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Cephalometric Analysis of Upper Airways in Adults with Class II Malocclusion in Qazvin

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Abstract

Background: Unusual enlargement of nasopharynx can disrupt air flow through the nose. The aim of this study was to investigate the cephalometric parameters in the upper airways.

Methods: This retrospective descriptive study was conducted on 32 adults with Class II malocclusion without the history of night apnea in Qazvin. The radiographs were obtained from the archives in Qazvin Orthodontics Department and private clinics. The selected radiographs were entered into the computer and measured by two observers using Foxit reader version 3. Then, according to the criteria in the Lieberg analysis, the average size of the variables related to the upper airways was determined as the final size. Coefficient of variations and Pearson correlation were calculated in SPSS.

Results: There was a significant positive correlation between tongue length and height and soft palate length and also between tongue length and vertical position of the vallecula (P<0.01). But there was a significant negative correlation between nasopharyngeal air space and hypopharyngeal air space, vertical and horizontal position of vallecula (P<0.01). Nasopharyngeal air space showed a significant positive correlation with posterior air space but a negative correlation with soft palate length (P<0.001). There was also a significant positive correlation between soft palate length and maximum thickness of soft palate, while the length of contact between the dorsal surface of the tongue and soft palate showed a significant negative correlation with vertical position of the vallecula (P<0.004).

Conclusion: Cephalometric parameters of upper airways were not significantly different in adults with CLII malocclusion in Qazvin.

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Introduction

Malocclusion refers to the abnormal position of the teeth or the jaws, and is a deviation from growth and development that affects teeth mating, ability to clean teeth, gum health, intellectual development, and learning to speak (1). Genetic and environment are the main risk factors for malocclusion. The shape and size of face, jaw, and teeth are often transmitted genetically. There are many environmental factors causing malocclusion such as dental caries or early loss of teeth in children, which most of them can be controlled by the pediatric dentist. The main environmental factors include habits such as mouth breathing, thumb-sucking, nail biting, and lip biting (1,2).

The pharyngeal upper airspaces include nasopharynx, oropharynx, and hypopharynx, which are effectively involved in breathing and swallowing. Since there is a close and reciprocal relationship between pharyngeal structures and faciodental structures, breathing and swallowing can endanger the stability results (1). There are several methods for studying the physiological structure and function of the upper airway (2-6). Cephalometry has a great importance in the attitude, vision, and perspectives toward the process of skull growth. Moreover, through cephalometry, the process of development of current and future abnormalities can be evaluated and its results determine the preventive and therapeutic methods (7).

Cephalometric analysis provides important information about the soft and hard tissues of the upper airway (8,9). The study of pharyngeal structures plays a significant role in diagnosis and treatment design of orthodontic problems and there is a relationship between pharyngeal structures and faciodental patterns (1) but the depth of these spaces in CL I and CL II malocclusion and vertical malformations have not been studied. Therefore, a study on different depth of the upper airways in Iranian subjects with various types of malocclusion (CL I, II, III) using standard lateral cephalograms is recommended (10).

Evaluation of the adenoid showed a significant correlation between posterior rhinoscopy and cephalometry results. Cephalometry also provides a good image for the size of the nasopharyngeal airway in children of all ages (11).

Craniofacial morphology and occlusal patterns are affected by several factors. Since the beginning of the last century, the relative occlusion of upper airways and its effects on craniofacial evolution and dental patterns have been studied. Several clinical studies have indicated the relationship between mouth breathing and development of skeletal and dental malocclusion. It is believed that proper nose breathing actually indicates the enough efficacy of nasopharyngeal and nasopharynx function. Abnormal size of structures in these anatomical regions, such as adenoid in the nasopharynx and turbinates of nasal cavities, can cause nasal airflow disruption. The blockage makes people to breathe through the mouth. In these cases, the moth breathing requirements cause postural conformations of the head and neck structures, which accordingly affect occlusion development and the relationship between the upper and lower jaws (12). According to the above mentioned results and since no study has been evaluated the cephalometric parameters of the upper airways, we decided to perform this study.

Many researchers use cephalometric radiographs to study the airways in craniofacial syndromes, obstructive sleep apnea (OSA), postoperative follow-up of orthopaedic patients, and other dentofacial disorders. Understanding the relationship between the volume of upper airways and various malocclusions can be helpful in managing OSA and finding whether individuals with different malocclusions have the potential to develop this syndrome (12).

