치의학석사 학위논문

Computed Tomography Evaluation of Retropalatal Airway and Velopharyngeal Dimensions after Clockwise Rotation of Maxillomandibular Complex in Skeletal Class 3 Malocclusion Patients

제 3골격적 부정교합 환자에서 상하악복합체의
시계방향회전 수술 후 후구개 부위의 기도와
구개인두 부위의 변화에 관한 연구

2013년 4월

서울대학교 대학원
치의학과 구강악안면외과 전공
김태윤

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이 논문을 치의학석사 학위논문으로 제출함

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치의학과 구강악안면외과 전공

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김태윤의 치의학석사 학위논문을 인준함

2013년 7월

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논문제목 : Computed Tomography Evaluation of Retropalatal Airway and Velopharyngeal Dimensions after Clockwise Rotation of Maxillomandibular Complex in Skeletal Class 3 Malocclusion Patients

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Abstract

Computed Tomography Evaluation of Retropalatal Airway and Velopharyngeal Dimensions after Clockwise Rotation of Maxillomandibular Complex in Skeletal Class 3 Malocclusion Patients

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Purpose

With recently published successful cases of treating obstructive sleep apnea syndrome with maxillomandibular advancement, there have been increased interests in the changes of airway after orthognathic surgery. There are numerous studies on the changes of

airway after advancing or setback mandible, but there are not many studies on the changes of airway after clockwise rotation of maxillomandibular complex. In order to find a relationship between the airway and the movement of maxilla, we have analyzed and compared pre-operative and post-operative 3-dimensional facial computed tomography (3-D CT) data to evaluate the changes in retropalatal airway and velopharyngeal dimensions after the clockwise rotation of maxillomandibular complex in skeletal class 3 malocclusion patients.

Materials and Methods

The subjects consist of sixty (26M/34F) skeletal classes 3 malocclusion patients whose maxilla underwent posterior impaction or posterior impaction and setback during bimaxillary surgery at Seoul National University Dental Hospital, Department of Oral and Maxillofacial Surgery. Their mean age was twenty-three years old with a range from eighteen to thirty-two years old. The subjects were divided into two groups. Thirty patients (12M/18F) whose maxilla underwent the posterior impaction (mean: 2.63mm; range: 2-3.5mm) at #16 and #26 mesiobuccal cusps were assigned as group 1. The rest (14M/16F) whose maxilla underwent posterior impaction (mean 2.75mm; range: 2-4mm) and setback (mean: 1.83mm; range: 1-3mm) at #11 and 12 incisal edges were assigned as group 2. Pre-operative 3-D CT data (one month before surgery) and post-operative 3-D CT data (at least 6 months after surgery) were compared to measure the changes in the retropalatal airway volume, minimum cross-sectional area, and lateral and antero-posterior dimensions of the minimum cross-sectional area. Moreover, in order to determine the changes in the velopharyngeal dimensions, the changes in soft palate angle, soft palate length, and pharyngeal depth were measured.

Results

The retropalatal airway volume and minimum cross-sectional area increased with a statistical significance ($P < 0.05$) in group 1. The retropalatal airway volume, minimum cross-sectional area, and lateral and antero-posterior dimensions of the minimum cross-sectional area decreased with a statistical significance in group 2. In both group 1 and 2, the soft palate length increased with a statistical significance. The pharyngeal depth increased in group 1with a statistical significance.

Summary and conclusion

This study investigated the effects of the clockwise rotation of maxillomandibular complex on the retropalatal airway and velopharyngeal dimensions in skeletal class 3 malocclusion patients. The directions of the movements of maxilla determined the changes in the retropalatal airway and velopharyngeal dimensions.

When the maxillomandibular complex was rotated clockwise with the posterior impaction only, the retropalatal airway dimensions increased. On the other hand, when the maxillomandibular complex was rotated with the posterior impaction and setback, the

retropalatal airway dimensions decreased. Moreover, the lengths of the soft palate increased when the complex was rotated clockwise irrespective of the movements of maxilla. Therefore, prior to performing the clockwise rotation of the maxillomandibular complex with the setback of maxilla, investigating and diagnosing sleep-related breathing disorders such as snoring or obstructive sleep apnea should be performed; the setback of the maxilla can worsen the sleep-related breathing disorders by reducing the retropalatal airway dimensions and lengthening the soft palate.

Key words: Pharyngeal and retropalatal airway, Velopharyngeal Dimension, Posterior impaction, Le-Fort 1 osteotomy setback, Snoring, Obstructive Sleep Apnea Syndrome.

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Introduction

Obstructive sleep apnea syndrome (OSAS) patients can suffer numerous detrimental conditions such as cardiac arrhythmias, cardiac arrest, sudden death, systemic inflammation, endothelial dysfunctions, and et al[1,2,3,4]. The etiology and pathogenesis of the OSAS are complex and are not completely understood. Initially, the causes of the syndrome were simply classified as central in nature or obstructions of the posterior superior airway. However, recent literatures have reported that the continuous vibration of uvula and soft palate via snoring deinnervate the sensory nerves in the upper airway causing or worsening the OSAS[5,6,7]. These findings have enhanced the importance of the posterior superior airway anatomy and physiology in diagnosing and treating the OSAS. The anatomical obstructions and the increased resistance of the posterior superior airway cause obstructive sleep apnea[8,9]. There are numerous treatment options: continuous positive airway pressure, oral appliances (tongue-retaining or mandibular-repositioning), tracheostomy, nasal reconstruction, uvulopalatopharyngoplasty, inferior mandibular sagittal osteotomy with geniohyoid advancement, base of tongue resection, and maxillomandibular complex advancement.

Since 1987 when Riley reported two cases of patients who acquired obstructive sleep apnea syndrome after mandibular setback surgeries[10], many clinicians have investigated the effects of orthognathic surgeries on the posterior superior airway. However, the direct effects of the movements of mandible and maxilla on the dimensions and the volume of the airway are still controversial. For example, some reported that mandible setback surgery decreased the airway dimensions [11,12] and caused mild OSAS when setback amount was large[13]. Whereas the others asserted that the airway did not change after mandible setback surgery[14,15]. The alleged reason for the unaffected airway dimensions after the orthognathic surgery is the adaptive changes of the morphology of pharyngeal soft tissue and muscles[14]. It was also reported that even with the decrease of the airway dimensions after mandible setback surgery, patients did not complain of any sleep-related breathing disorder[16]. These inconsistent results might be attributed to the different methods of investigation of airway; some studies used lateral cephalometric radiographs,[15,17] whereas the others utilized computed tomography (CT) images[18,19]. However, with the inherent limitations of the lateral cephalometric radiograph, the CT images may be considered more accurate and reliable.

