperative	3 months postoperative	6 months postoperative	1 year postoperative
Forward changes in the position of the sagittal mandibular condyle with the proximal segment positioned laterally (in millimeters)						
Average	0	1.01	0.8	0.51	0.77	0.61
Standard deviation	0	1.32	1.06	0.8	0.75	0.88
<i>t</i> test		$5.0 \times 10^{-4}$ (†)	$1.01 \times 10^{-3}$ (†)	$4.01 \times 10^{-3}$ (†)	$2.10 \times 10^{-5}$ (†)	$1.08 \times 10^{-2}$ (*)
Downward changes in position of the sagittal mandibular condyle with the proximal segment positioned laterally (in millimeters)						
Average	0	1.75	0.78	0.47	0.65	0.74
Standard deviation	0	1.41	1.03	0.68	0.59	0.7
<i>t</i> test		$7.41 \times 10^{-7}$ (†)	$6.93 \times 10^{-4}$ (†)	$1.94 \times 10^{-3}$ (†)	$6.65 \times 10^{-6}$ (†)	$4.4 \times 10^{-4}$ (†)
Forward changes in the position of the sagittal mandibular condyle with the proximal segment positioned posteriorly (in millimeters)						
Average	0	0.49	0.72	0.51	0.69	0.46
Standard deviation	0	0.69	0.41	0.47	0.54	0.64
<i>t</i> test		$8.06 \times 10^{-2}$	$.25 \times 10^{-3}$ (†)	$1.46 \times 10^{-2}$ (*)	$6.75 \times 10^{-3}$ (†)	$2.24 \times 10^{-1}$
Downward changes in the position of the sagittal mandibular condyle with the proximal segment positioned posteriorly (in millimeters)						
Average	0	1.67	0.69	0.93	0.49	0.9
Standard deviation	0	0.66	0.96	0.24	0.55	0.28
<i>t</i> test		$9.56 \times 10^{-5}$ (†)	$9.8 \times 10^{-2}$	$4.78 \times 10^{-6}$ (†)	$3.65 \times 10^{-2}$ (*)	$2.92 \times 10^{-3}$ (†)
Forward change in the position of the mandibular condyle with the proximal segment positioned medially (in millimeters)						
Average	0	0.16	0.27	0.55	-0.17	0.8
Standard deviation	0	0.46	0.31	$7.7 \times 10^{-2}$	0.47	0.11
Downward change in the position of the mandibular condyle with the proximal segment positioned medially (in millimeters)						
Average	0	1.23	1.12	0.97	0.8	1.0
Standard deviation	0	0.49	0.50	0.32	$3.68 \times 10^{-2}$	0.19

*t* test: \* < 0.05, † < 0.01.  
(mean ± SE)

**Table V.** Relationship between the position of the proximal bone fragment and the changes in temporomandibular joint symptoms, before and after IVRO

Case	Proximal segment, with respect to distal segment, after IVRO		RDC-TMD Axis I Group I–III diagnoses (preoperative)			RDC-TMD Axis I Group I–III diagnoses (postoperative)		
	Left side	Right side	Group I: left and/or right TMJ	Group II, III: left TMJ	Group II, III: right TMJ	Group I: left and/or right TMJ	Group II, III: left TMJ	Group II, III: right TMJ
1	Lateral	Posterior	Ia	IIc	IIc, IIIa	–	–	IIa
4	Lateral	Posterior	–	–	IIa	–	–	IIa
9	Lateral	Lateral	–	IIc	IIc	–	–	–
11	Lateral	Lateral	Ib	IIb, IIIa	IIb, IIIa	–	–	–
12	Lateral	Lateral	Ib	IIb	IIb, IIIa	–	–	–
14	Posterior	Lateral	Ib	IIa, IIIa	–	–	IIa	–
20	Lateral	Posterior	–	–	IIc	–	–	IIc

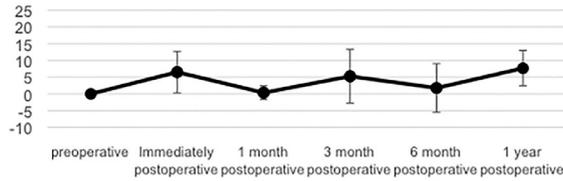
IVRO, intraoral vertical ramus osteotomy; RDC-TMD, Research Diagnostic Criteria for Temporomandibular Disorders; TMJ, temporomandibular joint.

period and remained elevated at 1 year after surgery. However, when the proximal segment was positioned posteriorly after IVRO, the degree of axial rotation of the proximal segment opened significantly increased immediately postoperatively; however, it then returned to a position relative to its preoperative location. Notably, when the proximal segment was positioned medially after IVRO, the degree of axial rotation of the proximal segment tended to increase immediately postoperatively; however, there was a tendency to rotate more medially, thereby moving beyond its preoperative location. In summary, when the proximal segment was positioned

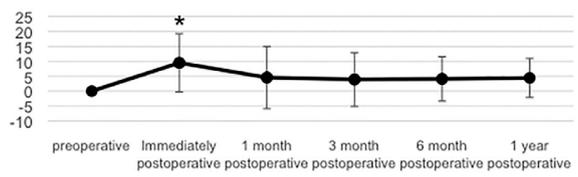
lateral to the distal segment, the angle of the mandibular condyle increased significantly and stayed there.

