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Pharyngeal Airway Sagittal Dimension in Patients with Class III Skeletal Dentofacial Deformity Before and After Bimaxillary Surgery

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SUMMARY

The aim of the present study was to estimate the mean values for the pharyngeal airway sagittal dimension in the three levels –naso, oro and hypopharyngeal – for the young adult patients with Class III dentofacial skeletal morphology in comparison with Class I patients with normal dentofacial morphology. Class III skeletal dentofacial anomalies in adults is most often treated by mandibular setback surgery. According to literature date this kind of treatment has an effect on airway anatomy, and in that way to diminish the potential of airway size. Effect of the bimaxillary surgery for correcting Class III dentofacial skeletal deformities has not been fully described in the literature. Therefore the second aim of this study was to estimate the changes in the pharyngeal airway sagittal dimension in patients with Class III skeletal dentofacial deformities after bimaxillary orthognatic surgery. The material consisted of 35 cephalometric radiographs of patients with Class III skeletal dentofacial deformity before orthodontic treatment and orthognathic surgery. From these 22 females (mean age 17.9 year) have had bimaxillary surgery and second cephalometric radiograms were taken 8 month after surgery.A paired t test was used to evaluate the difference between Class I and Class III pharyngeal airway sagittal dimension measurements and statistical analysis revealed a highly significant difference in naso and hypopharyngeal levels.Pre and postoperative changes in the pharyngeal airway sagittal dimension after bimaxillary surgery showed statisticaly significant increase in nasopharyngeal airway space,without significant reduction in oro and hypopharyngeal level.

Key words: pharyngeal airway sagittal dimension, Class III dentofacial skeletal morphology, bimaxillary surgery

The close relationship between the pharynx dentofacial and craniofacial structures determines their mutual interaction. In many studies, carried out on this subject, it was demonstrated, that there are statistically a significant relationship between the pharyngeal structures and both - dentofacial and craniofacial structures at varying degrees [1; 2; 3].

The treatment of the severe dentofacial deformities with jaw osteotomies has also an effect on oropharyngeal morfology [4; 5; 6]. Consequently, mandibular advancement has been successfully used to increase airways in patients with obstructive sleep apnea (OSA) [7; 8]. On the other hand, according to several studies, mandibular setback surgery is known to reduce airway size [9; 10; 11; 12]. In the past two decades, the OSA has received increasing attention in the medical literature. The characteristic cephalometric features of the upper airway in OSA subjects were published and now well known [13; 14]. The influence of orthognatic surgery on the upper airways in non OSA subjects is still not fully described in literature. In several studies the effect of the mandibular setback osteotomy is investigated. Reduction in airway space had probably been a causative factor in patients developing partial upper airway obstruction [4; 5; 8; 10; 24]. Effect of other orthognatic procedures, such as bimaxillary surgery, for correcting Class III dentofacial skeletal deformation has not been fully explored.

The aim of the present study was to establish the mean values for pharyngeal airway sagittal dimension measurements in the three levels of pharynx (naso, oro and hypopharynx) for the subjects with Class III dentofacial skeletal morphology in comparison with Class I dentofacial morphology. Different Angle classes represent discrepancies in the size and / or position of the maxilla and mandible and surrounding soft tissues as well as pharyngeal airway morphology.

The second aim of this study was to estimate the changes in the pharyngeal airway sagittal dimension before and after bimaxillary surgery in the cases of Class III dentofacial skeletal morphology.

MATERIAL AND METHODS

Cephalometric radiography in orthodontics is used as a diagnostic technique in the study of craniofacial morphology. That also provides information about the hard and soft tissue of the upper airway [15; 16]. Cephalometric radiographs of 35 subjects with skeletal Class III deformity were selected from the group of

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the orthognatic surgery treated subjects in Department of Oral and Maxillofacial Surgery, Institute of Stomatology, Rigas Stradins University, before the orthodontic treatment started. From these 22 (all of them females) have had orthognatic surgery and second cephalometric radiographs were taken average 8 months after bimaxillary surgery.
The control group consisted of 48 cephalometric radiographs selected from the dental students at the Riga Stradins University, without skeletal deformity, with Class I occlusion. All these individuals were in good health, with no subjective sleep-induced breathing disorders and no previous orthodontic treatment.

Cephalometric analysis. All lateral cephalogramms were taken using ORTHOPHOS 3/3 (Siemens) cephalostat in natural head position, with maximal intercuspation of the teeth, with lips in light contact.