Since limited studies have been performed in the field of cephalometric analysis of upper airways in the world and also in Iran, and there is no evidence for the volume of upper airways in CL II malocclusion in Iran, the present study was performed.

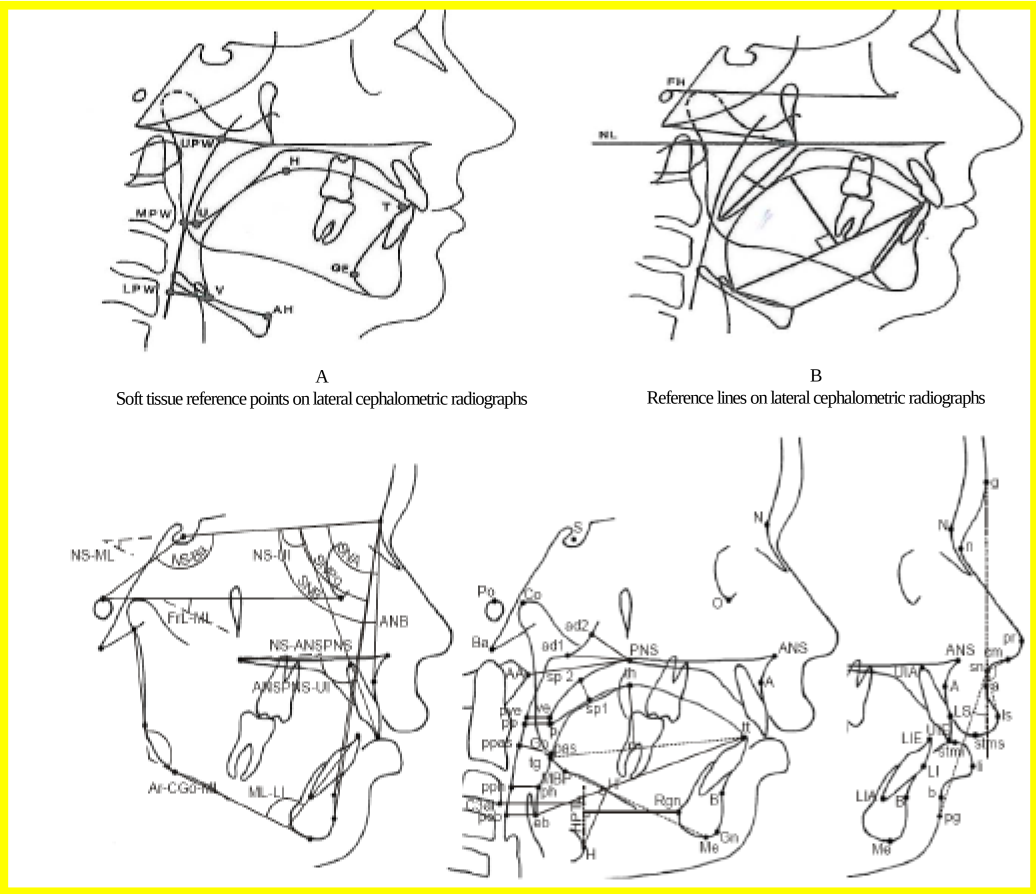
Lyberg et al., (1989) in their cephalometric analysis in patients with obstructive sleep apnea syndrome, found that soft palate length in the patients was significantly longer than that in the control group. Pharyngeal air space was significantly reduced in the anterior posterior aspect of the nasopharyngeal and velogopharyngeal surfaces. The lower surface of tongue was placed in a lower position in the patients (13). In the etiology of malocclusion, the involvement of genetic and environmental factors is mentioned. Respiratory disorders and airflow decrease in nasopharynx as one of the etiologic factors of malocclusion have been studied. Kachoei et al., (2010) studied the features of occlusion in preschool children with oral respiratory problems in Tabriz (14).

The research was a descriptive-analytical and cross-sectional one. In the mentioned study, 64 preschool children selected from five districts of Tabriz were divided into two groups (case and control). The molding was carried out for the participants and the casts of molding were measured. Data obtained from the casts and clinical examinations including arc form, symmetry, width between molar and canine, overjet and overbite, midline, molar ratio and cross existence were analyzed. Although there was evidence of increased malocclusion in the case group, none of the occlusion parameters in the case and control groups were significantly different. The findings of this study showed that the effect of mouth breathing on occlusion properties in childhood is not significant. It has been suggested that the duration and severity of nasal obstruction or airway can contribute to malocclusion (15).