In recent years many clinicians perform bimaxillary surgery (maxillary advancement and mandibular setback) for mandible prognathism patients to compensate the purported airway narrowing effects of the mandible setback surgery[12,20]. The maxillary advancement can increase the tension and decrease the collapsibility of velopharyngeal aponeurosis (palatoglossus, palatopharyngeus, uvulae, levator veli palatine, tensor veli palatine, and soft tissue with fat pads) with a subsequent increase of the nasopharynx and hypopharynx airway volume[15]. This is the result of anteriorly pulled velopharyngeal aponeurosis attachments at the posterior aspect of the maxilla. In Korea with a high prevalence of patients with protruded lips, the maxillary setback or posterior impaction is performed often than in the West. Moreover, in a skeletal class 3 malocclusion patient with a low occlusal plane angle and a mild hypoplastic midface, a bimaxillary surgery (maxillary setback and/ or posterior impaction and mandibular setback) with clockwise rotation is performed. However, there has been no published study on the volumetric and dimensional changes of the retropalatal airway and on the changes of velopharyngeal dimensions after the clockwise movement of maxillomandibular complex.

The purpose of this study is to investigate the changes in the retropalatal airway and the velopharyngeal aponeurosis in skeletal class 3 malocclusion patients who underwent the clockwise rotation of the maxillomandibular complex by utilizing three-dimensional (3-D) computed tomography (CT) images.

Materials and Methods

Materials

The subjects consist of sixty (26M/34F) skeletal class 3 malocclusion patients whose maxilla underwent Le-Fort 1 osteotomy with posterior impaction (at #16 and #26 mesiobuccal cusps) or posterior impaction and setback (at #11 and 12 incisal edge) and whose mandible were setback (mean 5.4mm right side; mean 4.4mm left side) with a bilateral sagittal split osteotomy technique from January 2010 to October 2012 by one surgeon (JYC) at the Department of Oral and Maxillofacial Surgery, Seoul National University Dental Hospital. Their mean age was twenty-three years old with a range from eighteen to thirty-two years old. The subjects were divided into two groups. Thirty patients (12M/18F) whose maxilla underwent the posterior impaction (mean: 2.63mm; range: 2-3.5mm) were assigned as group 1. The rest (14M/16F) whose maxilla underwent posterior impaction (mean 2.75mm; range: 2-4mm) and setback (mean: 1.83mm; range: 1-3mm) were assigned as group 2 (Table 1 and 2).

Superimposition

Whether the actual movements of the maxilla followed the pre-operative plans were confirmed with V-ceph software (V-ceph 5.5, Osstem, Korea) by superimpositioning pre-operative and post-operative lateral cephalograph radiographs.

Reconstruction of airway

3-D CT (SOMATOM Sensation 10, Siemens, Germany) was taken for all subjects 1 month pre-operatively (T0) and at least 6 months post-operatively (T1) at 120 kVp and 80 mAs with a slice thickness of 0.75 mm. InVivo dental software (version 5.1; Anatomage, San Jose, CA, USA) was used to reconstruct the 3-D CT images into 3-D images. The volume of the airway was measured by the automatic segmentation function of the software, which differentiates the air and the surrounding soft tissues by using the differences in the density values of the structures. The voxels within the range of -1,000 HU (Hounsfield Unit) and -600 HU were measured to standardize the density measurements.

Measurements

Following variables were measured and analyzed: retropalatal airway volume, minimum cross-sectional area within the retropalatal airway, lateral dimension of the minimum cross sectional area, antero-posterior dimension of the minimum cross sectional area, soft palate length, soft palate angle, and pharyngeal depth.

Retropalatal airway was defined as an airway space between a horizontal line drawn from the anterior nasal spine (ANS) to the posterior nasal spine (PNS) of maxilla and the other horizontal line drawn parallel to the aforementioned line but intersects the most inferior point of uvula. The retropalatal airway volume and the minimum cross-section of the airway were measured with airway volume measuring function of the Invivo dental software (Figure 1-4 and Table 3).

On the mid-sagittal view of the CT images, length and angle measuring functions of the program were used to measure the soft palate length (a distance from the PNS to the most inferior point of uvula), soft palate angle (between a horizontal line from the ANS to the PNS and a line from the PNS to the most inferior point of uvula), and pharyngeal depth (a distance from the PNS to the posterior wall of pharynx) (Figure 5-8 and Table 3).

Statistical analysis

The values of the variables obtained from the pre-operative and post-operative 3-D CT images were compared and statistically analyzed with the paired-T test by using the SPSS program (version 20.0; SPSS Inc., Chicago, IL, USA). P value less than 0.05 was considered statistically significant.

Results

Group 1: posterior impaction only

In group 1, the average pre-operative retropalatal volume was 4.37±1.47 mm^3 and it was increased to 5.17±1.84 mm^3 post-operatively with statistical significance (Table 4 and Figure 9). The average pre-operative minimum cross sectional area was 98.43±48.7 mm^2 and it was increased to 116.41±65.04 mm^2 post-operatively, and the change was statistically significant (Table 5 and Figure 10). The lateral dimension of the minimum cross sectional area was decreased from 22.64±7.92 mm to 21.54±7.0 mm and the AP dimension was increased from 9.02±2.88 mm to 9.45±2.63 mm. However, they were not statistically significant (Table 6,7 and Figure 11,12).

The soft palate angle decreased from 56.61±7.01°to 55.5±6.01° without a statistical significance (Table 8 and Figure 13). Soft palate length increased from 31.93±4.29 mm to 34.07±3.46 mm with a statistical significance (Table 9 and Figure 14). The pharyngeal depth increased from 24.73±3.43 mm to 26.33±3.31 mm with a statistical significance (Table 10 and Figure 15).

Group 2: posterior impaction and setback

In group 2 when maxilla was posteriorly impacted and setback, the retropalatal volume was decreased from 4.19±1.49 mm^3 to 4.16±1.68 mm^3 and it was statistically significant (Table 4 and Figure 9). The minimum cross sectional area was decreased from 119.53±65.80 mm^2 to 86.08±52.45 mm^2 and it was statistically significant (Table 5 and Figure 10). Both the lateral dimension (22.52±4.59 mm to 20.24±4.67 mm) and the AP dimension (9.31±2.61 mm to 7.77±2.71 mm) decreased with a statistical significance (Table 6,7 and Figure 11,12).

