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Oropharyngeal Airway Dimensions in Different Dentofacial Skeletal Patterns: A Cephalometric Study

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ABSTRACT

Aim: To compare the dimensions of oropharnynx in subjects with Class I and Class II malocclusions with normodivergent and hyperdivergent facial patterns.

Materials & Methods: Pretreatment cephalometric radiographs of 80 subjects in age range of 14 to 25 years were taken & divided into 4 groups according to ANB and FMA with 20 subjects in each group. The measurements of the dimensions of the oropharynx in all the subjects were obtained.

Results: In oropharynx dimension parameters no significant differences were observed among the four study groups as suggested by the measurements, Oph-1, PPW-3, Oph-2, PPW-4 & PAS.. According to ANOVA & Tukey HSD test no statistically significant results were found in our other multiple comparison of groups.

Conclusion: A close relationship is present between the pharynx and the dentofacial structures, thus mutual interaction is expected to occur between the pharyngeal structures and the dentofacial pattern.

Keywords: Airway, Nasopharynx, Oropharynx, Hypopharynx, Hyoid Bone.

INTRODUCTION

Abnormal growth of the tissues of the upper airway can make the airway narrower and prone to obstructive sleep apnea (OSA).[1] The importance of this obstruction in the development of many childhood problems is increasingly recognized. OSA in children is associated with excessive daytime sleepiness, hyperactivity, attention deficit disorder, poor hearing, physical debilitation and failure to thrive. Accordingly much attention has been paid to the relationship between respiratory function and facial morphology in orthodontics. [1-3]

The upper airway has always been an area of interest because the oropharyngeal and nasopharyngeal structures play an important role in the growth and development of craniofacial and orodental complex.[4,5] Class II patients have a narrower anteroposterior pharyngeal dimensions and this narrowing is specifically noted in the nasopharynx at the level of hard palate and in the oropharynx at the level of tip of soft palate and the mandible.[6] Pharyngeal space size is determined primarily by the relative growth and size of the soft tissues surrounding the dentofacial skeleton. From adulthood to older age (20-50 years of age), the nasopharyngeal skeleton may change.[7]

Vertical malocclusions can be sourced as predominantly skeletal or dentoalveolar. Various etiological factors, including dentoalveolar

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development, growth of maxilla and mandible, function of the tongue and lips, and eruption of the teeth, may cause vertical malocclusion during the growth period.[8] An interaction is present between the maxillary and mandibular growth pattern and respiratory function.[9]

The purpose of this study was to compare the dimensions of the oropharynx in subjects with Class I and Class II malocclusions with normodivergent and hyperdivergent facial patterns.

MATERIALS & METHOD

The study comprised of pretreatment cephalometric radiographs of 80 subjects in age range of 14 to 25 years. The subjects were divided into 4 groups according to ANB and FMA with 20 subjects in each group.

Group A: Class I malocclusion (ANB 0^{o} - 4^{o}) with average growth patterns (FMA 20^{0} - 30^{0})
Group B: Class I malocclusion (ANB 0^{o} - 4^{o}) with vertical growth patterns (FMA > 30^{0})
Group C: Class II malocclusion (ANB > 4^{o}) with average growth patterns (FMA 20^{0} - 30^{0})
Group D: Class II malocclusion (ANB > 4^{o}) with vertical growth patterns (FMA > 30^{0})

All lateral cephalograms were selected from the pre treatment records of orthodontic patients at the Department of Orthodontics & Dentofacial Orthopaedics, Guru Nanak Dev Dental College & Research Institute, Sunam. The measurements of the dimensions of the oropharynx in all the subjects were obtained. No subjects had a history of previous orthodontic or orthopaedic treatment or any palatal/lip cleft syndrome.

A. OROPHARYNX DIMENSION PARAMETERS :-

1. **Oph 1 (Oropharyngeal space 1)** a line parallel to the palatal plane from tip of soft palate (P) to the posterior pharyngeal wall.
2. **PPW 3 (Posterior pharyngeal wall 3)** oropharyngeal space 1 line extended from posterior pharyngeal wall to the anterior tangent of second cervical vertebrae(C2).
3. **Oph 2 (Oropharyngeal space 2)** mandibular plane drawn as a tangent to the inferior border of the mandible, extended from anterior pharyngeal wall (or base of tongue) to posterior pharyngeal wall.
4. **PPW 4 (Posterior pharyngeal wall 4)** oropharyngeal space 2 line extended from posterior pharyngeal wall to the anterior tangent of the second cervical vertebrae(C2).
5. **PAS (Posterior airway space)** that is, the distance between the base of the tongue and the posterior pharyngeal wall along a line extended from B point to gonion.

