Condylar and disc positions after sagittal split ramus osteotomy with and without Le Fort I osteotomy

Condylar and Disc Positions After Sagittal Split Ramus Osteotomy with and Without Le Fort I Osteotomy

Koichiro Ueki[1], Kohei Marukawa[1], Mayumi Shimada[1], Yukari Hashiba[1], Kiyomasa Nakagawa[1], and Etsuhide Yamamoto[1]

[1]Department of Oral and Maxillofacial Surgery, Graduate School of Medicine, Kanazawa University, 13-1 Takaramachi, Kanazawa 920-8641, Japan.

Key words:
Sagittal split ramus osteotomy
Le Fort I osteotomy
Disc position
Angle of condylar long axis

Address correspondence to: Koichiro Ueki, DDS, PhD.
Department of Oral and Maxillofacial Surgery, Graduate School of Medicine, Kanazawa University, 13-1 Takaramachi, Kanazawa 920-8641, Japan.
Tel: +81-76-265-2444; Fax: +81-76-234-4268
E-mail: kueki@med.kanazawa-u.ac.jp

Abstract

Purpose. The purpose of this study is to examine the changes in temporomandibular joint (TMJ) morphology and clinical symptoms after sagittal split ramus osteotomy (SSRO) with and without a Le Fort I osteotomy.

Subjects and Methods. Of 45 Japanese patients with mandibular prognathism, 23 underwent SSRO and 22 underwent SSRO in combination with a Le Fort I osteotomy. The TMJ symptoms and joint morphology, including disc tissue, were assessed preoperatively and postoperatively by magnetic resonance imaging (MRI) and axial cephalography.

Results. There were significant differences between pre- and postoperative horizontal changes in the condylar long axis on the right side in the group undergoing SSRO (sagittal split ramus osteotomy) alone. However, there were no other significant differences in pre- and postoperative measurements in this group as compared with the group receiving SSRO plus Le Fort I osteotomy, and the preoperative disc position could not be changed in either group.

Conclusion. These results suggest that SSRO, either with or without Le Fort I osteotomy, could not change the preoperative disc position or correct anterior disc displacement, although these procedures did improve the symptoms associated with TMJ dysfunction.

Introduction

Since its introduction by Trauner and Obwegeser[1] in 1957, the mandibular sagittal split ramus osteotomy (SSRO) has become one of the preferred surgical procedures for the correction of various jaw deformities. The Le Fort I osteotomy is currently a popular technique for the correction and treatment of dentofacial deformities.[2] It is frequently used in severe mandibular prognathism with maxillary deformity. When the mandubular setback amount is extremely large, or open bite is included, Le Fort I osteotomy is also used in order to maintain skeletal and occlusal stability.[3]

Dentofacial deformity may be associated with variations in the TMJ, including disc position.[4-6] The help of magnetic resonance imaging (MRI), such deformities have been classified into four types on the basis of disc position and shape: (1) anteriorly displaced disc, (2) anterior type, (3) fully covered type, and (4) posterior type.[4] Furthermore, our previous report regarding these deformities pointed out that SSRO could not correct anterior disc displacement (ADD).[7] However, very few of our patients had undergone SSRO with Le Fort I osteotomy (as opposed to SSRO alone), so that a statistical comparison between the two groups could was not possible.

The purpose of the present study was to compare the changes in temporomandibular joint (TMJ) morphology and clinical symptoms after SSRO with and without a Le Fort I osteotomy and to assess the relationship between a change in condylar position and improvement in ADD.

Patients and Methods

Patients

The 45 Japanese adults (13 men and 32 women) in this study presented with jaw deformities diagnosed as mandibular prognathism with and without maxillary deformity. At the time of orthognathic surgery, the patients ranged in age from 15 to 37 years, with a mean age of 23.3 years (standard deviation, 6.1 years).

