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ORIGINAL ARTICLE

CBCT Based Comparison of Pharyngeal Airway Area and Volume in patients with Angle's Class I and Class II Malocclusion: A Retrospective Study

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ABSTRACT

Aim: To ascertain if there was any association between dental malocclusion and narrow/constricted pharyngeal airway.
Methods: It was a retrospective study and cross-sectional in design. Oropharyngeal airway volume and regional area for 58 patients having either Class I or Class II Angles malocclusion were evaluated on the CBCT scans.
Results: Oropharyngeal airway volume and area among Angles class I and Class II patients was found to have no statistical difference. There was however statistical difference in the oropharyngeal regional area of male and female patients ($t=2.395$, $p=0.020$) with male patients having greater oropharyngeal regional area than female patients.
Conclusion: In summary, this research concludes that Angles Class I or Class II malocclusion does not influence oropharyngeal airway volume or area. Gender had no impact on the size of airway volume but had significant influence on the oropharyngeal regional area with male patients having greater oropharyngeal area than females.
Keywords: Oropharyngeal airway, CBCT, Class I Malocclusion, Class II Malocclusion

INTRODUCTION

The region from above the plica vocalis to its two apertures i.e. the nose and mouth, is referred to as airway space. The regulation of air and prevention of external irritation are some of the primary functions of the structures present in the airway space[1].

The posterior nasal and oral cavities are connected to the larynx and oesophagus via the pharynx, a tube-like tract in the upper airway[2]. The oropharyngeal airway one of the three regions of the pharyngeal airway is most likely to be impacted by the size and positioning of the tongue[3].

The pharyngeal airway is made up of various anatomic sub-sites which include tonsillar complexes, the soft palate, the base of the tongue, and the pharyngeal wall. A patent airway enhances respiration and is thought to be vital in the growth and development of craniofacial structures. There is increased interest in the evaluation and assessment of pharyngeal airway dimensions in orthodontic patients because of recent medical breakthroughs[1].

Some of the causes of constricted oropharyngeal airway include enlarged size of the neck, retrognathic mandible and maxilla, large adenoids as well as narrow and deep palate[4].

With a constricted airway, occlusion of the airway can occur due to incompetent motor tone of the tongue, airway dilator muscles, and thus, restricts air from passing. This creates repetitive episodes of obstruction leading to periods of deprivation in oxygen for a duration of 10 to 30 seconds or longer, which in turn causes blood oxygen levels to fall down, and heart rate and blood pressure levels to rise. Finally, the brain transmits a warning signal, which partially or completely rouses the individual and prompts the body to breathe, leading patient to gasp for air. This condition is known as Obstructive sleep apnea[5].

Clinically, obstructive sleep apnea (OSA) is characterized by daytime sleepiness, repetitive arousals from sleep, snoring, breathing interruptions, or 5 apneic or hypopneic episodes per hour of sleep.[6]

Although airway restrictions can resolve on their own over time, their impact on dentition, speech, and craniofacial development can have substantial and long-term consequences. The diagnostic tools for assessment of pharyngeal airway include nasopharyngoscopy, Nasal endoscopy, Acoustic rhinometry, Fluoroscopy, Lateral cephalogram, MRI and CBCT[7].

That is why in recent years we have shifted our paradigm towards CBCT as It allows clinicians to examine volumetric regions and cross-sectional areas in numerous planes, including coronal, sagittal, and axial, with regard to the oropharyngeal airway. The use of CBCT scans to quantify the oropharyngeal airway and analyse 3D morphology is a superior alternative for traditional 2D evaluation and allows for exact analysis in all three anatomical planes[1,4]. While the advantages of CBCT are many, clinicians must weigh the risk versus benefits when determining whether it is the best suited imaging modality for individual patient needs.