Nunes and Di Francesco performed a study on 114 children (aged 3-12 years) in the ambulatory area of Brazil to investigate the relationship between the type of teeth occlusion and the type of lymphatic tissue blockage in the pharynx and reported the separate enlargement of the third tonsil in 21.9% of the children, the separate enlargement of the palatine tonsils in 7%, and the tonsils and non-obstructive adenoid, in 6.1% of the children. In all types of pharyngeal obstruction, high prevalence of posterior crossbite (36.8%) was reported. There was a significant correlation between sagittal occlusion and lymph node obstruction (P=0.02). A higher percentage of class II occlusion (45.2%) was diagnosed in the group with nasal congestion and obstructive tonsillar enlargement. There was also a significant relationship between separate tonsillar enlargement (37.5%) and class II malacclusion (16).

Materials and Methods

The sample size was estimated about 61. Among all 50 digital lateral cephalometric radiographs of the patients which were extracted from the archives of Department of Orthodontics, School of Dentistry, Qazvin University of Medical Sciences and private clinics, 35 ones had a cephalometric profile of CL II malocclusion. In this study, 3 people were excluded from the statistical population due to sleep apnea based on the self-declarations of the patients. The radiographs were entered into the computer and measured by the observer using Foxit reader version 3, and then the average size of the variables related to the upper airspace was determined as the final size according to the criteria in the Lyberg analysis (Fig 1) (13).



A
Soft tissue reference points on lateral cephalometric radiographs

B
Reference lines on lateral cephalometric radiographs

Figure 1. Points and angles used in cephalometric measurements (13)

Data were collected and analyzed using descriptive statistics (mean, standard deviation and domain). To calculate the correlation between quantitative traits, Pearson correlation was used. To determine the significant difference in variables between the two groups, the within-subjects t-test was used. Also, to test the reliability of the measurements and to match the results, the paired t-test was used. In order to investigate the intensity of changes in the cephalometric traits, the coefficient of variation was used as follows:

$$CV\% = \frac{S}{\overline{X}} \times 100$$

in which CV is the coefficient of variation, S is the standard deviation and $\overline{X}$ is the average of the trait. For convenience and accuracy in statistical analysis, SPSS18 was used.

Results

Mean age of the patients was 22.67 ± 3.97 years and the most frequent age range was 18-21 years (26%). Mean tongue length (the distance between points V and T) was 62.68±6.9 mm (ranged from 78.55 to 45.61 mm). The coefficient variation of tongue length was 11%, which was significant at level of α=0.01. Mean height of tongue (the perpendicular distance from point H to the line between the points V and T) was 26.2±3.97 mm (ranged from 35.29 to 16.57 mm). The coefficient variation of tongue height was 15.1%, which was significant at level of α= 0.01.

The mean of nasopharyngeal air space (distance between pm and upw) was 20.73±3.99 mm (ranged from 26.69 to 10.16 mm). The coefficient variation of nasopharyngeal air space was 19.28%, which was significant at level of α= 0.01. Mean oropharyngeal air space (distance from u to mpw) was 47.8±2.37 mm (15.68 to 4.03 mm). The coefficient variation of oropharyngeal airspace was 28.16%, which was significant at level of α= 0.01.

Mean hypopharyngeal air space (distance from v to lpw) was 11.3±11 mm (ranged from 25.5 to 3.6 mm). The coefficient variation of the hypopharyngeal airspace was 39.8%, which was significant at level of α=0.05. Mean posterior airspace (the lowest distance between the vallecula and posterior wall of the pharynx (PAS min) was 8.12 ± 2.9 mm (ranged from 15.06 to 2.75 mm). The coefficient variation of posterior airspace was 35.9%, which was significant at level of α=0.01. Mean length of soft palate (distance between points pm and u) was 33.44 ± 6.07 mm (48.05 to 18.45 mm).The coefficient variation of soft palate was 18.17%, which was significant at level of α=0.01. Mean thickness of soft palate (perpendicular to pm line) was 8.12 ± 1.4 mm (4.83 to 11.89 mm). The coefficient variation of soft palate thickness was 17.58%, which was significant at level of α=0.01. Mean length of contact between the dorsal surfaces of the tongue and soft palate was 11.65 ± 5.5 mm (27.14 to 0 mm). The coefficient variation of contact between dorsal surface of the tongue and soft palate was 47.4%, which was significant at level of α=0.05. Mean perpendicular location of the vallecula (perpendicular distance from points V to FH) was 70.14 ± 7.42 mm (86.36 to 52.48 mm).