Surgery

Of the 45 patients in this study, 23 (9 men and 14 women, mean age: 24.2 years, standard deviation: 6.7 years) underwent bilateral SSRO. The other 22 patients (4 men and 18 women, mean age: 23.0, standard deviation: 6.5 years) underwent SSRO and a Le Fort I osteotomy; rigid fixation was achieved with min-plates and monocortical screws. After approximately 1 week of intermaxillary fixation, elastic was placed to maintain the ideal occlusion. All patients received orthodontic treatment before and after surgery. All were also assessed with MRI 1 month before surgery and 6 months after surgery. Objective TMJ symptoms were recorded and evaluated.

Axial cephalographic assessment

Axial cephalography was used to assess the condylar long axis. The focus-to-film distance was 130 cm, the ear rod-to-film distance was set at 15 cm, the tube voltage was 80 kV, and the tube current was 50 mA. The images of the apex in the ear rods were connected by a line. Two more lines were then drawn through the lateral and medial poles of both condyles. The angles between these two lines and the ear rod connecting line defined the horizontal condylar angles. Change in the angle of the condylar long axis was evaluated from the difference between preoperative and postoperative values (Fig. 1).

MRI assessment

A detailed MRI assessment of each pair of TMJs was performed by a 1.5-tesla MRI system (Signa Scanner, General Electric Medical Systems, Milwaukee, WI, USA) using bilateral 3-in dual surface coils with the jaw first in the closed, resting position and then in its maximally open position. An initial axial localizer was introduced to obtain exact midcondylar sections perpendicular and parallel to the long axis of each condyle. Images of the bilateral orthogonal sagittal planes and coronal planes of the TMJs in the closed position were acquired first with a repetition pulse (T_R) of 2000 ms, echo times (T_Es) of 20 ms, a 3-mm image slice thickness, and a 10-cm field of view. Then images of the bilateral sagittal planes of the TMJs in the open mouth position were obtained with a T_R of 1000 ms and T_Es of 20 ms.

Images of the midcondylar slices perpendicular and parallel to the long axis of each condyle were entered into a computer (PC9821Xa13, NEC, Tokyo, Japan) with a scanner (GT9500, Epson, Tokyo, Japan) and the coordinates of the highest points of the condyle determined with Scion Image software (Scion Corporation, Frederick, MD, USA).

In the sagittal images, the distance between the lowest point of the articular eminence and the squamotympanic fissure was measured and the line designated “X”. The distance from line X to the highest point of the glenoid fossa was measured and the line designated “Y.” The distance from line X to the highest point of the condyle was measured and the line designated “y.” Finally, the distance between the lowest point of the articular eminence and the highest point of the condyle parallel to line X was measured and designated “x.” The coordinate of the highest point of condyle was expressed as (x/X, y/Y). The change in condylar position was evaluated from the changes in the coordinates (postoperative value minus preoperative value).

The angle between the condylar long axis and the Frankfurt horizontal (FH) plane was measured in the coronal images. The change in the angle of the condylar long axis was evaluated from the difference between preoperative and postoperative values (Fig. 1).

In the sagittal plane images, the center point was determined to be the midpoint of the anteroposterior length of the condyle on the line between the lowest point of articular eminence and the squamotympanic fissure. The lowest point of the articular eminence was considered to be 0° and the squamotympanic fissure became 180°.

Definitions

All joint discs were classified according to following definitions, as shown in our previous report.[4]

1. Anterior displacement: the entire disc is anteroinferior to the most anterior point on the contour of the condyle.

2. Anterior type: the center of the intermediate zone is between 0° and 90° and the most posterior point of the posterior band is posterosuperior to the most anterior point on the contour of the condyle and less than 180°.

3. Fully covered type: the most anterior point of the anterior band is less than 0° and the most posterior point of the posterior band is greater than 180°.

4. Posterior type: the most anterior point of the anterior band is more than 0° and the most posterior point of the posterior band is greater than 180° (Fig. 2).

Statistical analysis

Data were compared between groups with the Mann-Whitney U-test and between pre- and postoperative values with the Wilcoxon's signed-ranks test using the Stat View version 4.5 software program (Abacus Concepts, Inc., Berkeley, CA, USA). The frequencies of data were compared within groups using the chi-square test and the Stat View software program. The differences were considered significant at $P < 0.05$.

