Original Article

Pharyngeal Airway Dimensions in Cleft Lip and Palate Patients Compared With Class I Subjects

Halise Aydemir, DDS, PhD[1,*] and Ufuk Toygar-Memikoğlu, DDS, PhD[2]

ABSTRACT

Objective: The aim of this study was to analyze and compare the pharyngeal airway dimensions of cleft lip and palate (CLP) and skeletal Class I patients.

Materials and Method: The study was carried out in 91 subjects asking for orthodontic treatment in Ankara University, Turkey. The patients were selected from the archives of the Orthodontics Department. Forty-eight of the patients had CLP and 43 were skeletal Class I patients. Both control and CLP groups were divided into 3 subgroups according to the ages 7–11, 11–14, and 15 years and older. The number of subjects was matched in the same age groups. The pretreatment lateral cephalometric head films of the subjects were used in the study. Airway dimensions were evaluated with area measurements using planimeter. The airway was divided into 3 parts, and measurements were done on those areas. SNA, SNB, ANB, and GoGnSN angles were measured in all cephalograms by the same examiner. The values were compared within the same age group in both the CLP and control groups.

Results: For statistical analysis, variance analysis was used. For control and cleft groups, there were no statistically significant differences in pharyngeal airway and skeletal measurements.

Conclusion: Our findings indicate that CLP patients have similar airway area measurements with normal Class I subjects, which might be attributed to adaptation in the pharyngeal area of CLP patients. (*Turkish J Orthod* 2014;27:46–50)

KEY WORDS: Airway, Cleft lip and palate, Lateral cephalometric films

INTRODUCTION

Facial growth is disturbed in patients with cleft lip and palate (CLP). Patients with surgically treated cleft lip and palate have reduced sagittal maxillary and mandibular development and larger vertical dimensions.[1,2] These differences in development can be due to management of cleft, functional changes, genetic patterns, or a combination of these factors.[3]

It has been reported that CLP patients have a reduced nasal airway compared with normal subjects[4]; therefore, the airway is impaired and mouth breathing is common. CLP patients might have different characteristics in the upper airway. There are similarities in the reduced sagittal maxillary and mandibular development, larger vertical dimensions between cleft patients suffering from nasal airway obstruction,[5,6] and patients with obstructive sleep apnea (OSA).[7] According to Oosterkamp *et al*.[8] craniofacial, craniocervical, and pharyngeal morphology of patients with OSA and bilateral cleft lip and palate (BCLP) demonstrate similarities. More retrognathic mandible in patients with BCLP leads more retruded position of the tongue and reduction of the pharynx size.[9]

Even with early primary repair of the cleft palate, secondary surgical procedures can be necessary to correct the velopharyngeal insufficiency in 5% to 70% of the patients.[8,10,11] Secondary procedures for velopharyngeal inadequacy can increase nasal airway resistance,[12] decrease airway size,[13] and increase the prevalence of mouth breathing.[14] The risk of sleep-disordered breathing increases in CLP patients because of the dysfunction of muscles controlling the soft palate and structural abnormal-

[1]Assistant Professor, Orthodontist, Turgut Özal University Oral and Dental Health Care Center, Ankara, Turkey

[2]Professor, Ankara University, Faculty of Dentistry, Department of Orthodontics, Ankara, Turkey

***Corresponding author:** Halise Aydemir, Turgut Özal University Oral and Dental Health Care Center, Ankara, Turkey. Alparslan Türkeş caddesi no: 57 Emek / Ankara / Turkey. Tel: +90-312-203 5352. E-mail: hsbolatoglu@yahoo.com

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Table 1. The distribution of patients with respect to age and group

Age, y	Cleft Lip and Palate	Control	Total
7–11	13	8	21
11–15	16	20	36
15+	19	15	34
Total	48	43	91

ities of the maxilla and mandible.[15] In some instances, pharyngeal flaps may even result in sleep apnea, especially in children.[12,16]

Airway anatomy and function differ between children and adults. Growth of the craniofacial skeleton and development of the respiratory neuromuscular system are affected by deformity of the cleft palate. A more mature respiratory neuromuscular system in older patients theoretically makes them less predisposed to moderate to severe upper airway obstruction during sleep when compared with younger patients.[17]

According to the literature, CLP patients have a smaller upper airway.[8,15,18] However, there are very few studies concerning the pharyngeal upper airway between CLP and control groups.[8,19] The purpose of this study was to analyze and compare the 2-dimensional size of the pharyngeal airway of CLP and control groups and demonstrate a relationship between the size/growth differences in the maxilla and mandible and changes in the pharyngeal anatomy/volume between the CLP and control groups.