Due to the close proximity of pharynx and dento-facial structures they can be expected to influence each other.[8]Some studies have shown a correlation between skeletal malocclusion types and difference in dimension and morphology of oropharyngeal airway due to the palate and/or tongue position[9]. However, some researchers provided contradicting conclusions and did not find any relationship between the width or volume of pharynx and malocclusion[10]

This study aimed to ascertain whether there is any correlation between dental malocclusion and narrow/constricted pharyngeal airway It was hypothesized that if dental malocclusion can affect dimensions of oropharyngeal airway space, then pharyngeal airway evaluation can be added as an integral part of orthodontic treatment planning.

MATERIAL AND METHODS

After IRB permission, this study was carried out in the Department of Orthodontics University College of Dentistry Lahore. The study was retrospective, cross-sectional in design. Fifty eight patients were included our research.32 patients were classified as having Angle's Class 1 malocclusion and 26 were identified as having Angle's class 2 malocclusion on basis of dental casts. From April 2019 to January 2021 CBCT scans were acquired from UCD Hospital's available CBCT archive.

Patients were exposed to medium field of view (FOV) 651mm x 651mm CBCT scans. A Planmeca Promax 3D Max CBCT machine was used to record the scans, which had the following parameters 90kV, 5mA, 12.081s, 778.5mGyxcm^2 and 0.2mm slice thickness. CBCT scans were saved as DICOM files and assessed with the help of Romexis software version 6.0.1.812. The inclusion criteria included:

1. Age Range 15-30 years; male and female patients
2. Class 1 molar relationship: "The mesiobuccal cusp of the permanent maxillary first permanent molar tooth occludes with the mesiobuccal groove of the mandibular first permanent molar"[11].
3. Class 2 molar relationship: "The mesiobuccal cusp of the maxillary first permanent molar occludes mesial to the mesiobuccal groove of the mandibular first permanent molar"[11].

A history of mouth breathing, asymmetry of the face, deformities such as cleft lips and palate, previous orthodontic treatment or any trauma was included as part of the exclusion criteria. Planmeca Romexis software version 6.0.1.812 airway extraction tool was used to evaluate and calculate the oropharyngeal airway volume and regional area for all 58 patients on the CBCT scans as shown in Figure 1. The extent of the oropharyngeal airway as measured in the software was limited between the following points. The superior limit: A line parallel to Frankfort Horizontal plane joining PNS point to PPW. The inferior limit: Another line parallel to Frankfort Horizontal plane which extends from

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the most antero-inferior point of the C2 vertebrae to the anterior pharyngeal wall.

Parameters that were measured included oropharyngeal airway volume (mm^3) and regional area for the above mentioned area. IBM SPSS Version 23 was used for analysis. Intergroup comparison was carried out by applying independent sample t test to test for statistical difference of mean values of volume and regional area between two groups. A p-value less than 0.05 was significant.

RESULTS

Fifty eight patients were involved in this research out of which 24 were male and 34 female. The subjects were then placed into two categories on the basis of Angle's Malocclusion as evaluated on study models. 32 patients were identified as having Angle's Class 1 malocclusion (n=32) out of which 12 were male and 20 females. Similarly, 26 patients were found to have Angle's class 2 malocclusion (n=26) with 12 being male and 14 female patients.

Table 1 shows Oropharyngeal airway volume compared among Class I and Class II malocclusion patients. No significant difference in the mean value of oropharyngeal airway volume for class 1(11.71±4.86 cm^3) and class 2 (10.70±6.25 cm^3) patients was found; (t=.688, p=0.495).

As shown in Table 2 the Class I group had a mean total airway area of 492.88±160.65 mm^2 and Class II group had a mean total airway area of only 431.87±143.10 mm^2. Comparison of the regional area between the Class I and Class II malocclusion groups revealed statistically non-significant result; (t=1.509, p = 0.137).