Results

After surgery there were no instances of wound infection or dehiscence, bone instability, nonunion, or long-term malocclusion. The mean amount of setback was 6.5±3.3 mm on the right side and 6.8±3.0 mm on the left side in the SSRO group and 6.4±3.0 mm on the right side and 6.3±3.1 mm on the left side in the group that had undergone SSRO with osteotomy. These figures did not differ significantly from the results of the statistical analysis, indicating that the comparison study between the groups was valid.

Condylar position and angle

There was no significant difference between pre-and postoperative condylar position (X and Y coordinates) or the angle of the condylar long axis on coronal images on both sides after SSRO. However, the postoperative angle of the condylar long axis on axial cephalography was larger than the preoperative angle on the right side after SSRO (*P* = 0.0001); there was no significant difference in left side.

There was no significant difference between pre- and postoperative condylar position (X and Y coordinates) or the angle of the condylar long axis on coronal images and axial images on both sides after SSRO with Le Fort I osteotomy.

In bilateral pre- and postoperative condylar position (X and Y coordinates), bilateral pre- and postoperative angle of the condylar long axis in a frontal image, and the results of axial cephalography (Table 1), there were no significant differences between those who underwent SSRO alone and those who also underwent osteotomy.

Further, with regard to changes in the X and Y coordinates (postoperative value minus preoperative value), there was no significant difference between the two groups (Table 2.).

Disc position

The anterior type was dominant in the SSRO group; however, the fully covered type was dominant in the SSRO with Le Fort I osteotomy group. The distribution of disc classification was significant (*P* = 0.0010).

Joints preoperatively classified as anterior type, fully covered type, or posterior type showed no postoperative changes in either group.

Preoperative anterior disc displacement with reduction (ADDwR) and without reduction (ADDwoR) did not change postoperatively in either group (Tables 3 and 4.).

TMJ symptoms

The TMJ symptoms most frequently reported preoperatively were abnormal sounds (clicking and crepitus) and slight pain upon opening the mouth; none of the patients reported trismus. Symptoms were improved by surgery in 80% of patients who underwent SSRO only and in 75% of patients who underwent SSRO with Le Fort I osteotomy; however, no statistically significant difference was found between the two groups (Table 4.).

Discussion

Signs and symptoms of TMJ dysfunction have previously been studied in patients with dentofacial deformities. Laskin et al.[8] reported that 14% (range, 0% to 75%) of their patients had TMJ symptoms before orthognathic surgery. Kerstens et al.[9] reported that 16.2% of 480 patients with dentofacial deformities had TMJ symptoms before surgery. White and Dolwick[10] reported that 49.3% of their patients showed some degree of TMJ dysfunction preoperatively. However, Link and Nickerson[11] found a very high incidence (97%) of internal TMJ derangements in an orthognathic surgery population. Fernandez Sanroman et al.[12] found that the incidence of disc displacement was 11.1% for the class I anterior open-bite group and 10% for the class III group. When the class II group was studied, ADD was diagnosed in 15 of the 28 joints (53.6%). Schellhas et al.[5] studied 100 patients with a retrognathic facial skeleton, examining the TMJs with MRI for signs of moderate to severe pathology. In short, a class II dentofacial deformity is reportedly strongly associated with moderate to severe TMJ pathology or an ADD. In our previous study, the incidence of disc displacement was 18.2% in the class III symmetry group and 56.8% in the class III asymmetry group.[4] These results suggest that asymmetry increases the occurrence of TMJ dysfunction with an ADD. The incidence ratio of ADD in the deviated side was higher than in the nondeviated side.

However, in this study, mandibular prognathism with asymmetry was not involved in analysis of frontal cephalogram, so that the patients with TMJ symptoms were very few. In particular, the patients who underwent SSRO with Le Fort I osteotomy had fewer TMJ symptoms. As to disc position, TMJ with ADD was also infrequent. However, anterior disc displacement does not always cause TMJ symptoms.