MATERIALS AND METHOD

Subjects

The pretreatment radiographs of the subjects were selected from the archives of the Department of Orthodontics at the University of Ankara, Faculty of Dentistry. The patient radiographs were selected among those who applied for orthodontic therapy between 1998 and 2006. The CLP group consisted of 48 cleft palate patients, either unilateral right or left or bilateral complete cleft palate with cleft lip. All of the CLP patients were nonsyndromic and did not have bone-grafting in the past. The inclusion criteria for the groups included good quality lateral cephalograms taken from patients after swallowing. The exclusion criteria included previous orthodontic or orthognathic surgery, OSA, and craniofacial anomalies except from a repaired cleft palate. The group was divided into 3 subgroups according to age. The first group consisted of patients between 7 and 11 years of age, the second group between 11 and 15,

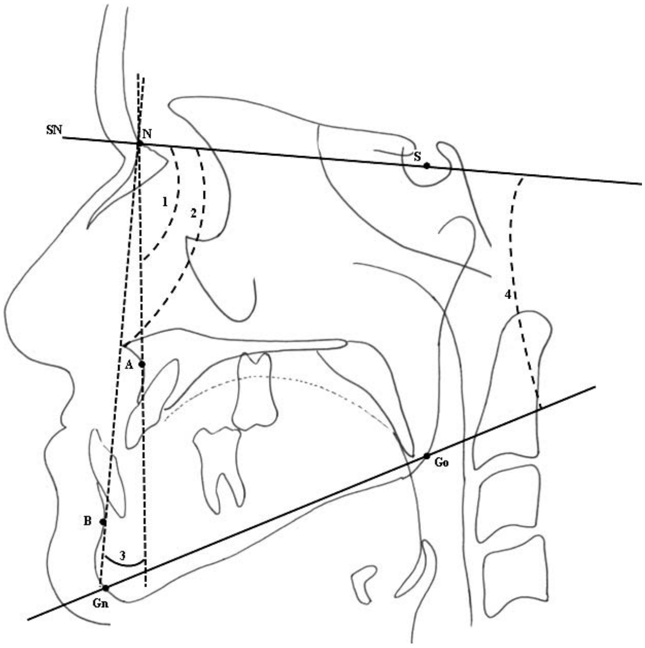

Figure 1. Skeletal measurements. (1) SNA. (2) SNB. (3) ANB. (4) GoGnSN.

Table 2. The mean values, standard deviation of the means of the variables, and comparison of the groups at each subgroup*

	Age Group 7–11			Age Group 11–15		
	Cleft	Control	*p*	Cleft	Control	*p*
SNA	79.36 ± 4.30	80.08 ± 13.04	0.85	78.98 ± 4.64	79.72 ± 5.31	0.63
SNB	78.03 ± 3.29	80.51 ± 13.15	0.52	76.16 ± 4.61	77.12 ± 4.72	0.92
ANB	1.32 ± 2.60	0.40 ± 4.53	0.27	2.72 ± 3.22	2.60 ± 3.98	0.43
GoGnSN	33.57 ± 4.61	32.37 ± 10.00	0.71	36.19 ± 5.22	35.63 ± 5.68	0.76
Nasopharynx	213.20 ± 109.20	224.40 ± 112.50	0.82	198.43 ± 82.47	200.50 ± 92.86	0.95
Oropharynx	301.10 ± 121.00	304.40 ± 90.30	0.95	294.56 ± 91.59	296.00 ± 79.41	0.96
Hypopharynx	312.50 ± 110.90	251.20 ± 102.50	0.22	250.30 ± 93.30	262.90 ± 107.3	0.71

* no *p* values shown are significant.