When maxilla was posteriorly impacted and setback, the soft palate angle decreased from 52.80±8.04°to 52.19±6.92°without a statistical significance (Table 8 and Figure 13). The soft palate length increased from 29.76±3.33 mm to 32.89±3.08 mm with a statistical significance (Table 9 and Figure 14). The pharyngeal depth increased from 26.00±2.89 mm to 27.11±3.58 mm without a statistical significance (Table 10 and Figure 15).

Discussion

Airway can be divided into the nasopharynx, oropharynx, and laryngopharynx. The nasopharynx is located behind the nasal cavity and above the hard palate. From the hard palate to the tip of the epiglottis, the oropharynx exists. The oropharynx can be further divided into the retropalatal and the retroglossal airway. The retropalatal airway is a space behind the soft palate and the retroglossal airway is located behind the tongue. Finally, below the tip of the epiglottis, there is the laryngopharynx.

With a close proximity, dentofacial structures and the posterior superior airway have intimate relationships. There have been reports of cases of patients who acquired OSAS after receiving mandibular setback surgeries[10], which decreased the airway dimensions[11,12]. This was a significant finding, because OSAS patients are predisposed to numerous detrimental clinical conditions, such as hypertension, cardiac arrest, and sudden death[1]. Considering that an OSAS patient tends to have a narrower oropharynx with thicker soft tissue walls with fat pads[21], the purported narrowing effects of the mandible setback surgery on the oropharynx deserve much attention.

Even after numerous studies and researches on the airway after a mandibular setback surgery, the effects of the surgery on the airway are still controversial with reports asserting that the mandible setback surgery decreased the airway[11,12], or did not decrease the airway[14,15]. The inconsistent results might be attributed to different physiological adaptations among patients[14] or to the different methods of investigation of airway; some studies used lateral cephalometric radiographs[15,17] whereas the others utilized CT images[18,19]. With inherent limitations of the lateral cephalometric radiograph, the CT images may be considered more accurate and therefore they were utilized in this study.

Within the posterior superior airway, the sites of the airway obstruction in the OSAS patients are located in multiple sites within the oropharynx and sometimes extending to the laryngopharynx, but the locations are not the same in all patients[22]. Most literatures studied the volumetric and dimensional changes of the whole posterior superior airway or the oropharynx. However, the retropalatal airway space was evaluated in this study for the following reasons. First, within the oropharynx the narrowest part is located at the retropalatal airway (behind soft palate) and the narrowing of this space can precipitate sleep-related breathing disorder[23]. Second, the retropalatal airway is the most collapsible part of the airway and the narrow cross-sectional area at the uvula to the posterior pharyngeal wall is reported to be a contributing factor for OSAS[24]. Finally, the mandible setback surgery can narrow the retroglossal airway within the orthopharyx. Therefore, in order to accurately see the effects of the clockwise rotation of the maxillomandibular complex, the change of the retroglossal airway volume was discounted.

The results of this study showed that the retropalatal airway of patients in group

1 increased in volume and the minimum cross-sectional area with a statistically significance (Table 4,5 and Figure 9,10). When the posterior impaction is performed on the maxilla, it is logical to imagine that the posterior nasal spine is moved supero-anteriorly pulling the velopharyngeal aponeurosis and soft palate supero-anteriorly, subsequently enlarging the retropalatal airway.

It was reported that mandible setback surgery can decrease both antero-posterior and lateral dimensions and the cross-sectional area at the soft palate and uvula[18]. The change of the posterior superior airway with the mandibular setback surgery is not within the context of this study. However, the results in group 1 showed the increase in the retropalatal airway volume (Table 4 and Figure 9) and dimensions (Table 5-7 and Figure 10-12) even with the mandibular setback surgery (mean 4.8mm right side and 4.2mm left side). This implies either that the amounts of the increase of the retropalatal airway volume and the minimum cross-sectional area were large enough to cover the narrowing effect of the mandibular setback surgery, or that the mandibular setback surgery did not have significance effects on the retropalatal airway volume or dimensions. Even though the effects of the mandibular setback surgery on the retropalatal airway cannot be ignored, it is logical to assume with the results of this study that the maxillary movement had greater effects on the retropalatal airway than the mandibular movement.

In group 2, the retropalatal airway volume, minimum cross-sectional area, and lateral and antero-posterior dimensions of the minimum cross-sectional area decreased with a statistical significance (Table 4-7 and Figure 9-12). The results imply that the maxillary setback pushes the soft palate and uvula posteriorly. This result can be considered clinically significant, because the OSAS patients have posteriorly located maxilla, hard palate and soft palate compared to the normal[25]. The constriction of the retropalatal airway, which is the most collapsible and the narrowest part of the posterior superior airway, may worse the signs and symptoms of sleep-related breathing disorders.

The inherent mechanism of the maxillary advancement in the maxillomandibular advancement procedure for treating the OSA patients is to tighten the velopharyngeal aponeurosis[26]. and to elevate the velopharyngeal aponeurosis and subsequently to increase the lateral width of the pharyngeal airway[27].The same logic is applied to the bimaxillary surgery when maxilla is advanced to compensate the decreasing effect of the mandible setback surgery on the airway.

Until now most studies on the velopharyngeal aponeurosis were performed on the pharyngeal anatomy of OSAS patients[29-34] and on the velopharyngeal insufficiency of cleft palate patients with retruded maxilla when the maxillary advancement surgery was performed[35,36]. The velopharyngeal aponeurosis is consisted of palatoglossus, palatopharyngeus, uvula, tensor veli palatine, levator veli palatine, and soft tissue with fat fads. The palataoglossus and palatopharyngeus help in respiration. The uvula, levator veli palatine, and tensor veli palatine function in swallowing.

In both group 1 and 2, the soft palate length increased with a statistical significance (Table 9 and Figure 14). This is a significant finding, because the OSAS patients have longer soft palate than the normal[28-33]. The increase of the soft palate length may reduce the tones of the muscles within the velopharyngeal aponeurosis and subsequently increase the collapsibility of the soft palate. Therefore, the clockwise rotation of the maxillomandibular complex in patients with long soft palates may have even longer soft palates post-operatively, with a possible resemblance to the soft palates of patients with the sleep-related breathing disorders.