Furthermore, the anterior type was dominant in SSRO group and the fully covered type was dominant in the group that underwent SSRO with Le Fort I osteotomy. This suggested that the patients with severe prognathism had TMJ with the fully covered type of disc. The joints and their disc tissue adapt to the individual skeletal morphology in these cases. Occlusion and skeletal discrepancies can lead to lead to morphologic changes in the structure of the TMJ, we proved this using rigid body spring theory model [6]. Correlation between classification and stress angulation indicated that the stress direction of the anterior displaced or anterior-type disc was more anterior to the condyle. On the other hand, the stress directions of the fully covered and posterior types had a tendency to be more superior to the condyle. In other words, disc position and morphology were related to stress distribution.

Regarding the TMJ clicking sound, not all patients with clicking sounds have ADD with reduction; nor do all patients with clicking sounds have a deviation in the form of the articular surfaces.[13] In our study, patients with the anterior type, fully covered type, and posterior type of disc can also experience the clicking sound. In such cases, when the condyle moved beyond the anterior hypertrophic part of the disc, the sound occurred. This may be characteristic in mandibular prognathism and of the nondeviated side in mandibular asymmetry.

Orthognathic surgery such as SSRO may cause changes in condylar position; therefore the position of the condyle must be monitored. However, the disc-condyle relationship is a more important parameter in assessing changes in TMJ morphology and symptoms. Many researchers, using different radiographic methods, have studied the movements of the condyle that occur in patients who undergo orthognathic surgery. Freihofer and Petresevic,[14] in a radiographic study of 38 patients who underwent SSRO for mandibular advancement, showed that 10 of 26 condyles appeared to be positioned anteriorly in the glenoid fossa. Similarly, Will et al.[15] found that both condyles were positioned posteriorly in 41 patients who underwent SSRO to advance the mandible. However, in their study of 15 patients, Hackney et al.[16] found no correlation between the amount of mandibular advancement and changes in condylar position or mandibular shape. In SSRO, rigid fixation of the mandible may result in a greater change in the position of the condyle and a higher incidence of TMJ dysfunction compared with nonrigid fixation.[17]

Although many studies report a reduction of TMJ symptoms after SSRO for advancement,[18,19] few specifically report the results after SSRO for setback. Gaggl et al.[20] reported that in skeletal class II patients, displacement of the articular disc was seen by MRI in 38 of 50 joints preoperatively and in only 28 postoperatively. In our study of class III patients, we found no improvement of disc displacement after either of the procedures described above. In another study, a comparison of the lengths of the axiographic protrusive curves showed significantly higher values in the class II group than in the class I group. Moreover, the inclinations of the protrusive and mediotrusive tracings were significantly flatter in the class III group than in the class I and II groups, demonstrating differences in the inclination of the functional protrusive and mediotrusive paths between the groups. Changes in the curvature of axiographic tracings showed significantly less curved protrusive tracings in the class III group than in the class II group.[21] In other words, class III patients can open their mouths wide without a condylar protrusive movement because they have longer mandible. Therefore condylar movement after SSRO with and without Le Fort I osteotomy was also comparatively limited in class III patients. In sum, significant changes of condylar and disc position were not found in this study. Westesson et al.[22] found that the mean horizontal condylar angle was most acute in joints with a normal superior disc position (mean 21.2°) and less so in joints with disc displacement (29.7°disc displacement without reduction) and/or with degenerative joint disease (36.5°). Fernandez Sanroman et al.[12] found that the mean horizontal condylar angle in the class II group was significantly larger than that in the control group and that the larger condylar angle can be an etiological factor for disc displacement and degenerative joint disease. Our previous study also showed a mean horizontal condylar angle for the class III symmetry group of

12.0° on the right and 11.8° or the left.[4] These reports indicate that if the skeletal pattern is changed, TMJ morphology, including that of the condylar long axis, will also be modified. In short, changes in occlusion and skeletal structure may induce a change in the condylar long axis. In this study, the horizontal dimension of the condylar long axis increased significantly on the right side; this increase tended to be greater on the left side in SSRO group and in both sides in the group undergoing SSRO plus Le Fort I osteotomy. The postoperative change in the condylar long axis may play a very important role to the change of TMJ symptons.[23]

In conclusion, these results suggest that SSRO either with or without Le Fort I osteotomy cannot alter the preoperative disc position, including anterior disc displacement, although these procedures can improve the symptoms of TMJ dysfunction.