Surgical techniques In 15 cases – bilateral vertical ramus osteotomy, in 7 cases – bilateral sagittal split osteotomy and in all cases – Le Fort I osteotomy.

Landmarks and measurements for upper airway used in this study:

1.Landmarks:

pm: pterygomaxillary fissure.
UPW: upper pharyngeal wall, intersection of the line pm-ba and posterior pharyngeal wall.
ba: basion.
U: tip of the uvula, the most posteroinferior point of the uvula.
MPW: middle pharungeal wall, intersection of the perpendicular line from U with the posterior pharyngeal wall.
V: vallecula, the intersection of the epiglottis and base of the tongue.
LPW: lower pharyngeal wall, intersection of the perpendicular line from V with posterior pharyngeal wall.

2.Linear measurements (Figure 1):

pm –UPW: the distance from pm to UPW, representing the nasopharyngeal airway space.
U – MPW: the distance from U to MPW, representing the oropharyngeal airway space.
V – LPW: the distance from V to LPW, representing the hypopharyngeal airway space.

Reliability

All the lateral cephalograms were traced twice by hand onto acetate paper for pharyngeal measurements and digitised twice with Dentofacial Planner computer program.

Statistics

All the statistical procedures were performed using SPSS PC.The comparison of the means was obtained by using a two-tailed pair Student's t-test.

RESULTS

Cephalometric upper airway measurements in the Class I and in the Class III subjects are shown in Table 1.

Statistically a significant ($p<0,001$) difference was found between nasopharyngeal area (pm-UPW) measurements in Class I and Class III group. Comparative cephalometric measurements of upper airway in controls and in Class III subjects are also shown in Table 1.

A minor difference was found in oropharyngeal airway dimension (U-MPW).

In hypopharyngeal level (V-LPW) there is a highly significant ($p<0,001$) difference between Class III malocclusion group and the group with normal dentofacial morphology.

The mean anteroposterior cephalometric measurements in subjects with Class III dentofacial morphology before and after bimaxillary surgery are shown in Table 2.

Comparisons of pharyngeal airway sagittal measurements between preoperative and postoperative Class III subjects are shown in Table 3.

Statistically a significant ($p<0,001$) difference is seen in nasopharyngeal level. Preoperative nasopharyngeal airway size was found to be, on average, 24.47 mm, but in the follow-up examination, this measurement was 29.13 mm - a increase which was statistically significant. No significant difference in oro and hypopharyngeal area were found before and after bimaxillary surgery.

Table 1. *Comparisons of the Class I and Class III pharyngeal airway sagittal dimension measurements.*

Variable	Pharyngeal airway means ± SD		Difference (mm)
	Angle I (A_1) mm	Angle III (A_3) mm	$A_1 - A_3$
Pm – UPW	14,91 ± 4,01	23,02 ± 4,20	8,11 (*)
U – MPW	12,77 ± 3,22	11,91 ± 3,11	0,85 (***)
V – LPW	28,31 ± 3,54	10,28± 3,60	18,63 (*)

* p < 0,001; ** p < 0,01; *** N.S.

Table 2. *SNA; SNB; ANB; pre and postoperative values (degree).*

Variables	Preoperative (SD)	Postoperative (SD)
SNA	$81,53^0$ ($3,22^0$)	$85,57^0$ ($3,24^0$)
SNB	$85,59^0$ ($4,24^0$)	$82,82^0$ ($3,50^0$)
ANB	- 4,04 (3,60)	2,7 (2,4)

Table 3. *Pharyngeal airway sagittal dimension measurement (mm) before and after bimaxillary surgery.*

Variables	Pre-operative T_1 (SD) mm	Post-operative T_2 (SD) mm	T_1-T_2 mm
Pm – UPW	24,47 (3,6)	29,13 (4,1)	4,65*
U- MPW	13,5 (3,4)	14,65 (3,1)	- 1,15***
V – LPW	11,9 (4,2)	9,8 (3,9)	- 2,06 **

* p < 0,001; ** p < 0,01; *** N.S.

DISCUSSION

In this study we want to estimate the mean values of pharyngeal airway sagittal dimension in subjects with Class III skeletal dentofacial deformities and to find if there is any difference in this means in comparison to the controls-subjects with normal, Class I dentofacial morphology. This interest is focused on the soft tissues and the structures of pharynx because of the potential relationship between the size and the structure of the upper airway and sleep-induced breathing disturbances[17; 18;19].