In both group 1 and group 2, the soft palate angle did not change with a statistical significance (Table 8 and Figure 13). Even though the angle between the hard and soft palates increased when the maxilla is advanced[36], there was no statistically significant change when the maxilla was posteriorly impacted or posteriorly impacted and setback. This implies that the amounts of the posterior movement or setback movement were not large enough to have effects on the soft palate angle. The pharyngeal depth increased in group 1 (Table 10 and Figure 15). As the posterior impaction was performed on the maxilla, the posterior nasal spine rotated supero-anteriorly. Therefore, the distance between the PNS and the posterior pharyngeal wall was increased.

Prior to performing the clockwise rotation of the maxillomandibular complex with the setback of maxilla, investigating and diagnosing sleep-related breathing disorders such as snoring or obstructive sleep apnea should be performed; the setback of the maxilla can worsen the sleep-related breathing disorders by reducing the retropalatal airway dimensions and lengthening the soft palate. Further studies with follow-up periods greater than 6 months should be performed.

Summary and conclusion

This study investigated the effects of the clockwise rotation of maxillomandibular complex on the retropalatal airway and velopharyngeal dimensions in skeletal class 3 malocclusion patients. The directions of the movements of maxilla determined the changes in the retropalatal airway and velopharyngeal dimensions.

When the maxillomandibular complex was rotated clockwise with the posterior impaction only, the retropalatal airway dimensions increased. On the other hand, when the maxillomandibular complex was rotated with the posterior impaction and setback, the retropalatal airway dimensions decreased. Moreover, the lengths of the soft palate increased when the complex was rotated clockwise irrespective of the movements of maxilla. Therefore, prior to performing the clockwise rotation of the maxillomandibular complex with the setback of maxilla, investigating and diagnosing sleep-related breathing disorders such as snoring or obstructive sleep apnea should be performed; the setback of the maxilla can worsen the sleep-related breathing disorders by reducing the retropalatal airway dimensions and lengthening the soft palate.

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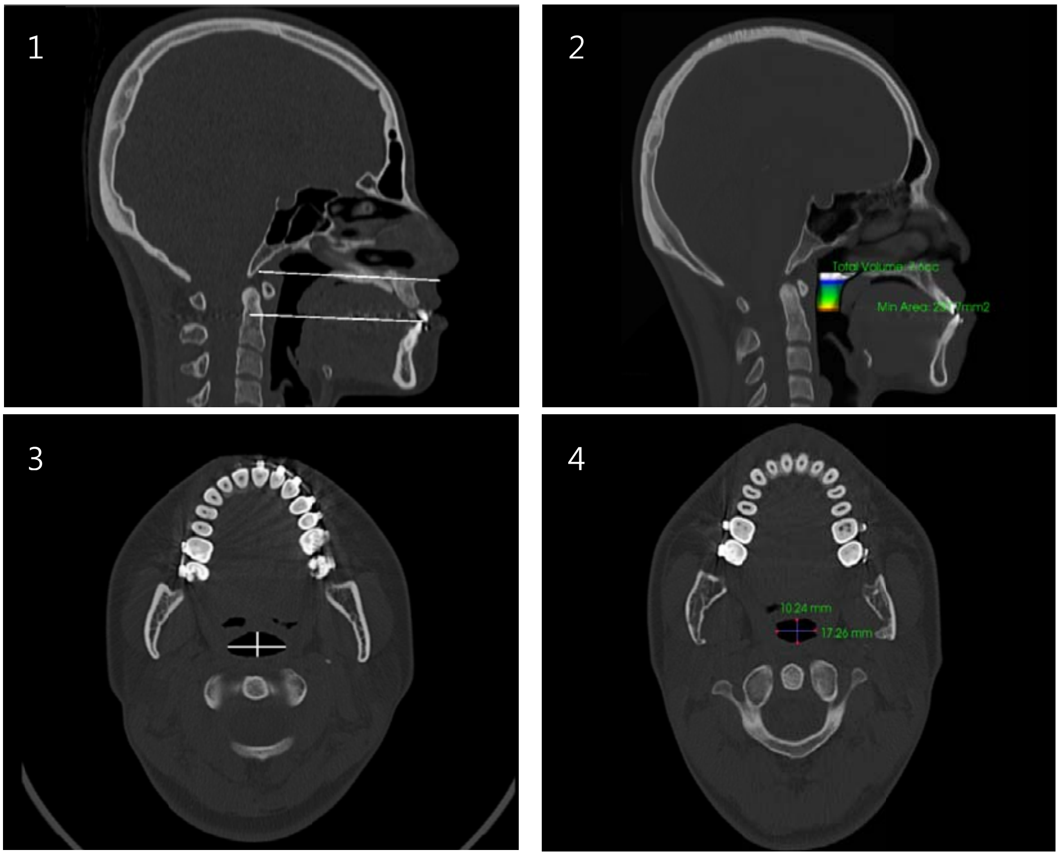

Figure (1-4). 1. The retropalatal airway: Airway space between a horizontal line drawn from the anterior nasal spine to the posterior nasal spine of maxilla and the other horizontal line drawn parallel to the aforementioned line but intersects the most inferior point of uvula. The minimum cross-sectional area: the minimum cross-sectional area within the retropalatal airway space. 2. An example of the measurement of the retropalatal airway volume and the minimum cross-sectional area. 3. Lateral dimension and the antero-posterior dimension of the minimum cross-sectional area. 4. An example of the measurements of the lateral and the antero-posterior didmension.