Table 3 shows that when airway volume was compared between Male class I malocclusion group (13.01±5.46 cm^3) and class II malocclusion group (12.07±7.35 cm^3) no statistical significance was found (t=0.355, p=0.726). Male patients with Class I malocclusion had a mean airway area of 579.167±182.15 mm^2 and male class II malocclusion patients had a mean airway area of 463.25±152.83 mm^2; no statistical significance was found between them (t=1.689, =0.105).

Table 4 shows no significant result was found when mean value of oropharyngeal airway volume of female patients with Angle's Class I malocclusion (10.93±4.43 cm^3) and Angle's Class II malocclusion (9.53±5.11cm) were compared; (t=0.847, p=0.403). Furthermore, when oropharyngeal regional area was compared among female Class I (441.10±123.99mm^2) and Class II group (405.00±133.91mm^2) no significant difference was observed (t=0.809, p=0.425).

Oropharyngeal airway dimensions were compared between male and female patients irrespective of their malocclusion type. Comparison of Male (12.54±6.35cm^3) and female (10.35±4.70mm^3) mean values of oropharyngeal volumes revealed no significant difference (t=1.511, p=0.137) as shown in table 5. There was however statistical difference in the oropharyngeal regional area of male (521.21±174.77cm^2) and female (426.24±127.44cm^2) patients (t=2.395, p=0.020).

Table 1: Comparison of oropharyngeal airway volume in Patients with Class 1 and Class 2

	Mean	Std. Deviation	t value	p value
Class I	11.71	4.86	0.688	0.495
Class II	10.71	6.25		

Fig 1 Sagittal view of patients CBCT showing oropharyngeal airway volume and regional area obtained through airway extraction tool in Romexis 6.0.1.812

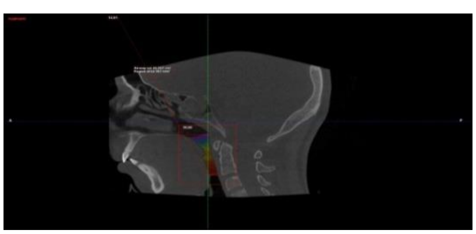

Table 2: Comparison of oropharyngeal airway regional area in patients with Class 1 and Class 2

	Mean	Std. Deviation	t value	p value
Class I	492.88	160.65	1.509	0.137
Class II	431.87	143.1		

Fig 2: Extent of oropharyngeal airway that was measured: pp, palatal plane; 2cv, most antero-inferior point of second cervical vertebrae

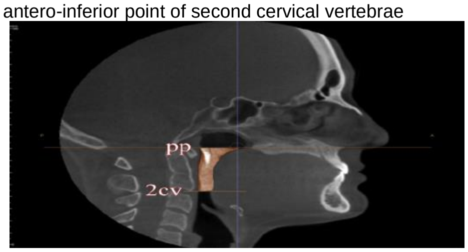

Fig. 2 shows superior and inferior limits of oropharyngeal airway.

Table 3: Comparison of oropharyngeal airway volume and area among male Class 1 and Class 2 patients

		Mean	Std. Deviation	t value	p value
Volume	Class I	13.01	5.46	0.355	0.726
	Class II	12.07	7.35		
Area	Class I	579.17	182.15	1.689	0.105
	Class II	463.25	152.83		

Table 4: Comparison of oropharyngeal airway volume and area among female Class 1 and Class 2 patients

		Mean	Std. Deviation	t value	P value
Volume	class I	10.93	4.43	0.847	0.403
	class II	9.53	5.11		
Area	class I	441.1	123.99	0.809	0.425
	class II	405	133.91		

Table 5: Comparison of oropharyngeal airway volume and area among male and female patients

		N	Mean	Std. Deviation	t value	p value
Volume	Male	24	12.54	6.35	1.511	0.137
	Female	34	10.35	4.7		
Area	Male	24	521.21	174.77	2.395	0.02
	Female	34	426.24	127.44		

DISCUSSION

Various tools can be used for oropharyngeal airway assessment which include conventional radiology, nasal endoscopy, 3D CT & CBCT, as well as MRI. 3D images allow for a more precise analysis. CBCT provides us with accurate dimensional measurements as well as gives information of depth of airway[12].