The coefficient variation of vertical position of vallecula was 10.57%, which was significant at level of α=0.01. Mean horizontal position of vallecula (the distance from V to the cervical vertebrae parallel with FH) was 16.14 ± 5.47 mm (34 to 6.78 mm). The coefficient variation of the horizontal position of vallecula was 33.9%, which was significant at level of α=0.01 (Figures 2 and 3).

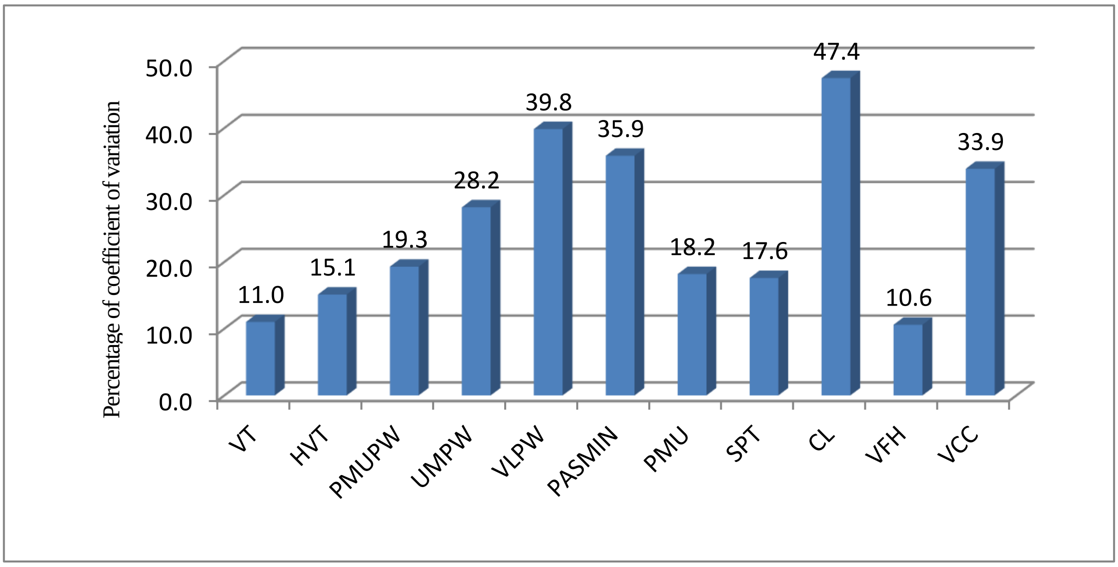


Figure2. Percentage of coefficient of variation of the results obtained from cephalometric measurements of the upper airways in the subjects