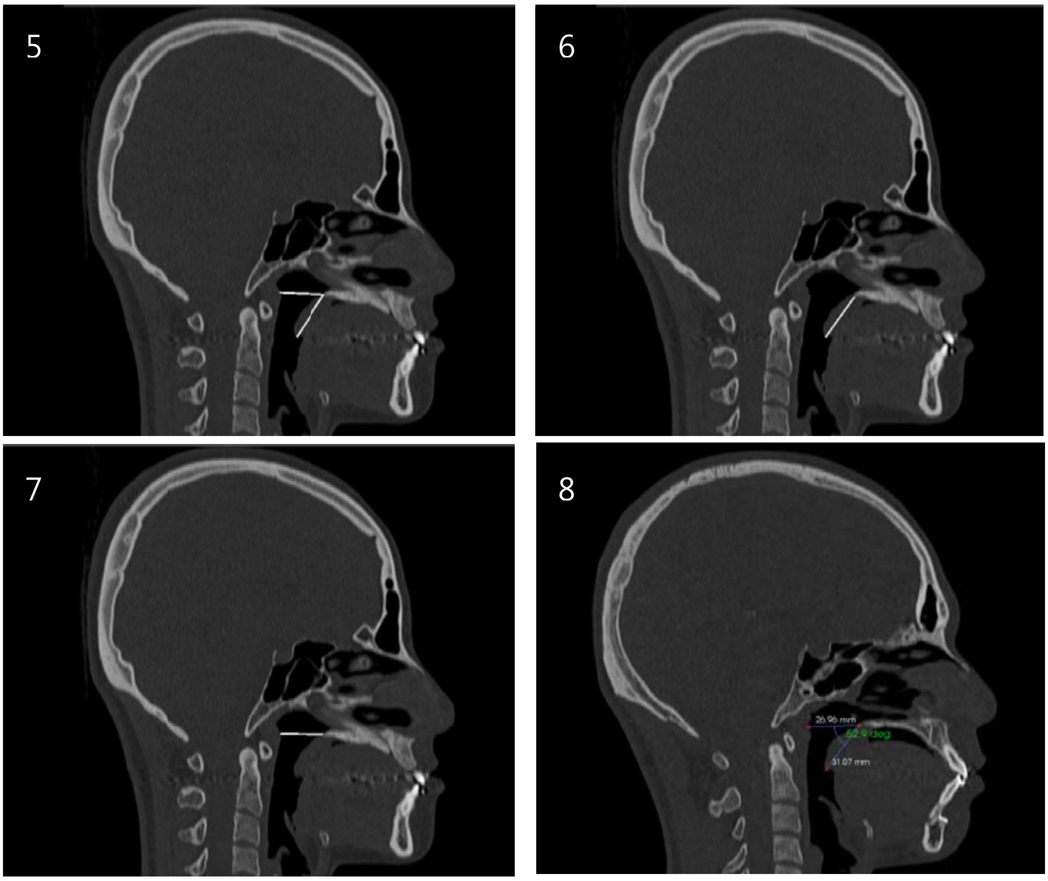

Figure (5-8). 5. Measurement of the soft palate angle: an angle between a horizontal line drawn from the anterior nasal spine to the posterior nasal spine and a line from the posterior nasal spine to the most inferior point of uvula. 6. Measurement of the soft palate length: the distance from the posterior nasal spine to the most inferior point of uvula. 7. Measurement of the pharyngeal depth: the distance from the posterior nasal spine to the posterior pharynx wall. 8. An example of measuring the soft palate angle, length, and the pharyngeal depth.

Table 1. Demographic data of subjects. In group 1 there were a total of 30 patients (12 males and 18 females). Their mean age was 22.6 years with a range from 18 to 31. In group 2 there were a total of 30 patients (14 males and 16 females). Their mean age was 23 years with a range from 18 to 32.

	Sex	Age (years)
Group 1	12 males/ 18 females	Mean: 22.6 range: 18-31
Group 2	14 males/ 16 females	Mean: 23 range: 18-32

Table 2. In group 1 the average amount of posterior impaction was 2.63mm with a range from 2 to 3.5mm. In group 2 the average amount of posterior impaction was 2.75mm with a range from 2 to 4mm. The average amount of setback was 1.83mm with a range from 1 to 3mm.

	Posterior impaction (mm)	Setback (mm)
Group 1	Mean: 2.63mm; range: 2-3.5mm	None
Group 2	Mean: 2.75mm; range: 2-4mm	Mean: 1.83mm; range: 1-3mm

Table 3. Definitions of the variables there were investigated in this study.

Measurement	Definition
Retropalatal volume	Airway space between a horizontal line drawn from the ANS to the PNS of maxilla and the other horizontal line drawn parallel to the aforementioned line but intersects the most inferior point of uvula
1) Minimum cross-sectional area	Minimum cross-sectional area within the retropalatal airway space

2)Antero-posterior dimension	Antero-posterior dimension of the minimum cross-sectional area
3) Lateral dimension	Lateral dimension of the minimum cross-sectional area
Soft palate angle	An angle between a horizontal line from the ANS to the PNS and a line from the PNS to the most inferior point of uvula
Soft palate length	The distance from the PNS to the most inferior point of uvula
Pharyngeal depth	The distance from the PNS to the posterior pharynx wall

ANS: anterior nasal spine; PNS: posterior nasal spine

Table 4. The retropalatal airway volume in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Retropalatal volume	Preoperative	Postoperative	P-value
Group 1	4.37±1.47 mm^3	5.17±1.84 mm^3	0.001*
Group 2	4.19±1.49 mm^3	4.16±1.68 mm^3	0.001*

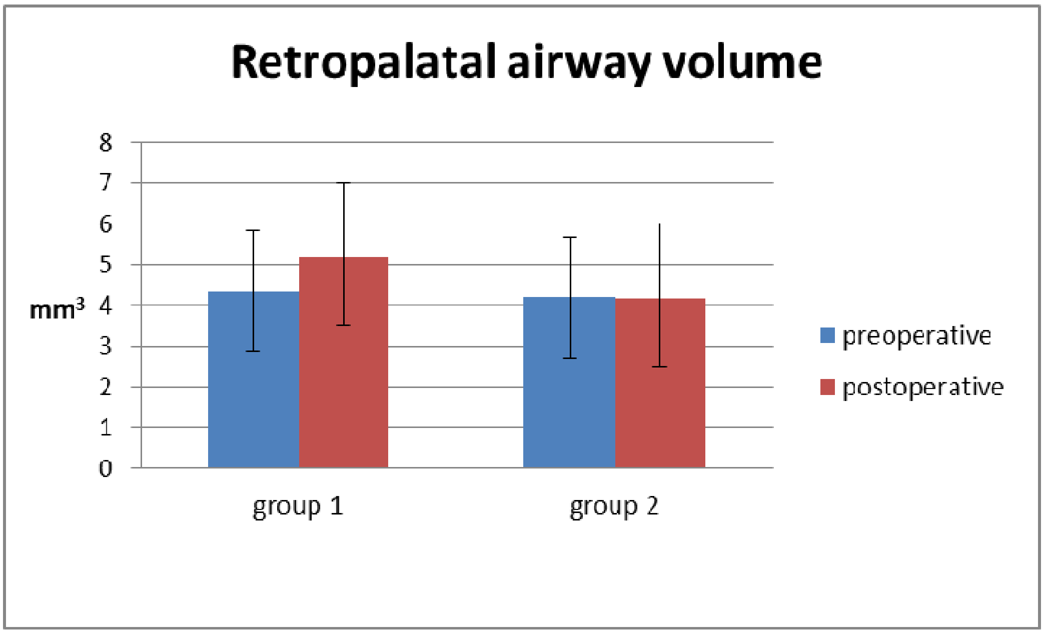

Figure 9. The retropalatal airway volume in both group 1 and 2 preoperatively and postoperatively.

