



Posterior Pharyngeal Airway in Clockwise Rotation of Maxillomandibular Complex Using Surgery-first Orthognathic Approach

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Background: Because obstructive sleep apnea is known to be an important preexisting factor causing chronic disease, many investigations have been done recently. There have been few reports regarding the posterior pharyngeal airway after clockwise rotation of maxillomandibular complex. Because the 2-jaw surgery in class III patients could cause obstructive sleep apnea or snoring, we investigated the posterior pharyngeal airway change of the clockwise maxillomandibular complex in the surgery-first orthognathic approach for the correction of class III dentofacial deformities.

Methods: A cephalometric evaluation of 35 patients with skeletal class III deformity was performed preoperatively and postoperatively. Three measurements of the posterior pharyngeal airway space (nasopharynx, oropharynx, and hypopharynx) and hyoid bone positions (the distance from palatal plane to hyoid bone and the distance from mandibular plane to the hyoid bone) were evaluated and correlated with the skeletal movement of the jaws using imaging software (V-Ceph, Osstem, Seoul, Korea).

Results: The preoperative airway space turned out to be enlarged in class III dentofacial deformities compared with those of normal persons. The preoperative P1, P2, and P3 in our cohort were increased and posterior nasal spine to hyoid bone and mandibular plane to hyoid bone were decreased compared with those of normal person's data because the cohort consists of prognathic patients where the mandible is located in forward position. After 6 months, most values were nearly normal.

Conclusion: Orthognathic surgery based on clockwise rotation of maxillomandibular complex did not cause severe posterior airway space changes at 6 months postoperation. (*Plast Reconstr Surg Glob Open* 2015;3:e485; doi: 10.1097/GOX.0000000000000446; Published online 20 August 2015.)

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Received for publication January 14, 2015; accepted June 9, 2015.

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DOI: 10.1097/GOX.0000000000000446

The treatment of patients with prognathism requires combined orthodontic and surgical procedures with the aim to achieve normal occlusion and an improved aesthetic facial profile. In the traditional treatment for orthognathic surgery, anterior-posterior discrepancies are corrected by advancement or setback of the jaw along the existing occlusal plane.¹⁻³ This procedure, however, often fails to move the maxilla and the mandible onto the ideal

Disclosure: The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.

positions and does not produce an optimal result in terms of aesthetics, especially in Asians who have a pre-existing dentoalveolar protrusion. Therefore, alternative treatment designs should be considered in such cases. Reyneke et al⁴ suggested that an alteration of the occlusal plane could be an alternative. A change of the occlusal plane based on the rotation of the maxillomandibular complex (MMC) could be a better solution to overcome the limits of simple advancement and setback of the jaw along the existing occlusal plane. We previously presented the effect of orthognathic surgery based on the clockwise rotation of the MMC using a 3-dimensional photogrammetric analysis.⁵

In our practice, the clockwise rotation of the MMC based on the alteration of the occlusal plane is a recently common procedure in surgery-first orthognathic approach because this approach can correct the dental compensation of the anterior teeth with minimal presurgical orthodontic treatment. In addition, because many Asian class III prognathic patients have a preexisting dentoalveolar protrusion, clockwise rotation of MMC could often be much better when the simple maxillary advancement and mandibular setback would not be appropriate. Furthermore, this kind of clockwise rotation of the MMC is a very useful way in which a surgery-first orthognathic approach without presurgical orthodontic treatment overcomes and minimizes the dental instability that immediately follows orthognathic surgery. Many recent reports revealed to us that the surgery-first orthognathic approach turned out to be quite reliable and satisfactory in terms of the correction of the occlusion and facial aesthetics, if it is done based on the proper indications and preoperative dental evaluation.⁶⁻⁹

Meanwhile, the change of the posterior pharyngeal airway space after the maxillary advancement and mandibular setback in class III dentofacial deformities has been investigated intensively.¹⁰⁻¹⁹ However, the change of the posterior pharyngeal airway after maxillomandibular clockwise rotational movement in patients who have undergone orthognathic surgery has not been investigated. There have also been only a few reports regarding the clockwise rotation of the MMC, but not for the airway. Because any kind of 2-jaw surgery in class III patients could cause snoring or obstructive sleep apnea, we investigated the posterior pharyngeal airway change of the clockwise MMC in the surgery-first orthognathic approach for the correction of class III dentofacial deformities as a first step.