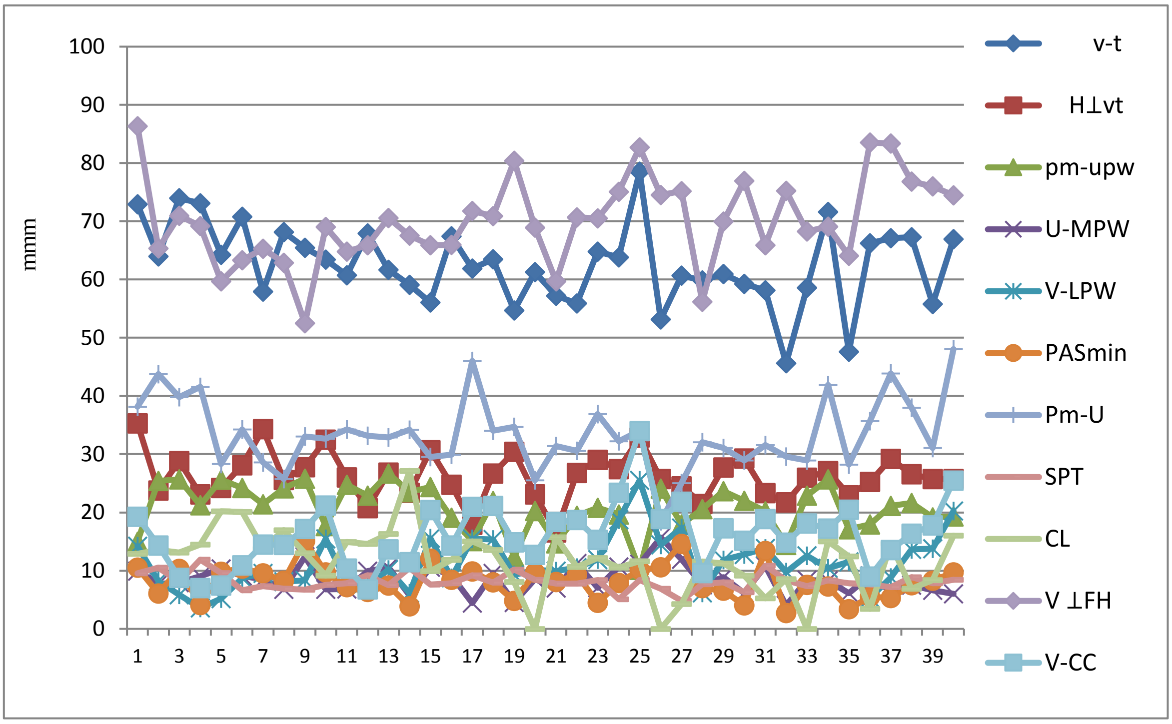


Figure3. The rate of changes obtained from cephalometric measurements of upper airways in the subjects

The estimates of Pearson correlation coefficient between the traits are shown in Table 1. Tongue length had significant positive correlation with tongue height (P=0.05) and soft palate length (P=0.001). The correlation coefficient between tongue length and tongue height (30.1%) and the correlation between tongue length and soft palate length (50.3%) were determined. This means that greater tongue height and soft palate length is associated with greater tongue length. However, there was no significant correlation between tongue length and other traits. The tongue height had a significant positive correlation with vertical position of vallecula (r=39.9%, P=0.011). This means that increase of vertical position of vallecula is associated with greater tongue height. However, there was no significant correlation between tongue height and other traits.

Table 1. Pearson correlation matrix between the evaluated traits in upper airways in the subjects

		VT	HVT	PMUPW	UMPW	VLPW	PASMIN	PMU	SPT	CL	VFH	VCC
VT	**Correlation**	1	0.301*	0.130	0.187	0.028	0.207	0.503**	0.122	0.295	0.153	-0.040
	P-value		0.050	0.425	0.248	0.865	0.200	0.001	0.454	0.064	0.345	0.808
HVT	**Correlation**	0.301*	1	0.002	0.187	0.301	0.185	0.007	-0.193	-0.060	0.399*	0.268
	P-value	0.050		0.991	0.249	0.059	0.253	0.965	0.233	0.713	0.011	0.094
PMUPW	**Correlation**	0.130	0.002	1	0.286	-0.441**	0.101	-0.047	-0.089	0.237	-0.486**	-0.492**
	P-value	0.425	0.991		0.073	0.004	0.536	0.775	0.584	0.140	0.001	0.001
UMPW	**Correlation**	0.187	0.187	0.286	1	0.179	0.612**	-0.419**	-0.251	-0.276	-0.086	0.153
	P-value	0.248	0.249	0.073		0.269	0.000	0.007	0.118	0.084	0.597	0.347
VLPW	**Correlation**	0.028	0.301	-0.441**	0.179	1	0.363*	-0.014	-0.297	-0.288	0.420**	0.936**
	P-value	0.865	0.059	0.004	0.269		0.021	0.932	0.063	0.071	0.007	0.000
PASMIN	**Correlation**	0.207	0.185	0.101	0.612**	0.363*	1	-0.185	-0.278	-0.183	-0.202	0.351*
	P-value	0.200	0.253	0.536	0.000	0.021		0.252	0.083	0.260	0.210	0.026
PMU	**Correlation**	0.503**	0.007	-0.047	-0.419**	-0.014	-0.185	1	0.428**	0.405**	0.228	-0.012
	P-value	0.001	0.965	0.775	0.007	0.932	0.252		0.006	.010	0.158	0.940
SPT	**Correlation**	0.122	-0.193	-0.089	-0.251	-0.297	-0.278	0.428**	1	0.240	-0.002	-0.268
	P-value	0.454	0.233	0.584	0.118	0.063	0.083	0.006		0.135	0.989	0.095
CL	**Correlation**	0.295	-0.060	0.237	-0.276	-0.288	-0.183	0.405**	0.240	1	-0.323*	-0.224
	P-value	0.064	0.713	0.140	0.084	0.071	0.260	0.010	0.135		0.042	0.164
VFH	**Correlation**	0.153	0.399*	-0.486**	-0.086	0.420**	-0.202	0.228	-0.002	-0.323*	1	0.313*
	P-value	0.345	0.011	.001	0.597	0.007	0.210	0.158	0.989	0.042		0.049
VCC	**Correlation**	-0.040	0.268	-0.492**	0.153	0.936**	0.351*	-0.012	-0.268	-0.224	0.313*	1
	P-value	0.808	0.094	0.001	0.347	0.000	0.026	0.940	0.095	0.164	0.049	