Table 5. The minimum cross-sectional areas in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Minimum cross-section	Preoperative	Postoperative	P-value
Group 1	98.43±48.70 mm^2	116.41±65.04 mm^2	0.025*
Group 2	119.53±65.80 mm^2	86.08 ±52.45 mm^2	0.002*

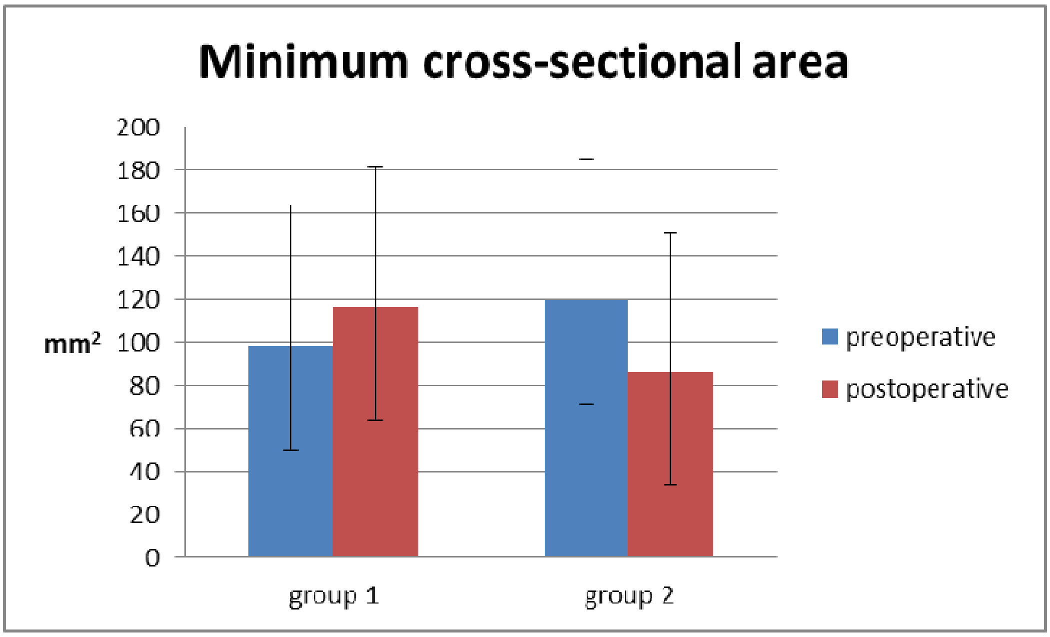

Figure 10. The minimum cross-sectional areas in both group 1 and 2 preoperatively and postoperatively.

Table 6. The lateral dimensions in the minimum cross-sectional area in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Lateral dimension	Preoperative	Postoperative	P-value
Group 1	22.64±7.92 mm	21.54±7.00 mm	0.301
Group 2	22.52±4.59 mm	20.24 ±4.67 mm	0.007*

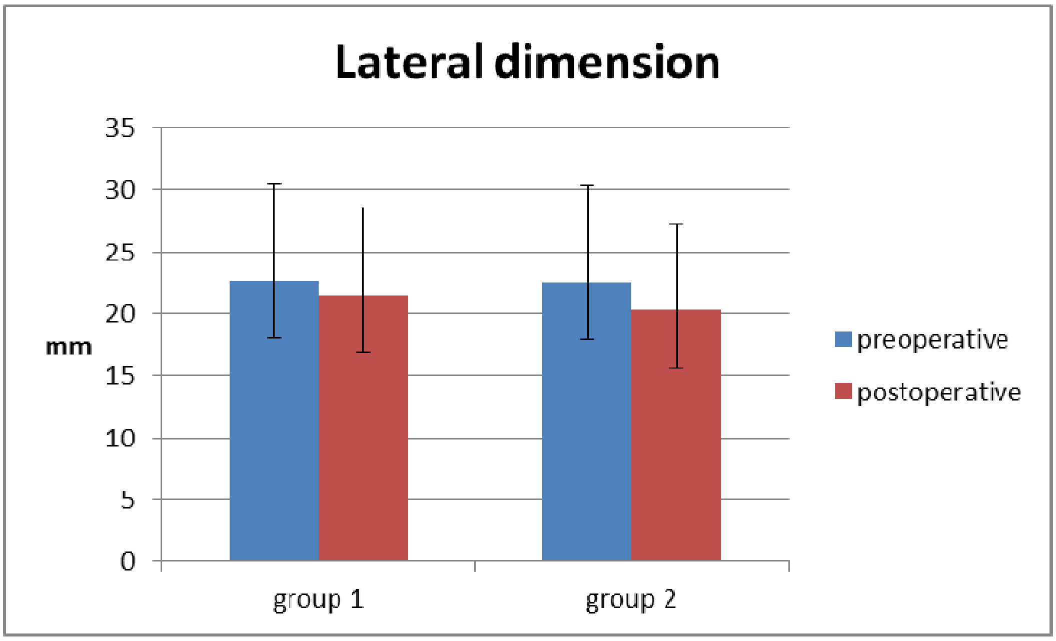

Figure 11. The lateral dimensions in the minimum cross-sectional area in both group 1 and 2 preoperatively and postoperatively.