When the proximal segment was positioned laterally after IVRO, the position of the mandibular condyle moved both downward and forward, with significant changes occurring both immediately postoperatively and at 1 year after surgery. However, when the proximal segment was positioned posteriorly after IVRO, the position of the mandibular condyle moved downward and forward; these changes were significant, but the forward changes had regressed by the 1-year postoperative assessment. When the proximal segment was

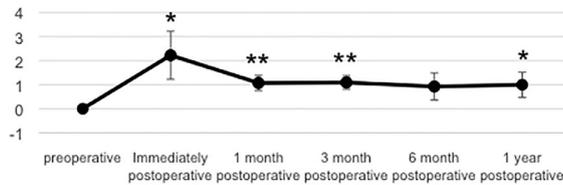
A.Changes in the degree of axial rotation of the proximal segment with the proximal segment positioned laterally (in degrees)



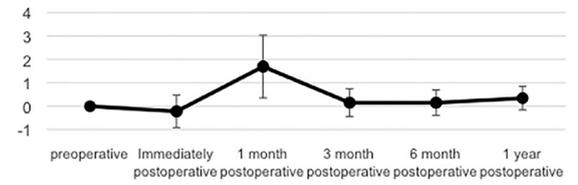
B.Changes in the degree of axial rotation of the proximal segment with the proximal segment positioned posteriorly (in degrees)



C.Forward changes in the position of the mandibular condyle with the proximal segment positioned laterally (in mm)

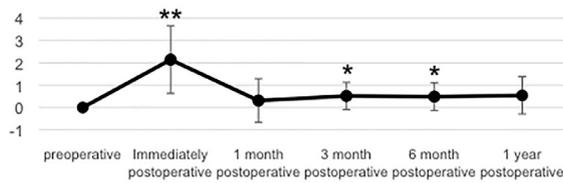


D.Forward changes in the position of the mandibular condyle with the proximal segment positioned posteriorly (in mm)

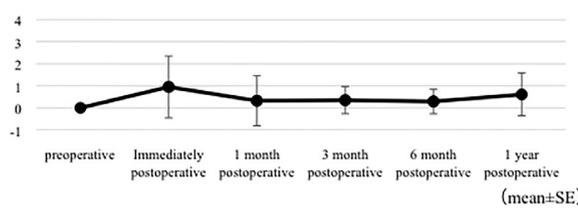


t-test , \* < 0.05, \*\* < 0.01.

E.Downward changes in the position of the mandibular condyle with the proximal segment positioned laterally (in mm)



F.Downward changes in the position of the mandibular condyle with the proximal segment positioned posteriorly (in mm)



(mean±SE)

Fig. 5. Changes in the degree of axial rotation of the proximal segment and mandibular condyle position in patients with temporomandibular joint symptoms before intraoral vertical ramus osteotomy.

positioned medially after IVRO, the position of the mandibular condyle moved both downward and forward; there was no significant difference, relative to the other 2 groups, in the trend of the change. In summary, when the proximal segment was positioned lateral to the distal segment, the position of the mandibular condyle moved anteroinferiorly in a significant manner.

IVRO has been shown to have no negative effects on the TMJ, and many studies have found that IVRO aids in reducing temporomandibular pain.<sup>1-9</sup> In the present study, diagnosis was performed according to the RDC-TMD; in this context, temporomandibular symptoms showed improvement when the proximal segment was located laterally. This change may have occurred because IVRO moves the condylar long axis laterally and the condylar position anteroinferiorly, thereby reducing stress on the TMJ.<sup>9,14</sup> Anterior displacement of the articular disk and the corresponding degenerative changes have been reported in TMJs in which the mandibular condyle was rotated medially<sup>15,16</sup>; this suggests that IVRO, which is accompanied by lateral rotation of the condylar long axis and anteroinferior movement of the mandibular condyle, creates better physiologic conditions for the TMJ. In the present study, new temporomandibular symptoms did not

appear or the existing symptoms did not worsen in any patient; additionally, symptoms appeared to be reduced upon lateral movement of the condylar long axis and anteroinferior movement of the condylar position after IVRO, which suggests that the lateral opening of the angle of the condylar long axis and the anteroinferior movement of the condylar position may have a positive effect on the TMJ.

However, among cases where TMJ symptoms were present before IVRO, only those cases where the position of the proximal segment was located laterally, relative to the distal segment, showed symptomatic improvement. Regarding the tendency toward change in the degree of axial rotation of the proximal segment and the tendency toward positional change in the mandibular condyle, the results showed that the sole difference was in the tendency toward change in the degree of axial rotation of the proximal segment. Therefore, we think that one of the most important factors for resolving TMJ symptoms is the degree of axial rotation of the proximal segment, in addition to the anterior downward movement of the TMJ, which has been regarded as the primary factor thus far.

On the basis of this evidence, lateral placement of the proximal segment appears to be an important

factor. This study has some limitations. First, it was only a preliminary study with a small number of patients. Second, if the proximal segment is located posteriorly, reoperation should be considered for the TMJ; thus, this requirement will increase the difficulty in collecting further cases in the future. Therefore, it is necessary to consider adding past cases to increase the number of cases.

## CONCLUSIONS

In IVRO, it is important and effective to locate the proximal segment laterally to rotate lateral to the mandibular condyle and ensure anteroinferior movement; this may maximize alleviation of temporomandibular symptoms. If the proximal segment is located posteriorly, satisfactory results may be achieved through reoperation.

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