References

1) Trauner R, Obwegeser H. The surgical correction of mandibular prognathism and retrognathia and consideration of genioplasty: Surgical procedures to correct mandibular prognathism and reshaping the chin. Oral Surg Oral Med Oral Pathol 1957: **10:** 677-689.

2) Proffit WR, Phillips C, Prewitt JW, Turvey TA. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. 2. Maxillary advancement. Int J Adult Orthodn Orthognath Surg 1991; **6:** 71-80.

3)Moldez MA, Sugawara J, Umemori M, Mitani H, Kawamura H. Long-term dentofacial stability after bimaxillary surgery in Class III open bite patients. Int J Adult Orthod Orthognath Surg. 2000; 15; 309-319.

4) Ueki K, Nakagawa K, Takatsuka S, Shimada M, Marukawa K, Takazakura D, Yamamoto E. Temporomandibular joint morphology and disc position in skeletal class III patients. J Cranio Maxillofac Surg 2000; **28:**362-368.

5) Schellhas KP, Piper MA, Bessette RW, Wilkes CH. Mandibular retrusion, temporomandibular joint derangement, and orthognathic surgery planning. Plast Reconstr Surg 1992; **90**:218-29.

6) Ueki K, Nakagawa K, Maruakwa K, Takatsuka S, Yamamoto E. The relationship between temporomandibular joint and stress angulation in skeletal Class III patients. Eur J Orthod 2005; **27**:501-506.

7) Ueki K, Marukawa K, Nakagawa K, Yamamoto E. Condylar and temporomandibular joint disc positions after mandibular osteotomy for prognathism. J Oral Maxillofac Surg. 2002; **60:**1424-32.

8) Laskin DM, Ryan WA, Greene CS. Incidence of temporomandibular symptoms in patients with major skeletal malocclusions: A survey of oral and maxillofacial surgery training programs. Oral Surg Oral Med Oral Pathol 1986; **61**:537-41.

9) Kerstens HCJ, Tuinzing DB, van der Kwast WAM. Temporomandibular joint symptoms in orthognathic surgery. J Cranio-Maxillofac Surg 1989;**17**:215-18.

10) White CS, Dolwick MF. Prevalence and variance of temporomandibular dysfunction in orthognathic surgery patients. Int J Adult Orthod Orthognath Surg 1992; **7**:7-14.

11) Link JJ, Nickerson JW. Temporomandibular joint internal derangements in an orthognathic surgery population. Int J Adult Orthod Orthognath Surg 1992; **7**:161-9.

12) Fernandez Sanroman J, Gomez Gonzalez JM, del Hoyo JA. Relationship between condylar position, dentofacial deformity, and temporomandibular joint dysfunction: an MRI and CT prospective study. J Cranio-Maxillofac Surg 1998; **26**:35-42.

13) Oster C, Katzberg RW, Tallents RH, Morris TW, Bartholomew J, Miller TL, Hayakawa K. Characterization of temporomandibular joint sounds. Oral Surg. 1984; **58**: 10-16.

14) Freihofer HPM, Petresevic D: Late results after advancing the mandible by sagittal splitting of the rami. J Maxillofac Surg 1975; 3:250-257.

15) Will LA, Joondeph DR, Hohl TH, West RA. Condylar position following mandibular advancement: Its relationship to relapse. J Oral Maxillofac Surg 1984; **42**:578-588.

16) Hackney FL, Van Sickels JE, Nummikoski PV. Condylar displacement and temporomandibular joint dysfunction following bilateral sagittal split osteotomy and rigid fixation. J Oral Maxillofac Surg 1989; **47**:223-7.

17) Buckley MJ, Tulloch JF, White RP Jr, Tucker MR. Complications of orthognathic surgery: A comparison between wire fixation and rigid internal fixation. Int J Adult Orthod Orthognath Surg 1989; **4**:69-74.