The assessment of the airway and its relation with various soft tissue profiles, skeletal malocclusion, age, and gender-related changes have been conducted and mentioned in various studies[13,14].

In literature one can find many studies which have discussed about the effects of skeletal malocclusion and craniofacial morphology on the dimensions of pharyngeal airway[1,15,16]. Very little evidence is found in the literature whether there is any correlation between Angle's malocclusion with Pharyngeal airway volume and regional area.

According to our results Angle's Class I or Class II malocclusion has no significant influence on the oropharyngeal airway area or volume which is in agreement with the findings of Alves and Zhao who sated that most of the airway dimensions measurement had no relation with the type of malocclusion[17].

Our results also corroborate the findings of de Freitas et although reported that "Although Class I and Class II malocclusions patients with vertical growth patterns have significantly narrower upper pharyngeal airways than those with normal growth patterns; malocclusion type does not influence upper pharyngeal airway width, and malocclusion type and growth pattern do not influence lower pharyngeal airway width"[18].

Results of the currents study are however in contradiction to the results of Li et al & Alhammadi et al who stated that Class II malocclusion patients appeared to have constricted pharyngeal airway on CBCT[19,20].

Our findings contradict the results of Lucas et al who reported that there was bigger volume for the class I patients as compared to class II (p<0.05)[21].

Variation in results may be due to the change in positioning of mandible or vertical dimensions of face as the current study focused solely on dental aspects of malocclusion and did not take into account any skeletal malocclusion of vertical dimension factor.

In our research, comparison was made of the oropharyngeal airway dimensions between men and women irrespective of their malocclusion type. The oropharyngeal airway volume revealed no significant results between the two genders and this correlates with the findings of Alves et al[22]. El and Palomo found no difference in airway volume between men and women in their study, which is consistent with our findings[23]. Our results are however different from those of Chiang et al. who reported that "males have larger volumes of the airway. They found that the total volume of the airway increased at a faster rate in male than in female patients with the rate of growth in the volume increasing after the age of 11 years"[24].

There was however significant difference reported in oropharyngeal airway regional area in our study, with males having larger oropharyngeal regional area as compared to that of females which is similar to the results of Daniel et al who stated that dimensions of oropharyngeal airway are greater in males as compared to females[25].Correspondingly, our results support the findings of Chiang et al who found that the regional area was significantly narrower in the female patients than the male patients[24]. In contrast Alves et al. stated no significant difference in regional area between the two genders[22].

Findings of this study indicate that Angles Class I or Class II malocclusion itself has no influence on the oropharyngeal airway volume or area. However, it has been reported in literature the effect that orthodontic treatment of various malocclusions has on the volume and regional area of pharyngeal airway.

Results of systematic review conducted by Hu Z et al stated that “during orthodontic treatment with extraction of all four premolars, large retraction of the anterior teeth and mesial movement of molars were the two factors that affected the dimensions of the upper airway”[26]. Significant anterior teeth retractions appear to cause upper airway constriction[27,28,29]. While molar mesial movement appeared to expand the dimensions of the upper airway[29].

It is probable that significant anterior teeth retraction can cause a dorsal shift of the oral cavity's anterior boundary which may lead to backward movement of the tongue, compressing the soft palate and resulting in constriction of upper airway. Another possible explanation maybe the backward and downward movement of the hyoid bone however its impact on upper airway dimensions remains controversial[26].

Al Maaitah et al however has reported “no significant upper airway changes after extraction of all first premolars”[30].

CONCLUSION

In conclusion, the findings of this research revealed that Angles Class I or Class II malocclusion does not influence oropharyngeal airway volume or area. Gender had no impact on the oropharyngeal airway volume but had significant influence on the oropharyngeal regional area with male patients having greater oropharyngeal area than females.

Conflict of interest: Nil

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