* Statistically significant at level of 0.01
**Statistically significant at level of 0.05

Nasopharyngeal airspace showed a significant negative correlation with hypopharyngeal airspace (r=−44.1%, P=0.04), vertical position of vallecula (r=−48.6%, P=0.001) and parallel orientation of the tongue base (r=−49.2, P=0.001). In other words, increase of hypopharyngeal airspace, vertical position of vallecula and horizontal position of vallecula is associated with nasopharyngeal airspace decrease. Nasopharyngeal airspace showed a significant positive correlation with posterior airspace (r=−61.2%, P=0.0005) but a significant negative correlation with soft palate length (r=−41.9%, P=0.007). This means that greater posterior airspace and smaller soft palate length are associated with greater nasopharyngeal airspace.

Hypopharyngeal airspace showed a significant positive correlation with posterior airspace (r=36.3%, P=0.021), vertical position of vallecula (r=42%, P=0.007) and horizontal position of vallecula (r-93.6%, P=0.0001). This means that increase of posterior airspace, vertical position of vallecula and horizontal position of vallecula is associated with greater hypopharyngeal air space. The posterior air space showed a significant positive correlation with horizontal position of vallecula (r=35.1%, P=0.026). In other words, greater posterior airspace is associated with increase in horizontal position of vallecula.

The soft palate length showed a significant positive correlation with maximum thickness of soft palate (r=42.8%, P=0.006), and the contact length between dorsal surface of the tongue and soft palate (r=40.5%, P=0.01). This means that increase of maximum thickness of the soft palate and the length of contact between the dorsal surface of the tongue and soft palate is associated with increase of soft palate length. The length of contact between dorsal surface of the tongue and soft palate showed a significant negative correlation with vertical position of vallecula (r=−32.3%, P=0.042). The correlation was 32.3% (P=0.042). That is, increase of vertical position of vallecula is associated with reduction of the length of contact between dorsal surface of the tongue and soft palate. However, vertical position of vallecula showed a significant positive correlation with horizontal position of vallecula (r=31.3%, P=0.049). This means that increase of vertical position of vallecula is associated with increase of horizontal position of vallecula.

Discussion

In this study, mean hypopharyngeal airspace was 11.3 ± 4.5 mm (r=39.8%) which is similar to the results of Martin et al study (2006) in which mean of hypopharyngeal airspace was 11.6 ± 3.3% mm (17). The only difference between these two studies is related to the amount of coefficient variation, because the coefficient variation of the hypopharyngeal airspace in the present study (r=39.8%) was larger than that in the study of Martin et al (28.4%). This difference shows high degree of variation of this parameter in the population studied in Qazvin.

In this study, mean oropharyngeal airspace was 8.47 ± 2.37 mm (r=28.16%). While in the study of Martin et al, it was 17.3 ± 3.9 mm (r=23.5%), which is not consistent with the results of this study. This inconsistency indicates a large difference in this trait between these two studies. However, the coefficient of variation in these two studies was roughly the same, indicating similar variation in the two studied populations.