MATERIALS AND METHODS

The present retrospective study assessed the preoperative, immediate postoperative, and 6- to 12-month postoperative lateral cephalometric radi-

ography of 35 patients with skeletal class III deformities. Thirteen patients were men, and 22 patients were women among the study subjects. The average age of our study group was 24.7 years. Three measurements of the posterior pharyngeal airway space (nasopharynx, oropharynx, and hypopharynx) and hyoid bone positions (the distance from palatal plane to hyoid bone) and the distance from mandibular plane to the hyoid bone were evaluated and correlated with the skeletal movement of the jaws using imaging software (V-Ceph, Osstem, Seoul, Korea) (Fig. 1).

1. P1 (nasopharynx): the distance from the posterior nasal spine to the nearest point in a straight line on the posterior wall
2. P2 (oropharynx): the most adjacent distance from the uvula to the posterior pharyngeal wall
3. P3 (hypopharynx): the most adjacent distance from the back of the tongue to the posterior pharyngeal wall
4. Posterior nasal spine to hyoid bone (PNS-H): the distance from the palatal plane to the hyoid bone
5. Mandibular plane to hyoid bone (MP-H): the distance from the mandibular plane to the hyoid bone

Each patient had surgery consisting of a Le Fort I maxillary osteotomy with maxillary posterior impaction pivoted on A point and bilateral sagittal split mandibular ramus osteotomies with mandibular setback and autorotation. Patients who also underwent a genioplasty procedure not including the genioglossus tubercle as part of the surgical correction were included in the study. It is for this reason that the B-point was selected as a reference point because this area of the mandible is not influenced by the genioplasty procedure. All patients received surgery performed by a single surgeon. In terms of the change of the occlusal plane, the treatment planning and surgical movements were performed based on those previously described by Reyneke and coworkers.^{4,20} All patients had undergone orthognathic surgery using the surgery-first orthognathic approach without presurgical orthodontic treatment.⁶ The Student's *t* test for paired samples was used to assess the presence of significant differences.

RESULTS

The mean change of occlusal plane was 5.6 degree. Because we rotate the maxilla pivoted on A point, the maxillary position based on A point was not changed. The amount of mandibular setback in average was 9.5 mm, 9.1 mm on the first molar level. According to the data of Kitahara et al,²¹ the normal Asian person's PP1-PNS, PP2-UV, PP3-Tb, and PNS-H are 27.3, 9.8, 10.1, and 60.9 mm, respectively. Preoperatively, our

