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Cephalometric evaluation of airway dimensions in subjects with different sagittal and vertical variables

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ABSTRACT

Introduction: The pharynx is a tube shaped structure that extends superoinferiorly from the cranial base to the level of the inferior surface of the sixth cervical vertebra. A nasal breather may change to a mouth breather because of an obstruction in the nasal or pharyngeal airway. In addition, pharyngeal narrowing is a commonly described characteristic in obstructive sleep apnea/hypopnea syndrome (OSAHS) patients.
Aim: The aim of this study is to investigate whether the upper and lower airway dimensions are affected by the sagittal and vertical skeletal variables.
Materials and Methods: The pre-treatment lateral cephalograms of 140 patients aged between 16years to 26 years were traced for the study. For each subject angular and linear cephalometric parameters were measured. Continuous variables were compared by one-way analysis of variance (ANOVA) and the significance of mean difference between the groups was done by Tukey's post hoc test. A two-sided (α = 2) $P < 0.05$ was considered statistically significant.
Conclusion: in this study, we found a significant difference among Class I subjects with three different vertical growth pattern. Hyperdivergent patients had statistically significant narrower upper and lower pharyngeal width when compared to normodivergent and hypodivergent growth patterns. Patients with Class II malocclusions have significantly narrower upper and lower pharyngeal airways than those with Class I and Class III malocclusions.

1. Introduction

The pharynx is a tube shaped structure that extends superoinferiorly from the cranial base to the level of the inferior surface of the sixth cervical vertebra.[1] It lies dorsal to the nasal and oral cavity and is cranial to the esophagus, larynx, and trachea.

A nasal breather may change to a mouth breather because of an obstruction in the nasal or pharyngeal airway. In addition, pharyngeal narrowing is a commonly described characteristic in obstructive sleep apnea/hypopnea syndrome (OSAHS) patients.

Many cephalometric studies have shown craniofacial abnormalities in OSAHS patients. A steeper mandibular plane angle, a shorter mandibular body length, and a low hyoid bone position were consistently reported by most investigations.[2]

According to close relationship between pharyngeal structures and dentofacial structures in OSA patients, a mutual association is expected to exist between the pharyngeal structures and the dentofacial pattern in the common population.

2. Aim

The aim of this study is to investigate whether the upper and lower airway dimensions are affected by the sagittal and vertical skeletal variables and comparison of upper and lower pharyngeal widths in patients with untreated Class I malocclusions and normal, vertical and horizontal growth patterns and to compare upper and lower pharyngeal widths in patients with untreated Class I, Class II and Class III

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malocclusions with normal growth patterns.

3. Materials and Methods

The pre-treatment lateral cephalograms of 140 patients aged between 16 years to 26 years were traced for the study. The lateral cephalograms were collected from the Department of Orthodontics and Dentofacial Orthopedics at Vyas Dental College and Hospital, Jodhpur.

3.1. Inclusion criteria

1. Lack of orthodontic treatment and/or maxillary functional treatment
2. Full complement of teeth, with exception of third molar
3. No history of nasal respiratory complex surgery or any surgery in the head and neck region.
4. Enough sharpness and contrast for good visualization and identification of the structures that make tegumentary tissue, bony structures and dental elements.
5. Pre treatment lateral cephalogram

3.2. Exclusion criteria

1. Previous orthodontic treatment
2. Previous history of nasal respiratory complex surgery
3. Vestibular or equilibrium problems
4. Visual or hearing disorders and with facial and spinal abnormalities
5. Radiographs with image distortion
6. Pharyngeal pathology, nasal obstruction, enlarged adenoids or tonsils

Lateral Cephalograms were taken for each individual using a standardized and specified technique. Cephalograms were traced onto .003 inch acetate paper. For each subject the following cephalometric parameters were measured:

3.2.1. Angular Measurements

- Frankfort mandibular plane angle (FH-MP): angle between Frankfort horizontal plane and the mandibular plane.
- ANB angle: angle between the NA and NB lines.

3.2.2. Linear Measurements

- Upper pharyngeal airway width (McNamara airway analysis)
- Lower pharyngeal airway width (McNamara airway analysis)
- The subjects will be divided into two groups: a normodivergent facial pattern group and a normal sagittal facial pattern group.

The selection criteria for the normodivergent facial pattern group was FH-MP between 17^o and 28^o (mean 21.9^o). This group was further divided into three subgroups according to the ANB angle.

- Subgroup 1: Class III, i.e., ANB angle smaller than 0
- Subgroup 2: Class I, i.e., ANB angle between 0 and 2
- Subgroup 3: Class II, i.e., ANB angle larger than 2

The selection criteria for the normal sagittal facial pattern group was ANB angle between 0 and 4 (mean 2.9). This group was divided into three subgroups according to the FH-MP angle:

- Subgroup 1: Low angle, i.e., FH-MP angle smaller than 17
- Subgroup 2: Normal angle, i.e., FH-MP angle between 17 and 28
- Subgroup 3: High angle, i.e., FH-MP angle larger than 28

3.3. Statistical analysis

Continuous data were summarized as mean $\pm$ standard deviation. Continuous variables were compared by one-way analysis of variance (ANOVA) and the significance of mean difference between the groups was done by Tukey's post hoc test. A two-sided (α = 2) $P < 0.05$ was considered statistically significant. Continuous data were summarized as mean $\pm$ standard deviation. Continuous variables were compared by one-way analysis of variance (ANOVA) and the significance of mean difference between the groups was done by Tukey's post hoc test. A two-sided (α = 2) $P < 0.05$ was considered statistically significant.