Tourne [20] stated that the nasopharyngeal depth is formed at early ages and then it usually remains the same during the lifetime. But it also has been stated, that nasopharynx continues to increase in the width until adulthood. Kollas and Krogstad [21] found that sagittal dimension of pharynx and the minimal distance between the base of the tongue and the posterior pharyngeal wall decrease during adulthood. The average age in our study was the age of 17,9 years. This could be the period when active growth has ceased and insignificant changes in dentofacial morphology could occur.

In our study we find a statistically significant difference in hypopharyngeal level between Class III group and Class I, that could be associated with different location and / or size of the tongue and mandibular hyperplasia [2;22;23].

A number of studies have reported the changes in the pharyngeal airway sagittal dimension after orthognatic surgery. There are studies evaluating the effects of mandibular setback surgery on the upper airway [24; 25; 10].Rilay et al [8] reported on 2 cases of development of OSA after mandibular setback surgery.Tselnik et al [24] also reported the influence of the mandibular setback surgery on pharyngeal airway. The recent studies [13; 16; 19] have shown that during episodes of OSA the site of airway narrowing is located either in the oropharyngeal or the hypopharyngeal region. According to our study, we could expect the less narrowing in the hypopharyngeal area after bimaxillary surgery in comparison with mandibular setback only. These findings are similar to Samman et al [12]

Hochbah et al [10] reported, that sleep-related breathing disorders after mandibular setback were rare, but recommended caution when planning mandibular setback of 10 mm or more, especially when the distance between base of tongue and posterior pharyngeal wall is less than 10-12 mm. For these patients, when setback is planned more than 10mm,bimaxillary osteotomy might be better consideration.

In conclusion, it is evident, that orthognatic surgery may cause narrowing of the airway, and may be a causative factor in development of a breathing disorder, in cases if the predisposing factors, such us craniofacial type is present and individual neiromuscular adaptation is insufficient to compensate reduction in airway size.

Therefore, particularly in severe anteroposterior discrepancies cases, careful airway analysis should be performed.

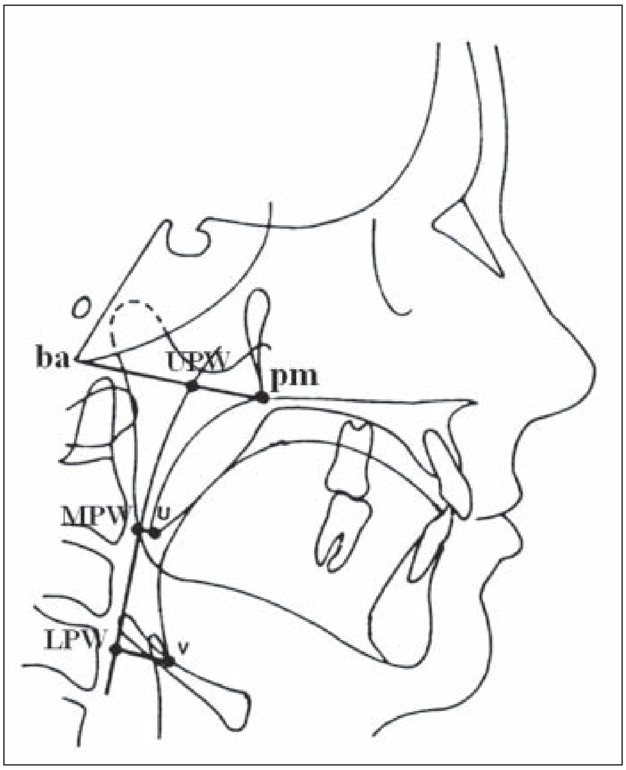

Figure 1. *Uvulo-glossopharyngeal reference points used in this study: pm – pterygomaxillare; ba-basion; UPW – upper pharyngeal wall; U-tip of uvula; MPW – middle pharyngeal wall; V-vallecula; LPW-lower pharyngeal wall.*

CONCLUSION

There is a significant association between craniofacial morphology and pharyngeal airway sagittal dimension in three different levels. Subjects with Class III dentofacial morphology compearing with Class I have increased nasopharyngeal airway sagittal dimension and decreased hypopharyngeal airway sagittal dimension.

After bimaxillary surgery no statistically significant difference between nasopharyngeal and hypopharyngeal airway sagittal measurements was found, but a statistically significant increase after bimaxillary surgery was in nasopharyngeal level.

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