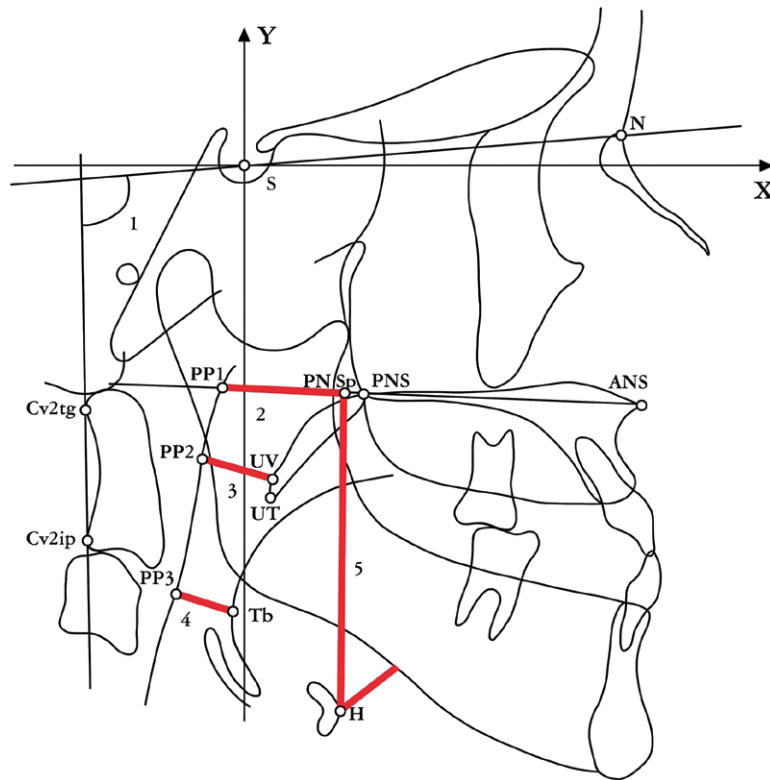


Fig. 1. Airway parameters assessed in this study. Airway length was measured using 3 parameters: 1. P1 (nasopharynx): the distance from the posterior nasal spine to the nearest point in a straight line on the posterior wall. 2. P2 (oropharynx): the most adjacent distance from the uvula to the posterior pharyngeal wall. 3. P3: PP3-Tb (hypopharynx): the most adjacent distance from the back of the tongue to the posterior pharyngeal wall. 4. PNS-H: the distance from the palatal plane to the hyoid bone. 5. MP-H: the distance from the mandibular plane to the hyoid bone. ANS indicates anterior nasal spine; Cv2ip, inferior point of 2nd cervical vertebrae; Cv2tg, tangent point of 2nd cervical vertebrae; H, hyoid bone; N, nasion; PNS, posterior nasal spine; PP, posterior pharyngeal wall; S, sella; Tb, tongue base; UT, tip of uvula; UV, most adjacent point on the soft palate to the posterior pharyngeal wall.

current data showed P1, P2, P3, PNS-H, and MP-H levels as 23.78, 11.3, 11.6, 56.8, and 8.16mm, respectively (Table 1). Compared with normal person’s data,

Table 1. Comparison between the Normal and Prognathic Patients in Terms of the Preoperative Posterior Pharyngeal Airway Space

	Preoperative Evaluation			
	Normal Person (Control; Kitahara et al ²¹)		Prognathic Patients (Experimental)	
	Mean (mm)	SD	Mean (mm)	SD
P1	27.3	3.4	23.8	3.1
P2	9.8	2.5	11.3	2.4
P3	10.1	2.5	11.6	3
PNS-H	60.9	5.4	56.8	3.3
MP-H			8.2	2.3

MP-H, distance between mandibular plane and hyoid bone; P1, nasopharynx; P2, oropharynx; P3, hypopharynx; PNS-H, distance between posterior nasal spine (PNS) and hyoid bone.

the P1 and PNS-H were smaller in our cohort but the P2 and P3 were larger than normal because our cohort can be categorized as a prognathic. In particular, the preoperative airway space was enlarged in class III dentofacial deformities in P2 and P3. The MP-H was shortened compared with those of normal persons without dentofacial deformities, which might reflect the result of the forward position of the mandible in class III dentofacial deformities (Table 1).

In terms of immediate results after the orthognathic surgery using the rotation of the MMC in the sample of 35 subjects (22 women and 13 men), the airway spaces of the nasopharynx and oropharynx were decreased. P1 was changed from 23.8 to 22.5 mm, P2 was changed from 11.3 to 9.4, and P3 was changed from 11.6 to 9.9mm. These changes were statistically significant (Table 2). Despite these changes, except for P3, the postoperative airway

Table 2. Comparison between Preoperative Value and Immediate Postoperative Value

	Preoperative		Postoperative		Preoperative – Postoperative			P*
	Mean	SD	Mean	SD	Mean	SD	95% CI	
P1	23.753	3.076	22.496	2.873	1.257	2.528	0.389–2.126	0.006
P2	11.296	2.423	9.353	2.609	1.943	2.482	1.091–2.796	<0.001
P3	11.626	3.028	9.866	3.185	1.760	3.584	0.529–2.991	0.006

Preoperative vs postoperative (*n* = 35).

*Paired *t* test.

P1, nasopharynx; P2, oropharynx; P3, hypopharynx.

space was not significantly different from those of normal persons using the normal data of Kitahara et al.²¹ Only decreased airway space in the hypopharynx (P3) was statistically significant (*P* = 0.02).

However, the 6-month postoperative data showed quite different results after the soft-tissue adaptation. The values that were negatively impacting the airway were restored (Table 3). The P1 was changed from 22.5 to 24.1 mm, the P2 from 9.4 to 10.2 mm, and the P3 from 9.9 to 9.6 mm. The PNS-H changed from 68.5 to 63.0 mm, and MP-H changed from 12.0 to 11.0 mm. The P1, PNS-H, and MP-H were approximately 50% restored compared with their preoperative values.