18) Nemeth DZ, Rodrigues-Garcia RC, Sakai S, Hatch JP, Van Sickls JE, Bays RA, Clark GM, Rugh JD. Bilateral sagittal split osteotomy and temporomandibular disorders: rigid fixation versus wire fixation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 89: 29-34.

19) Alder ME, Deahl ST, Matteson SR, Van Sickels JE, Tiner BD, Rugh JD. Short-term change of condylar position after sagittal split osteotomy for mandibular advancement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999; 87: 159-165.

20) Gaggl A, Schultes G, Sabtler G, Kärcher H, Simbrunner J. Clinical and magnetic resonance finding in the temporomandibular joints of patients before and after orthognathic surgery. Br J Oral Maxillofac Surg 1999; **37**:41-5.

21) Zimmer B, Jäger A, Kubein-Messenburg D. Comparison of “normal” TMJ in Class I, II, and III individuals. Eur J Orthod 1991; **13**:27-34

22) Westesson PL, Bifano JA, Tallents RH, Hatala MP. Increased horizontal angle of the mandibular condyle in abnormal temporomandibular joints. Oral Surg Oral Med Oral Pathol 1991; **72**:359-363.

23) Ueki K, Marukawa K, Shimada M, Nakagawa K, Yamamoto E, Niizawa S. Changes in the chewing path of patients in skeletal class III with and without asymmetry before and after orthognathic surgery. J Oral Maxillofac Surg. 2005; **63**:442-8.

Legends

Table 1. Changes in the highest condylar point and condylar long axis.

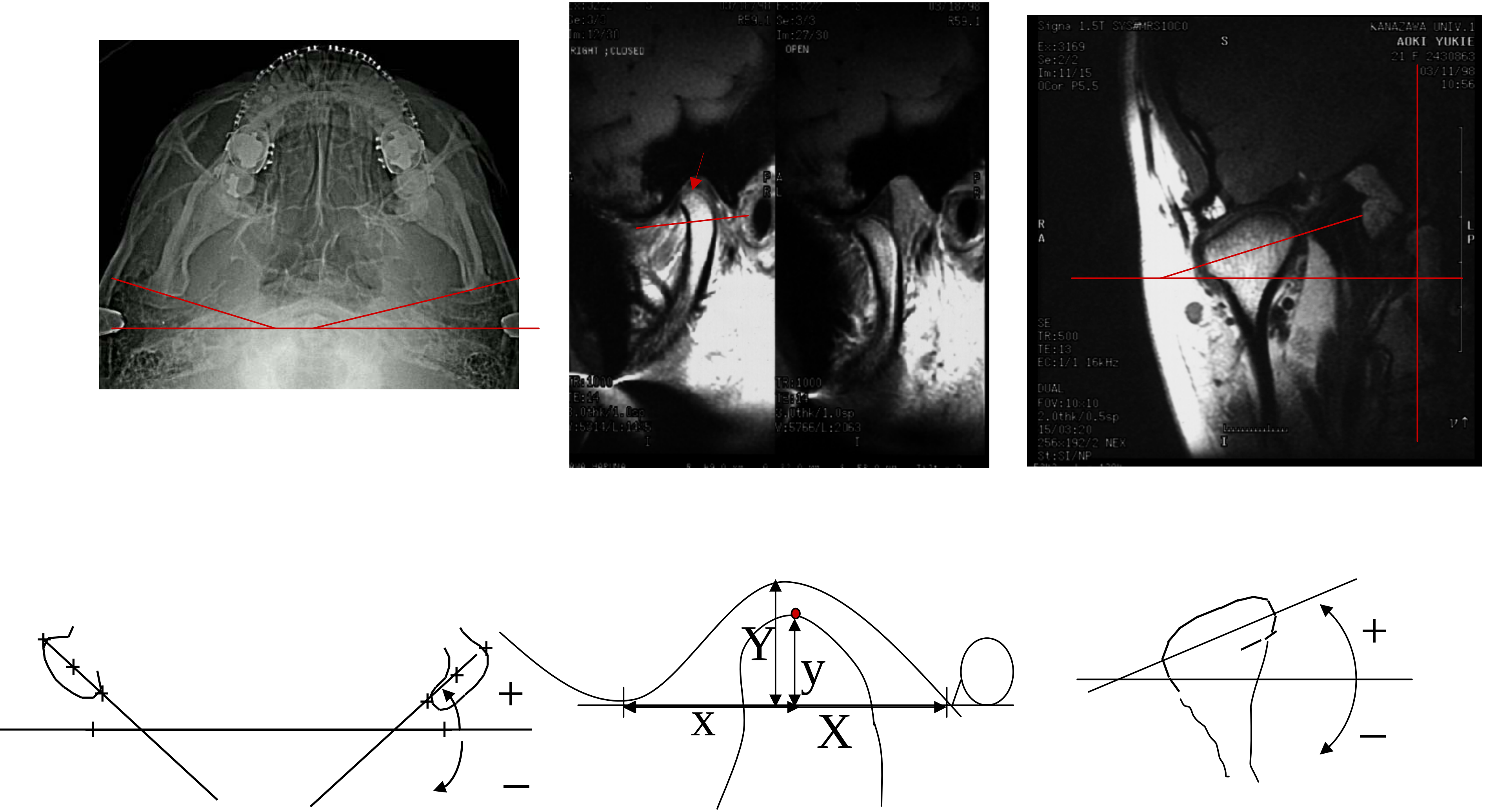
Table 2. Difference between pre and postoperative highest condylar point.