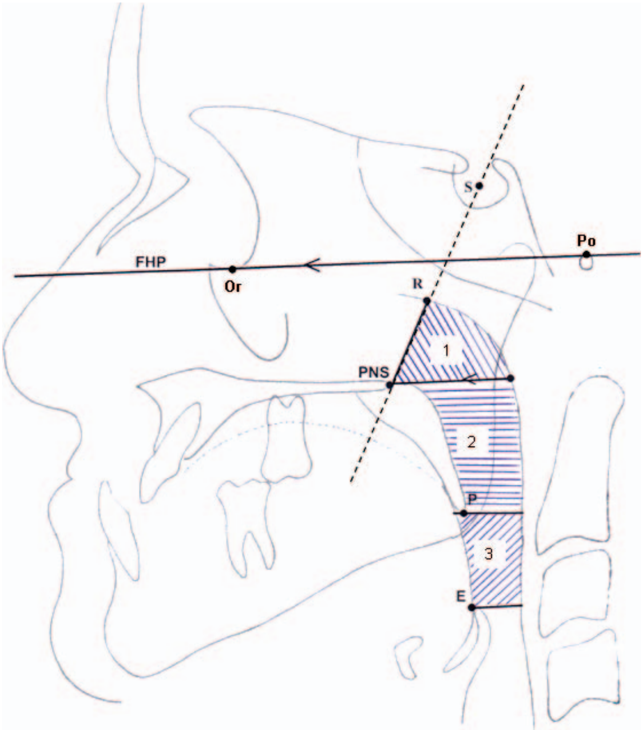

Figure 2. Pharyngeal area measurements. (1) Nasopharynx. (2) Oropharynx. (3) Hypopharynx.

and the third group included patients 15 years of age and older.

The control group consisted of 43 skeletal and Class I subjects. The exclusion criteria for the control group included previous orthodontic and orthognathic surgery, OSA, and craniofacial anomalies. The CLP group was matched with the control group according to age. The distribution of subjects according to the groups is shown in Table 1.

Ethical committee approval was received from Ankara University, Faculty of Dentistry, and patient consent from each patient was received for the study.

Table 2. Extended

Age Group 15+		
Cleft	**Control**	***p***
75.14 ± 20.13	80.90 ± 13.82	0.35
71.06 ± 18.34	78.03 ± 11.60	0.21
4.08 ± 4.20	2.87 ± 5.83	0.49
33.01 ± 4.37	34.37 ± 13.11	0.65
151.96 ± 92.84	162.11 ± 94.62	0.76
255.00 ± 70.60	269.79 ± 71.95	0.55
249.60 ± 83.20	304.90 ± 155.30	0.19

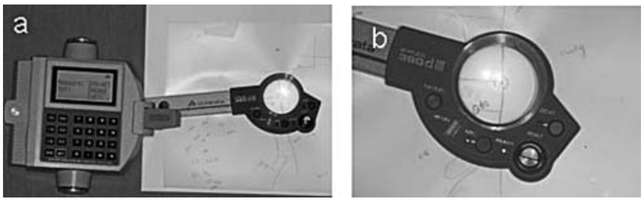

Figure 3. (a) Digital planimeter. (b) Measurement of the areas using digital planimeter.

Radiographs

The lateral cephalometric radiographs were taken by the same technician on the same machine. Cephalograms were obtained under standardized conditions in natural head position with the mandible in centric relation; patients were informed not to swallow during radiography.

Lateral cephalograms were traced by one examiner, and cephalometric reference points were determined by using acetate paper. The skeletal landmarks were digitized and calculated with the help of the PorDios (Purpose on Request Digitizer Input Output System, trademark of the Institute of Orthodontic Computer Science, Aarhus, Denmark) program. Four main skeletal measurements were used (Fig. 1). The pharyngeal airway area measurements were chosen similar to the investigations done before (Fig. 2).[20] Pharyngeal area measurements were made on the acetate paper by using planimeter (Ushikata X-Plan380dIII/460dIII, Tokyo, Japan) (Fig. 3).