In summary, the preoperative P1, P2, and P3 in our cohort were increased and PNS-H and MP-H were decreased compared with those of normal person’s data because the cohort consists of prognathic class III patients where the mandible is located in forward position. Immediately after the clockwise rotation of MMC, P1, P2, and P3 were decreased slightly. However, after 6 months, most values were similar to

those of normal a person’s data after the soft-tissue adaptation and subsidence of swelling (Fig. 2).

Finally, among the 35 patients we analyzed, none complained of any breathing difficulties. Only 5 patients complained of a mild increase in snoring, which was noticed by their spouse or parents in 6 months postoperation.

DISCUSSION

Recently, numerous articles have been published regarding the change of the posterior pharyngeal airway space after orthognathic surgery.^{1,3,11,13,14,16,17,22–30} In addition, because obstructive sleep apnea accompanied by snoring symptoms has been recognized as an important preexisting factor causing many chronic diseases such as hypertension, coronary heart disease, and cerebral vascular disease, orthognathic surgery has been used as an ultimate tool for the correction of obstructive sleep apnea.^{16,28,31} However, when we perform the mandibular setback surgery in prognathic patients, some patients with class III dentofacial deformities suffer from postoperative snoring and

Table 3. T0, T1, and T2 Data in Terms of P1, P2, P3, H, and MH (Subjects = 35, *n* = 102)

Time	Mean	95% CI	P	
			Preoperative	Postoperative
P1				
Preoperative	23.75	22.76–24.75		
Postoperative	22.50	21.50–23.49	0.007	0.001
6 months	24.10	23.09–25.12	0.458	
P2				
Preoperative	11.30	10.47–12.12		
Postoperative	9.35	8.53–10.18	<0.001	
6 months	10.18	9.33–11.02	0.012	0.062
P3				
Preoperative	11.63	10.62–12.63		
Postoperative	9.87	8.86–10.87	0.002	
6 months	9.59	8.55–10.63	0.001	0.630
H				
Preoperative	56.82	54.64–59.00		
Postoperative	68.48	66.31–70.66	<0.001	
6 months	63.01	60.81–65.21	<0.001	<0.001
MH				
Preoperative	8.16	6.65–9.67		
Postoperative	12.02	10.16–13.88	<0.001	
6 months	11.06	9.54–12.59	<0.001	0.038

Linear mixed model, multiple comparison, Bonferroni correction.

H, distance between posterior nasal spine to hyoid bone; MH, distance between mandibular plane to hyoid bone; P1, nasopharynx; P2, oropharynx; P3, hypopharynx.