Table 3. Changes in disc tissue seen in sagittal images.

Table 4. The rate of improvement anterior disc displacement seen in sagittal images and TMJ symptoms.

Figure 1. Measurements of axial cephalogram, and measurements in the sagittal and coronal MR images. a, angle of the condylar long axis in the horizontal plane; b, coordinate of the condyle expressed as (x/X, y/Y) in the sagittal plane; c, angle of the condylar long axis in the coronal plane.

Figure 2. Classification of disc position. a, anterior displacement; b, anterior type; c, fully-covered type; d, posterior type; a, b, c, and d were found in the sagittal images.


RIGHT ;CLOSED
OPEN
Signa 1.5T
KANAZAWA UNIV.1
AOKI YUKIE
03/11/98
10:56
Ex:3169
Se:2/2
Im:11/15
S
R
A
L
P
SE
TR:500
TE:13
DUAL
FOV:10x10
+
−
Y
y
x
X

a b c

Fig. 1

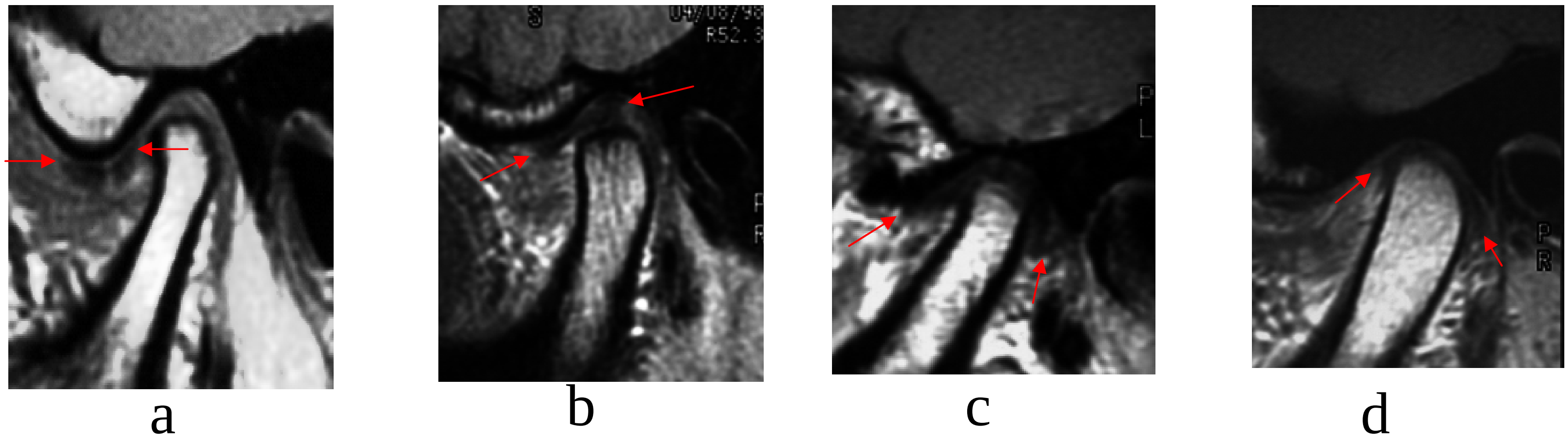


Fig. 2

			x/X-coordinate		y/Y-coordinate		in coronal image (degree)		in axial image (degree)	
			Average	SD	Average	SD	Average	SD	Average	SD
SSRO	Right side	Preoperation	0.56	0.06	0.71	0.15	9.38	9.94	12.21	5.13
		Postoperation	0.57	0.07	0.74	0.13	8.51	10.80	16.52	4.69
		P-value	NS		NS		NS		0.0001	
	Left side	Preoperation	0.55	0.06	0.73	0.13	11.81	12.57	12.97	5.57
		Postoperation	0.56	0.06	0.73	0.13	12.76	15.20	15.43	5.47
		P-value	NS		NS		NS		NS	

			Condylar point in sagittal image				The angle of condylar long axis			
			X-coordinate		Y-coordinate		in coronal image (degree)		in axial image (degree)	
			Average	SD	Average	SD	Average	SD	Average	SD
SSRO+Le Fort I	Right side	Preoperation	0.59	0.08	0.72	0.10	10.29	10.74	12.06	7.18