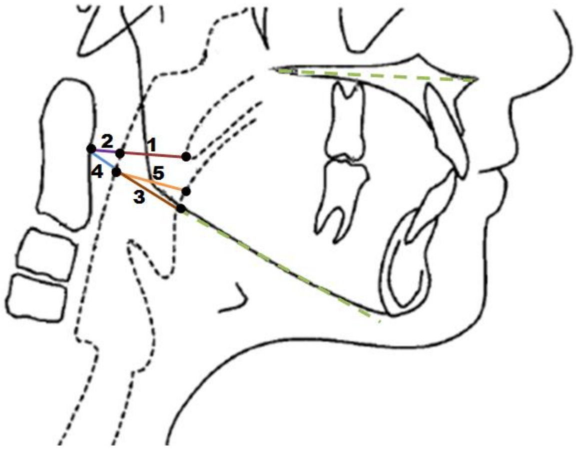

Fig 1: Oropharynx Dimension Parameters. Oph1, 2) PPW3, 3) Oph2, 4) PPW4, 5) PAS

STATISTICAL ANALYSIS

Descriptive statistics including the mean and the standard deviation for each group were computed using SPSS PC+ (SPSS Inc., Chcago, III). The differences between growth pattern were tested using student's t-test. Analysis of variance was used to determine whether significant differences existed between the groups. Least significant difference multiple comparison test was applied to identify which of the groups were different. Pearson's correlation coefficient test was used to detect any relationship between ANB angle and other variables. Arithmatic mean and statndard deviation values were calculated for each measurement. Group differences were analyzed with one way analysis of variance (ANOVA). For multiple comparisons, a post hoc Tukey honestly significant difference (HSD) test was used. When p-value was less that 0.05, the statistical test was regarded as statistically significant.

RESULTS

According to ANOVA & Tukey's HSD test no statistically significant differences were found in oropharyngeal airways dimensions among the four groups as suggested by the measurements, Oph-1, PPW-3, Oph-2, PPW-4 & PAS (Table 1, Graph 1). When oropharynx dimensions comparison was done between Class I Average growth pattern & Class I Vertical growth pattern groups, then also the results were non significant as suggested by the measurements (Table 2, Graph 2). When comparison was done between Class I & Class II Average growers then also the results were not significant as suggested by the measurements (Table 3, Graph 3). Similarly the results were non significant when comparison was done between Class I & Class II Vertical growth pattern individuals (Table 4, Graph 4). No significant differences were observed when we compared Class II Average growth pattern individuals with Class II Vertical growth pattern individuals (Table 5, Graph 5).

Table 1: Oropharynx Parameters

Parameters	Group A (n=20)		Group B (n=20)		Group C (n=20)		Group D (n=20)		Sig.
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Oph-1 (mm)	11.25	2.36	10.60	3.21	11.20	1.96	10.4	2.82	NS
PPW-3 (mm)	5.300	1.58	5.225	1.56	5.900	1.86	5.85	2.02	NS
Oph-2 (mm)	11.90	2.59	11.68	2.73	12.10	2.44	11.3	3.20	NS
PPW-4 (mm)	4.00	1.48	4.60	2.06	4.30	1.74	5.08	2.11	NS
PAS (mm)	11.85	2.24	11.48	2.61	11.83	2.15	10.5	2.40	NS

NS = Non Significant

Graph 1: Oropharynx Parameters

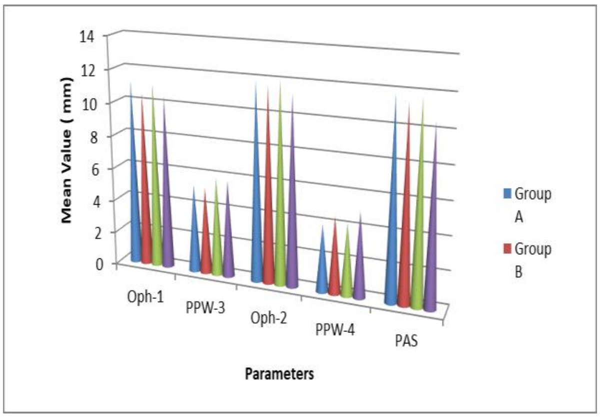

Table 2: Comparison of oropharynx dimension parameters in Class I skeletal malocclusion with average growth pattern (Group A) & Class I skeletal malocclusion with vertical growth pattern (Group B).

Parameter	Mean Value (Group A)	Mean Value (Group B)	Std. Error	p-value
Oph1	11.25 mm	10.60 mm	0.83	NS
PPW3	5.30 mm	5.22 mm	0.55	NS
Oph2	11.90 mm	11.68 mm	0.87	NS
PPW4	4.00 mm	4.60 mm	0.59	NS
PAS	11.85 mm	11.48 mm	0.74	NS

NS = Non Significant

Table 3: Comparison of oropharynx dimension parameters in Class I skeletal malocclusion with average growth pattern (Group A) & Class II skeletal malocclusion with average growth pattern (Group C).