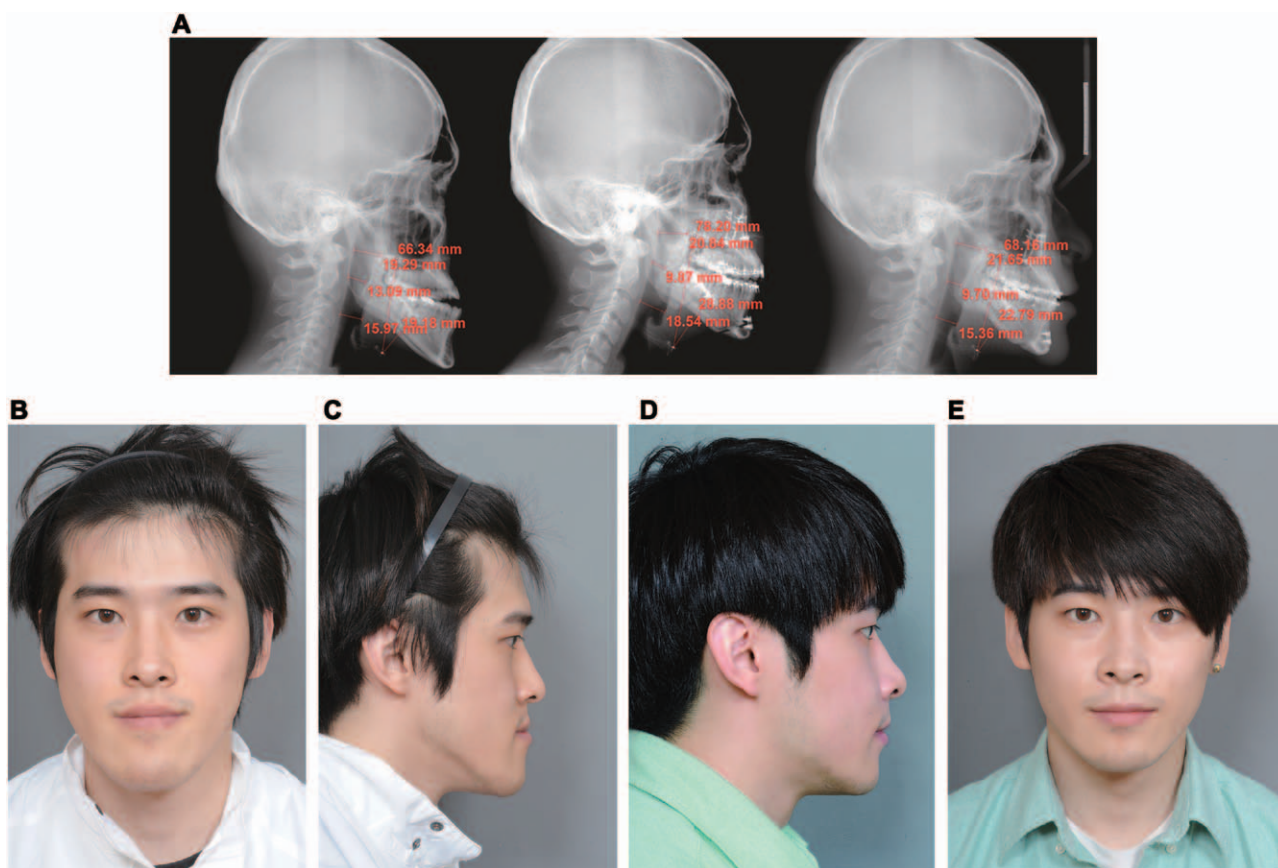


Fig. 2. A 25-year-old male patient with prognathism. The measurements on the lateral cephalometry (A) were shown. Preoperative (B and C) and postoperative (D and E) photographs. Clockwise rotation of the maxillomandibular complex was done.

some degree of obstructive sleep apnea for the same reason. Given the fact that the mandibular surgery is a setback procedure, the obstructive sleep apnea symptoms are always possible depending on the degree of mandibular setback. This would be a reason why many publications have been done about the change of posterior pharyngeal space after the orthognathic surgery in class III dentofacial deformity.

As the surgery-first orthognathic surgery was recently introduced, particularly in Asia and Europe,

rotation of the MMC is recognized as a very valid and effective method for the restoration of the dentofacial deformities.^{4,5} However, the investigation for the change of posterior pharyngeal space after the clockwise rotation of MMC looks very rare. We would like to know what happens in terms of the posterior pharyngeal airway space when a clockwise rotation of the MMC instead of a traditional maxillary advancement and mandibular setback procedure in class III dentofacial deformity is used (Figs. 3, 4).

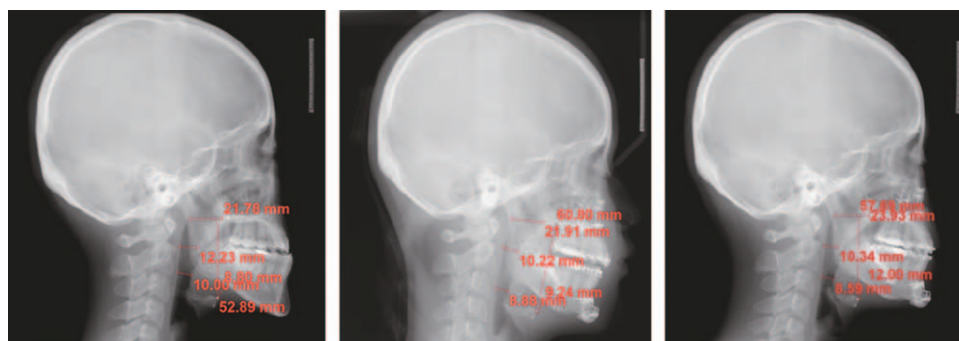


Fig. 3. A 22-year-old female patient with class III dentofacial deformity. The measurements on the lateral cephalometry are shown.