		Postoperation	0.58	0.08	0.73	0.11	10.30	11.51	15.15	6.50
		P-value	NS		NS		NS		NS	
	Left side	Preoperation	0.59	0.08	0.75	0.10	10.05	12.60	10.60	7.21
		Postoperation	0.57	0.07	0.73	0.13	10.31	11.19	11.59	7.62
		P-value	NS		NS		NS		NS	

Table 1.

		Condylar point in sagittal image				The angle of condylar long axis			
		x/X-coordinate		y/Y-coordinate		in coronal image (degree)		in axial image (degree)	
		Average	SD	Average	SD	Average	SD	Average	SD
SSRO	Right side	-0.56	0.06	-0.71	0.15	-9.38	9.94	-12.21	5.13
	Lef side	-0.55	0.06	-0.73	0.13	-11.81	12.57	-12.97	5.57
SSRO+Le Fort I	Right side	-0.57	0.07	-0.74	0.13	-8.86	10.92	-16.49	4.80
	Lef side	-0.56	0.06	-0.73	0.13	-13.64	14.95	-15.08	5.33

Table 2.

	Disc position classification		(joints) preoperatively	postoperatively	symptomatic joints preoperatively	postoperatively
SSRO	Anterior displacement	with reduction (ADDwR)	3	3	2	0
		without reduction (ADDwoR)	1	1	1	0
	Normal					
		Anterior type	25	25	8	2
		Posterior type	6	6	0	0
		Fully-coverd type	11	11	4	1
SSRO+Le Fort I	Anterior displacement	with reduction (ADDwR)	1 *	1 *	1	1
		without reduction (ADDwoR)	0	0	0	0
	Normal					
		Anterior type	9	9	3	1
		Posterior type	10	10	1	0
		Fully-coverd type	24	24	3	0
			P=0.0010		NS	

Table 3.

Procedure	Number (joints)	Symptomatic joints preoperativrly	Joints improved postoperatively	Rate of improvement (%)
SSRO	46	15	12	80
SSRO+LeFort I	44	8	6	75

Procedure	Number (joints)	Joints with ADD preoperativrly	Joints improved postoperatively	Rate of improvement (%)
SSRO	46	7	0	0
SSRO+LeFort I	44	1	0	0

Table 4.