Mean tongue length was 62.68 ± 6.9 mm (r=11%). In the study of Shen et al performed on Chinese population, mean of tongue length was 72.1 ± 4.1 mm (r= 5.5%)(18), which is significantly longer than that of the samples in Qazvin. However, in terms of coefficient of variation, there is no significant difference between the results of two studies, which indicates the low variation of this trait in the two studied populations.

In this study, the tongue height was 26.2 ± 3.97 mm (r= 15.1%). In the study of Shen et al, it was 36.9 ± 3.3 mm. The coefficient of variation in the mentioned study was 8.9%, which is lower than that in the present study. Therefore, the results of the mentioned study are not consistent with the present study. On the other hand, the degree of variation in the population studied in this study is higher than that in Shen et al study. Also, in terms of oropharyngeal airspace and posterior airspace, the difference between the results of these two studies was not significant, and therefore, the results are consistent (18).

In the present study, hypopharyngeal air space (VLPW) and the length of contact between the dorsal surface of the tongue and soft palate (CL) were 39.83% and 47.43%, respectively. However, the difference in variables between the patients was not significant. It can be concluded that changes in the upper airways in the patients were probably due to these two parameters. Because, these two parameters are influenced more by different environmental conditions and genetic variations.. These results are consistent with those of Freitas et al study. They concluded that upper airway in patients with CL I and II malocclusion and patients with different vertical growth pattern, is significantly narrower than those with Class I and II malocclusion who have normal growth pattern. But, malocclusion has no effect on the upper airway. And malocclusion and growth pattern have no effect on the pharyngeal lower airway (15).

Nasopharyngeal airspace showed a significant positive correlation with posterior airspace but a significant negative correlation with soft palate length. This means that by increasing nasopharyngeal air space, the posterior airspace also increases, but the soft palate length decreases. The hypopharyngeal airspace showed a significant positive correlation with posterior airspace, vertical and horizontal position of vallecula. This means that by increasing each of the parameters, the hypopharyngeal airspace also increases, which is consistent with the results of Freitas et al. study (15).

One of the important findings of the present study is the positive correlation between soft palate length and maximum thickness of soft palate. This means that by increasing or decreasing one of these parameters, the other parameter will increase or decrease. Another important point is that maximum thickness of soft palate showed no significant correlation with other parameters of the upper airway. Therefore, this parameter will be independent of changes in other parameters. For this reason, this parameter can be analyzed independently of other parameters. These results are obviously consistent with the findings of Martin et al study (17).

Kachoei et al (2010), in their study on the relationship between primary occlusion characteristics and mouth breathing in pre-school children in Tabriz, found that the effect of mouth breathing on the occlusion characteristics in childhood ages is not significant; therefore, the duration and severity of obstruction of nose or airways are suggested to have effect on the incidence of malocclusion. They suggested genetic factors and race specificity as the most important factors in this case, which has a close relationship with environmental factors. They concluded that the lack of difference in the airways between the subjects is attributed mostly to the genetic factors rather than environmental factors (14) which is consistent with the results of this study.

Takemoto et al., (2011) in their study on pharyngeal airway in children with prognathism and normal occlusion showed that there is a significant difference between pharyngeal airway width and maxillary prognathisma and normal occlusion (19), which is consistent with the results of this study.

One of the most important problems in the field of epidemiology of malocclusions is comparing the results of different studies. Different statistical methods, sample sizes, and diagnostic criteria are the main issues which reduce the validity of the comparison. EI et al (2011) in their study on nasal passage (NP) and oropharyngeal (OP) airways in patients with Class I, II, II malocclusion and with different dentofacial skeletal patterns, found that OP volume in patients with class II occlusion is significantly different from that in patients with class I and III and was lower than that in other groups. The only statistically significant difference for NP volume was observed between the Class I and Class II groups. The volume of OP in patients with Class II occlusion was smaller when compared with that of the Class I (20). But in this study, no significant difference in airways among the patients with class II malocclusion was observed. In other words, no difference in cephalometric parameters was found between the patients.

Conclusion

Cephalometric parameters of upper airways in adult patients with Class II malocclusion in Qazvin were not significantly different. Among the parameters, hypopharyngeal airway (VLPW) and the length of contact between the dorsal surface of the tongue and soft palate (CL) compared to the other parameters showed high degree of variation. However, these parameters showed no significant difference. The maximum thickness of soft palate, other than soft palate length, showed no significant correlation with other parameters, indicating that the parameter was independent of the other parameters.

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