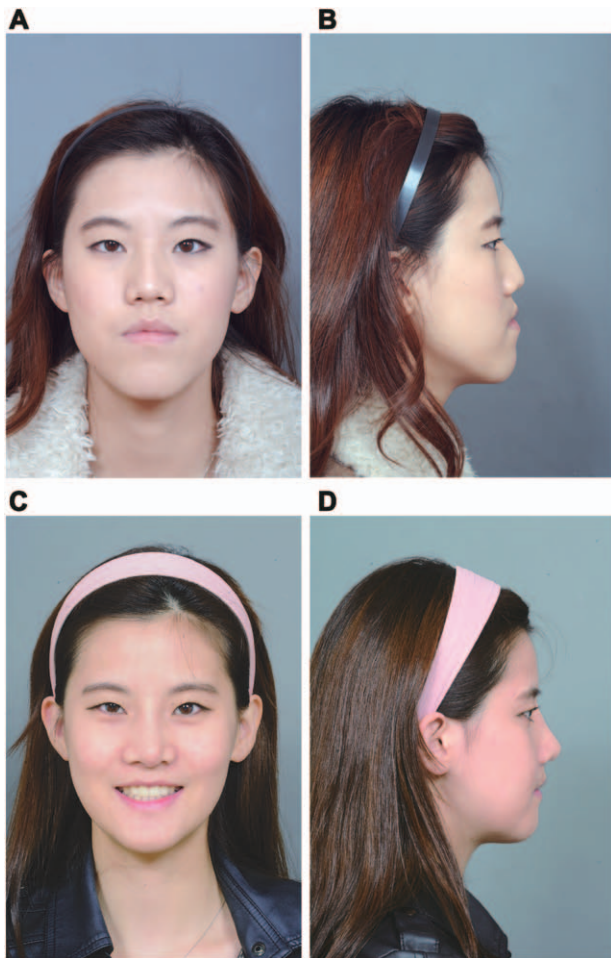


Fig. 4. A 22-year-old female patient with class III dentofacial deformity. Preoperative (A and B) and postoperative (C and D) photographs. Clockwise jaw rotational orthognathic surgery was performed using maxillary posterior impaction and mandibular rotational setback.

Although there have been many investigations regarding the change of the posterior pharyngeal airway space after a traditional maxillary advancement and mandibular setback, any potential changes to the posterior pharyngeal airway space after a contemporary clockwise rotation of the MMC in class III dentofacial deformities have not yet been assessed. This is the reason why we investigated this issue in our current study. There are 2 possibilities in terms of outcome. Because we did not perform a maxillary advancement, the posterior pharyngeal airway could be aggravated compared with that of the traditional jaw advancement and setback procedure. On the other hand, because we did the mandible setback along the oblique line after the maxillary posterior impaction, the oblique directional mandibular setback could result in different outcomes.

Our results showed us that although the posterior pharyngeal airway space is decreased somewhat im-

mediately after the surgery, this loss could be restored as time passes after soft-tissue adaptation and subsidence of swelling. In addition, because the preoperative airway space is enlarged in a class III dentofacial deformity, the posterior pharyngeal airway after a clockwise MMC in the surgery-first orthognathic approach does not show a significant decrease compared with the normal airway space at the naso- and oropharynx level at 6 months postoperation. Given the significant decrease of the posterior pharyngeal airway at the hypopharynx level and inferior repositioning of the hyoid bone immediately after the surgery, patients with class III dentofacial deformities should be warned in advance of the risk of snoring or obstructive sleep apnea from the clockwise rotation of the MMC. However, P1, P2, and MP-H were restored a good deal at the 6-month postoperative time point compared with the values immediately after the orthognathic surgery, suggesting that the airway changes after the rotation of the MMC can be restored. The other possibility is that there is swelling of the pharyngeal space immediately after the orthognathic surgery. Regardless of which of these explanations is correct, the final values in the airway showed no significant difference compared with those of normal persons. Our result argues that surgery-first orthognathic surgery based on the clockwise rotation of the MMC will not cause severe airway problems based on the evaluation of posterior pharyngeal airway space.

In addition, the traditional maxillary advancement procedure may enlarge the P1. However, because P3 is the most influential area after clockwise rotation of the MMC, the preexisting P3 enlargement is a crucial value. The fact that P3 lengthening occurs in class III dentofacial deformities reveals the potential reason why most of the class III patients who undergo clockwise rotational orthognathic surgery do not complain of a breathing problem after the surgery.

CONCLUSION

Because the posterior airway space after the rotation of the maxillomandibular complex was not decreased much, we could achieve acceptable results in terms of facial aesthetics and occlusal function without huge change of posterior airway pharyngeal space.^{1,4,32}

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PATIENT CONSENT

Patients provided written consent for the use of their images.

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