Table 7. The antero-posterior dimensions in the minimum cross-sectional area in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

AP dimension	Preoperative	Postoperative	P-value
Group 1	9.02±2.88 mm	9.45±2.63 mm	0.302
Group 2	9.31±2.61 mm	7.77 ±2.71 mm	0.002*

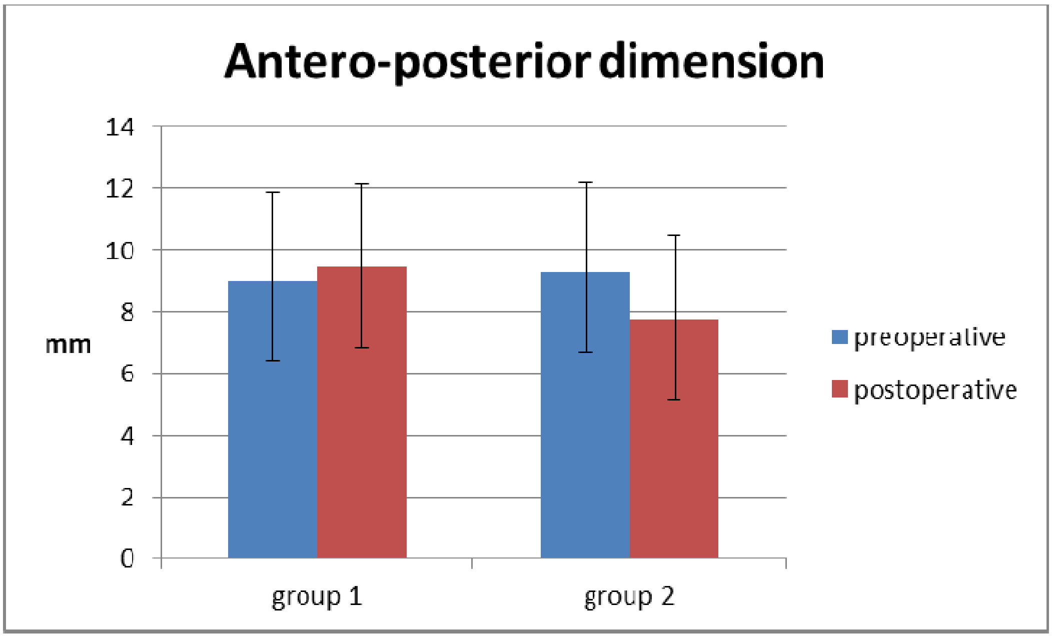

Figure 12. The antero-posterior dimensions in the minimum cross-sectional area in both group 1 and 2 preoperatively and postoperatively.

Table 8. The soft palate angles in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Soft palate angle	Preoperative	Postoperative	P-value
Group 1	56.61±7.01°	55.5±6.01°	0.365
Group 2	52.80±8.04°	52.19 ±6.92°	0.632

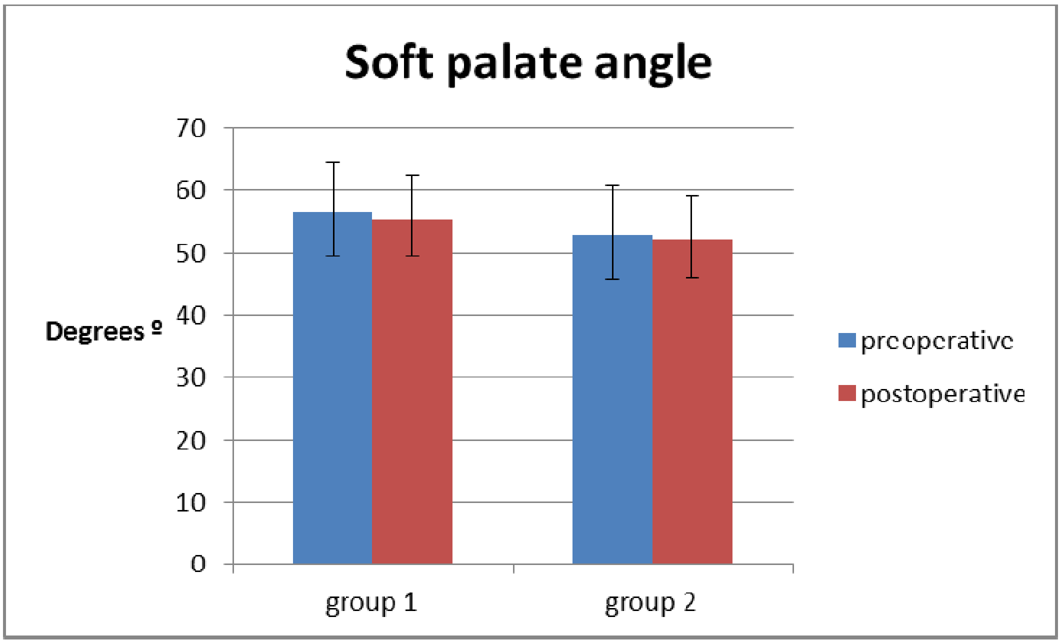

Figure 13. The soft palate angles in both group 1 and 2 preoperatively and postoperatively.

Table 9. The soft palate lengths in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Soft palate length	Preoperative	Postoperative	P-value
Group 1	31.93±4.29 mm	34.07±3.46 mm	0.002*
Group 2	29.76±3.33 mm	32.89 ±3.08 mm	<0.001*

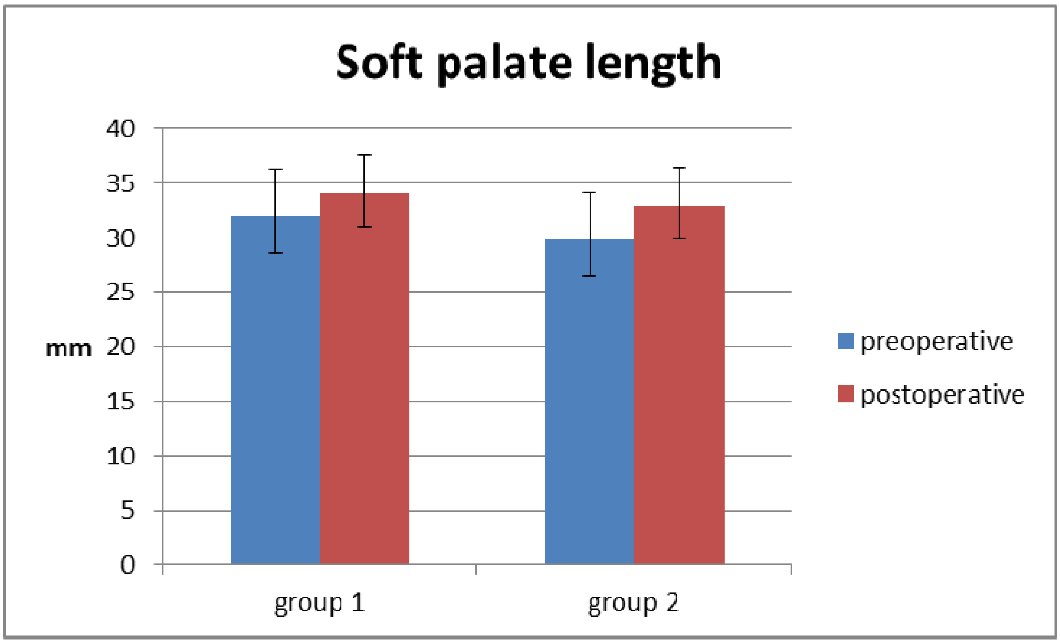

Figure 14. The soft palate lengths in both group 1 and 2 preoperatively and postoperatively.