4. Results

Group 1: Normodivergent facial pattern group with variable sagittal relationship

The mean upper airway width and mean lower airway width of class III subgroup was highest followed by Class I and least in Class II subgroup

Group 2: Normal sagittal facial pattern group with variable growth pattern

The mean upper airway width and lower airway width of hypodivergent subgroup was highest followed by normodivergent subgroup, and least in hyperdivergent subgroup.

5. Discussion

1. This study was performed with two-dimensional cephalometric films to evaluate pharyngeal airway length and depth — not airway flow capacity, which would have required a more complex three-dimensional cone beam computed tomography (CBCT) and dynamic estimation.[3]
2. Therefore, these results do not suggest that individuals with vertical growth patterns or Class II sagittal

Table 1: Mean of upper airway width and lower airway width

Characteristic	Class I (n=17)	Class II (n=51)	Class III (n=11)	
Upper airway width (mm)	11.20±2.53	10.38±2.10	12.77±2.78	0.0083
Lower airway width (mm)	9.14±2.7	8.39±2.50	10.45±2.69	0.0528

Table 2: Significance of mean difference of upper airway width between the groups byTukey Post Hoc Test

Comparisons	Values
Class II v/s Class III	0.0069
Class I v/s Class III	0.1872
Class I v/s Class II	0.7162

Table 3: Significance of mean difference of lower airway width between the groups by Tukey Post Hoc Test

Comparisons	Values
Class II v/s Class III	**0.0475**
Class I v/s Class III	0.3897
Class I v/s Class II	0.5526

Table 4: Mean upper airway width and lower airway width ofhypodivergent, normodivergent and hyperdivergent.

Characteristic	Hypodivergent (n=12)	Normodivergent (n=42)	Hyperdivergent (n=17)	
Upper airway width (mm)	12.5±3.02	11.71±2.16	10.14±1.85	0.0154
Lower airway width (mm)	10.45±2.77	9.01±2.55	7.20±2.31	0.0036

Table 5: Significance of mean difference of upper airway width between the groups byTukey Post Hoc Test

Comparisons	Values
Hypodivergent v/s Hyperdivergent	0.0193
Hypodivergent v/s Normodivergent	0.5362
Hyperdivergent v/s Normodivergent	0.0472

Table 6: Significance of mean difference of lower airway width between the groups byTukey Post Hoc Test

Comparisons	Values
Hypodivergent v/s Hyperdivergent	0.0032
Hypodivergent v/s Normodivergent	0.2079
Hyperdivergent v/s Normodivergent	0.0377

relationship have smaller airway flow capacities than those with normal growth patterns. This should be further investigated.

3. Malkoc et al. has stated that cephalometric films are significantly reliable and reproducible in determining airway dimensions.[4]
4. We chose lateral cephalograms for this study because posterior airway space, as measured by lateral cephalometric radiography, was highly correlated with measurements using three-dimensional CT scan, with 92% accuracy in predictability.[5]
5. Aboudara et al found a significant positive relationship between nasopharyngeal airway size on cephalometric films and its true volumetric size as determined from CBCT scan in adolescents.[6]
6. Ceylan and Oktay reported that changes in the ANB angle affected nasopharyngeal airway size, and that the oropharyngeal space was reduced in subjects with an enlarged ANB angle.[7]
7. Kerr reported that Class II malocclusion subjects showed smaller nasopharyngeal dimensions compared with Class I and normal occlusion subjects.[8]
8. Ucar et al. in another study reported that nasopharyngeal airway space and upper pharyngeal airway space in Class I subjects were larger in low angle subjects than in high angle subjects.[9]
9. We found that the hyperdivergent facial pattern subjects are belonging to skeletal Class I malocclusions showed a statistically significantly the narrow upper pharyngeal airway width when compared to normodivergent and hypodivergent facial patterns.

6. Conclusion

1. Based on the data produced in this study, we found that
2. Statistically, a significant difference were identified among Class I subjects with three different vertical

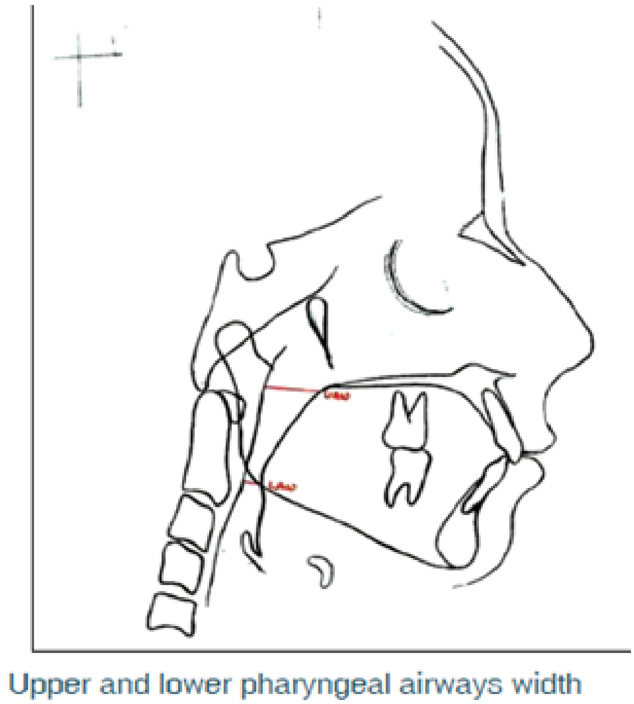

Fig. 1:

growth pattern.

3. Hyperdivergent patients had statistically significant narrower upper and lower pharyngeal width when compared to normodivergent and hypodivergent growth patterns.
4. Patients with Class II malocclusions have significantly narrower upper and lower pharyngeal airways than those with Class I and Class III malocclusions.

7. Source of Funding

None.

8. Conflict of Interest

None.

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