Parameter	Mean Value (Group A)	Mean Value (Group C)	Std. Error	p-value
Oph1	11.25 mm	11.20 mm	0.83	NS
PPW3	5.30 mm	5.90 mm	0.55	NS
Oph2	11.90 mm	12.10 mm	0.87	NS
PPW4	4.00 mm	4.30 mm	0.59	NS
PAS	11.85 mm	11.83 mm	0.74	NS

NS = Non Significant

Table 4: Comparison of oropharynx dimension parameters in Class I skeletal malocclusion with vertical growth pattern (Group B) & Class II skeletal malocclusion with vertical growth pattern (Group D)

Parameter	Mean Value (Group B)	Mean Value (Group D)	Std. Error	p-value
Oph1	10.60 mm	10.48 mm	0.83	NS
PPW3	5.22 mm	5.850 mm	0.55	NS
Oph2	11.68 mm	11.33 mm	0.87	NS
PPW4	4.60 mm	5.08 mm	0.59	NS
PAS	11.48 mm	10.58 mm	0.74	NS

NS = Non Significant

Table 5: Comparison of oropharynx dimension parameters in Class II skeletal malocclusion with average growth pattern (Group C) & Class II skeletal malocclusion with vertical growth pattern (Group D) .

Parameter	Mean Value (Group C)	Mean Value (Group D)	Std. Error	p-value
Oph1	11.20 mm	10.48 mm	0.83	NS
PPW3	5.90 mm	5.850 mm	0.55	NS
Oph2	12.10 mm	11.33 mm	0.87	NS
PPW4	4.30 mm	5.08 mm	0.59	NS
PAS	11.83 mm	10.58 mm	0.74	NS

DISCUSSION

The current study evaluated the oropharyngeal dimensions of individuals with skeletal class I and class II malocclusions and different growth patterns; accordingly, skeletal and airway measurements were performed on cephalometric radiographs that were taken before treatment. It has been accepted that measurements on a 2-dimensional cephalometric radiograph cannot reveal the transverse dimensions of the airway. However, it has been reported that cephalometry is easy to use, economical, and can provide definite and quantitative information about the soft palate and nasopharynx.[10,11]

Aboudara et al.[12] showed that there was a significant positive relationship between nasopharyngeal airway size on cephalometric radiographs and its true volumetric size as determined by cone beam computed tomography in adolescents. Lateral cephalograms are still the major evaluation tool for upper airway research, despite their disadvantages.[13] However, lateral cephalometric radiographs should be taken in natural head posture to measure nasopharyngeal airway size dimensions precisely, because head position may influence upper airway dimensions, a possibility that has previously been proposed by many authors.[14,15]

No significant difference was observed in oropharynx parameters in various comparison groups taken. Our findings corroborate with other previous studies in which Freitas et al[16] found no statistically significant difference in lower pharyngeal airways between Class I and Class II malocclusions and different growth pattern groups, showing no association of lower pharyngeal airway space with craniofacial growth pattern and malocclusion type. Our findings also corroborates with the study of Ceylan and Oktay[4] who also claimed that the pharyngeal structures were not affected by the ANB angle. Similar results were reported by Sosa et al[17] who reported no significant relationship between pharyngeal structures and ANB angles of subjects with Class I & and Class II malocclusion. Similarly, Solow et al[18], Wenzel et al[19], and Mergen & Jacobs[20] could find no relationship between pharyngeal size and the measurements regarding the anteroposterior jaw relationship.

Uslu-Akcam et al[21] showed that PNS-PPW1 and the lower oropharyngeal airway space (E-PPW3) exhibited an increase during growth in all malocclusion groups. However, the upper oropharyngeal airway space (SPT-PPW2) increased only among class II, division 2 patients during growth. On the other hand, a statistically significant difference in the upper oropharyngeal airway among groups and growth periods was found, showing an association of SPT-PPW2 with craniofacial growth pattern and malocclusion type. This is at variance with the findings of our study.

The smallest dimension of OAS2 was recorded in the class II, division 2 group; hence, the oropharyngeal airway dimension should be carefully considered for treatment timing. If there is no finding of upper nasopharyngeal airway pathology related to oversized adenoids or tonsils, or chronic respiratory problems, early correction of a skeletal class II, division 2 malocclusion might eliminate the possibility of having disturbed respiratory function during sleep, such as snoring.[22] It should be noted that airway size and shape is extremely variable depending on the head posture and breathing stage,[23] and there are no norms or studies at this point to compare this with our results.

The possibility that hyperdivergent growth, with its associated airway narrowing, may predispose patients to obstructive episodes also needs to be studied. Therefore, orthodontists must be aware that specific dimensional characteristics such as a greater constriction might be associated with the skeletal pattern.

CONCLUSION

No statistically significant oropharyngeal airway dimension changes were found in our study groups. A close relationship is present between the pharynx and the dentofacial structures, thus mutual interaction is expected to occur between the pharyngeal structures and the dentofacial pattern. Narrowing of the pharyngeal space might be a factor in obstructive sleep apnea. With an appropriate treatment plan considering nasoorophryngeal dimension differences, an improvement in the skeletal relationship may benefit naso-oropharyngeal airway dimensions, as well as improve the facial profile and dentoalveolar relationships

Volumetric measurements are not possible in a two-dimensional lateral cephalograph. A small change in linear measurement can result in a substantial volumetric change that could affect airway resistance. Moreover, this study was only an anatomic assessment. Functional assessmenmt easuring air flow would be useful in understanding airway status. Prospective, long-term, longitudinal studies consisting of cephalometric analysis and functional airway assessment will be useful in determining whether upper airway obstruction causes hyperdivergent growth of the facial skeleton.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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