Reliability

Cephalometric landmarks of the radiographs were digitized twice, and area measurements were repeated 3 times by the same investigator. The average values of 3 pharyngeal measurements were calculated to eliminate the errors in measurements.

Statistical Analysis

The statistical analysis of the study was performed by using variance analysis. The mean value and standard deviation of the parameters were calculated. Variance analysis was used to compare the measurements between the subgroups in the CLP and control groups.

RESULTS

There was no statistically significant difference in SNA, SNB, ANB, and GoGnSN measurements between the CLP and control groups (Table 2). Also, there was no statistically significant difference in nasopharyngeal, oropharyngeal, and hypopharyngeal areas between the age-matched CLP and control groups.

DISCUSSION

We used lateral cephalograms in our study and evaluated posterior pharyngeal airway space in area measurements using planimeter. According to Riley and Powell,[21] PAS (pharyngeal airway space) measured by cephalograms was highly correlated with measurements using a 3-dimensional computed tomography scan with considerably high accuracy in predictability.

The upper airway of children has specific characteristics that differ from those of adults. Children have a relatively large tongue, a high larynx, a relatively large epiglottis, bulging arytenoid cartilage, and a soft trachea—all factors explaining why minor changes in the airway dimensions yield respiratory consequences.

There is a marked age-dependent difference in upper airway length in growing children.[22,23] Especially with puberty with the help hormones, a change in pharyngeal airway occurs.[23] Therefore, we used 3 subgroups: prepubertal, pubertal, and postpubertal.

Studies performed up to now usually evaluated nasopharyngeal area, nasopharyngeal airway flow, and resistance[24–26] and found restriction of the nasopharyngeal area and increase in nasopharyngeal airway resistance. There are also studies evaluating the change in the pharyngeal area after palatoplasty in CLP patients.[27–29] However, there are very few studies concerning nasopharyngeal, oropharyngeal, and hypopharyngeal areas in CLP and control groups.[8,19]

Oosterkamp *et al*.[8] evaluated pharyngeal airway 2-dimensionally with linear measurements in adults with OSA and BCLP and control subjects and found similar craniofacial, craniocervical, and pharyngeal morphology except for a significantly more retrusive maxilla in the BCLP group. Yoshihara *et al*.[19] studied pharyngeal airway 3-dimensionally among age-matched groups of CLP patients and controls. They showed no significant difference in total pharyngeal airway between CLP patients and control groups, though bimaxillary retrusion was detected in the CLP group. In our study, there was no significant difference between these 2 groups in oropharyngeal, nasopharyngeal, and hypopharyngeal airway areas.

In CLP patients, morphologic anatomic alterations mostly occur at the pharyngeal area. Those anatomic alterations can self-correct because of structural changes within the upper airway, like the change in orientation of the pharynx, with growth to more horizontal to the more vertical type.[30] The more vertical type of growth can explain the adaptation of the airway for breathing and similar airway areas (mm^2) between the CLP and control groups.

Although SNA and SNB measurements were higher in control subgroups, no significant differences were detected in any skeletal variable between the CLP group and controls. In our study, there was no significant difference in maxillary and mandibular growth between the 2 groups. Moreover, there was no decrease in the nasopharyngeal, oropharyngeal, and hypopharyngeal airway when compared with the age-matched control groups. In fact, this was not the result we had expected. The skeletal result is perhaps because of mixed cleft palate population and not allocating to subgroups according to cleft type. Furthermore, in the CLP group, there were skeletal Class II patients, thus affecting the statistical results. In our opinion, the insignificance in pharyngeal parameters is due to an adaptation of the pharyngeal airway as we detected more longitudinal growth when tracing the pharyngeal area in CLP patients. This is a pilot study evaluating the pharyngeal airway between CLP and Class I patients. Thus, further investigation is needed to evaluate the pharyngeal airway with more patients and divided subgroups of CLP patients.

CONCLUSIONS

There was no statistically significant difference at skeletal and pharyngeal area values between the CLP and control groups. According to our study, CLP patients do not have a risk for airway obstruction when compared with controls. However, further investigations are necessary to highlight the effect of cleft on the pharyngeal airway.

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