Table 10. The pharyngeal depths in both group 1 and 2 preoperatively and postoperatively. (*P<0.05)

Pharyngeal depth	Preoperative	Postoperative	P-value
Group 1	24.73±3.46 mm	26.33±3.31 mm	0.002*
Group 2	26.00±2.89 mm	27.11 ±3.58 mm	0.087

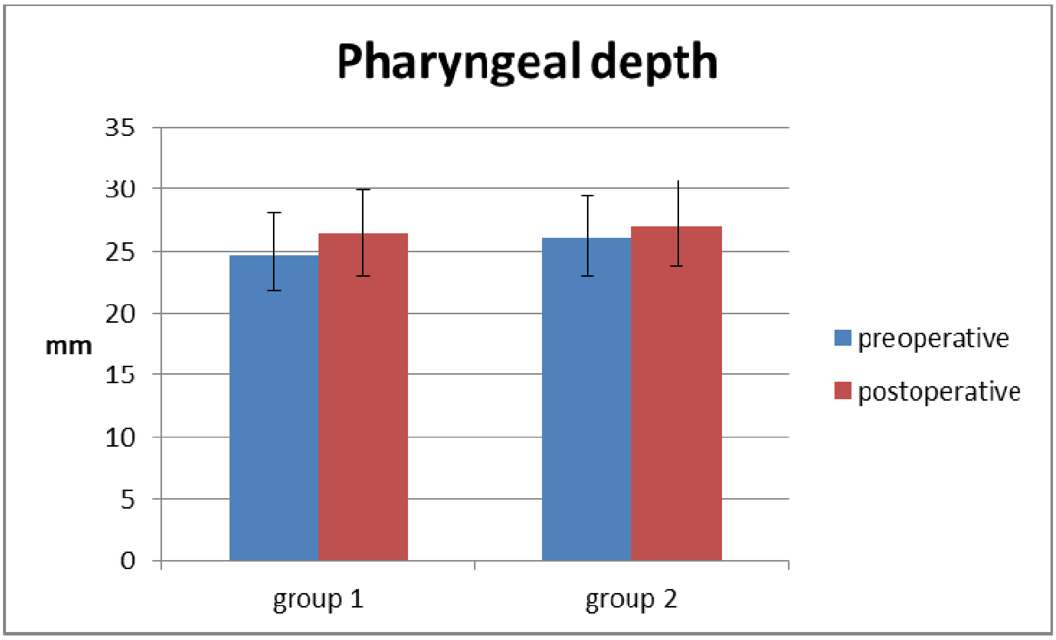

Figure 15. The pharyngeal depths in both group 1 and 2 preoperatively and postoperatively.

국문초록

제 3골격적 부정교합 환자에서 상하악복합체의 시계방향회전 수술 후 후구개 부위의 기도와 구개인두 부위의 변화에 관한 연구

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(지도교수 최 진 영)

김 태 윤

연구목적

상악과 하악을 동시에 전방으로 이동하는 것은 수면무호흡증후군의 효과적인

치료방법 중 하나이다. 턱교정외과의 발달로 상하악을 전후, 상하, 좌우 등 모든 방향으로 이동이 가능케 되었으나, 상악을 후상방이나 후방부위를 상방으로 이동하였을 때에 기도변화에 대한 논문은 많지 않다. 경미한 중안모의 돌출과 교합각이 낮은 환자에게 시행되는 이 술식이 기도에 어떤 영향을 미치는지는 확실치 않다. 제3 골격적 부정교합 환자에서의 악교정 수술 시 상하악복합체의 시계방향회전 후 후구개 부위의 기도와 구개인두 부위의 변화를 관찰 하였다.

연구 대상 및 방법

제 3 골격적 부정교합으로 서울대학교치과병원 구강악안면외과에서 악교정 수술을 시행 받은 환자로 상악이 후상방이나 후방부위를 상방으로 이동된 60명의 환자 (남성: 26명, 여성: 34명) 를 대상으로 하였다. 이 60명의 환자는 두 그룹으로 나뉘었으며 첫번째 그룹 (남성: 12명, 여성: 18명; 평균나이: 22.6, 범위: 18-31)은 상악의 후방이 상방으로 이동 된 (평균 이동량: 2.63mm; 범위: 2-3.5mm) 환자이고 두번째 그룹 (남성: 14명, 여성: 16명; 평균나이: 23, 범위: 18-32) 은 상악의 후방이 상 후방으로 이동 된 (평균 상방 이동량: 2.75mm, 범위: 2-4mm; 평균 후방 이동량: 1.83mm, 범위: 1-3mm) 환자이다. 수술 1달전 촬영된 3-D CT와 수술 6개월 후 촬영된 3-D CT를 비교하여 상기도 중 후구개 기도의 부피와 횡단면의 최저

면적을 측정하였다. 또한 구개인두 부위의 변화를 연구하기 위하여 연구개 길이와 각도 및 인두벽의 깊이를 측정하였다.

결과

그룹 1에서 후구개 기도의 부피와 횡단면의 최저 면적이 늘어났으며 이는 통계학적 유의성이 있었다 ($p<0.05$). 그룹2에서 후구개 기도의 부피, 횡단면의 최저 면적과 이 면적의 좌우와 앞뒤 길이가 줄어들었으며 이는 통계학적으로 의미가 있었다. 그룹 1과2에서 연구개의 길이는 늘어났으며 그룹 1에서 인두벽의 깊이는 늘어났고 통계학적으로 의미가 있었다.

결론

코골이나 수면관련 호흡장애가 있는 환자들에서 상하악복합체를 시계방향으로 회전하며 상악을 후방이나 후상방으로 이동시에 상기도 부위가 좁아지고 연구개의 길이를 증가시켜 수면관련 호흡장애의 증상을 악화시킬 수 있으므로 술 전에 수면관련질환에 관한 검사 및 진단이 필요하며 충분한 검토와 설명이 필요할 것으로 생각된다.

주요어: 후구개 기도의 변화, 수면무호흡증, 상하악복합체의 시계방향회전, 구개인두 부위의 변화, 코골이

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