EVALUATING THE UPPER AND LOWER PHARYNGEAL AIRWAY WIDTH IN DIFFERENT SKELETAL AND DENTAL MALOCCLUSIONS AMONG CHENNAI POPULATION

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ABSTRACT
Treating any malocclusion either a skeletal or dental malocclusion requires a proper diagnosis and treatment planning. Cephalometric radiographs proven to be sufficient for the better diagnosis of malocclusions apart from clinical diagnosis. In soft tissue cephalometric findings, the pharyngeal airway widths are often looked down and are not considered for many of the treatment planning and more importance is given to lip protrusions, nasolabial and mentolabial angle. In literature, pharyngeal airway width are evaluated either for class II or class III skeletal patients or patients with hyper divergent facial patterns and no comparisons has been done in a single literature to support the airway width among these malocclusions. This study aims to evaluate the pharyngeal airway width in all three skeletal malocclusions and dental malocclusions in people living in chennai.

INTRODUCTION
The pharynx is closely associated with oral structures. The pharynx anatomically as we know is a median fibromuscular tube that extends from the base of the skull. It is continuous from the sphenoid and the occipital bones to the level of the sixth cervical vertebrae, where it is continuous with the esophagus. Certain structural features of the pharynx under genotypic control are associated with skeletonofacialstructure.

Adult nasopharyngeal depth dimensions are established early in life. At the oropharyngeal level the sagittal stability is exemplified by the constant position of the hyoid bone relative to the cervical column. The ultimate capacity of the pharynx depends on the soft tissues, their growth and size. Adenoid vegetation or tongue mass may decrease the patency and induce postural adaptations at the oropharyngeal level (Tourne, 1999). As the pharyngeal space size is determined primarily by the relative growth and size of soft tissues surrounding the dentofacial skeleton, it is implied that the malocclusion characteristics have a predisposing anatomical factor for these airway problems. According to the close relationship between the 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. The pathogenesis of obstructive sleep apnea (OSA) has been investigated for many years. Previous studies of different samples have shown an association between craniofacial skeletal morphology and upper airway dimension in OSA patients (Lowe et al, 1986; Bacon et al, 1988; Hui et al, 2003; Battagel et al, 1991). Since previous studies has been done on skeletal class I and class II cases and various divergent patterns separately, no studies has concentrated on all the three types of skeletal malocclusion and three divergent patterns. So this study aims to evaluate the airway width in all the three skeletal malocclusions and three divergent facial patterns.

METHODOLOGY
Pre-treatment lateral cephalogram of 293 patients who seek orthodontic treatment from our college were taken. Of these radiographs patients who were residents of chennai only selected. Total of 155 patients were found to be residents of chennai. Total of 59 male patients and 96 female patients were taken as sample. Patients were grouped into Skeletal Class I, Class II and Class III based on the ANB angle. Skeletal Class I group has total of 87 patients of which 38 were male and 49 were female. Skeletal Class II group has total of 45 patients of which 16 were male and 29 were female patients. Skeletal
Class III patients has total of 23 patients of which 5 were male and 18 were female. Patients used for this study were under the age category of 18-31. 0.003 inch matte acetate sheets were used for the tracing of these radiographs. Upper and lower pharyngeal airway width was measured using McNamara analysis.

The subjects were classified into skeletal class I, skeletal class II and skeletal class III by the ANB angle

Skeletal class I group has ANB angle in the range of $2^\circ \pm 2^\circ$ (i.e.$0^\circ$ to $4^\circ$)

Skeletal class II group has ANB angle greater than $4^\circ$. Skeletal class III group has ANB angle less than $0^\circ$.

The skeletal class I, skeletal class II and skeletal class III subjects were subdivided into normodivergent, hyperdivergent and hypodivergent pattern. Subjects with mandibular plane angle of $<21^\circ$ were grouped as low angle or hypodivergent pattern

Subjects with mandibular plane angle of $22^\circ$ to $28^\circ$ were grouped under normal divergent or average angle. Subjects with mandibular plane angle of $>29^\circ$ were grouped under high angle or hyperdivergent pattern

**RESULTS**

In skeletal class I malocclusion the highest upper pharyngeal width was found in hypodivergent cases and the narrowest being the hyperdivergent patterns followed by normodivergent pattern.

Highest lower pharyngeal width was found in normodivergent pattern followed by the hypodivergent and hyperdivergent pattern cases. In skeletal class II malocclusion the highest upper pharyngeal width was found in normodivergent pattern followed by hypodivergent pattern. The least width was found in hyperdivergent cases.

Highest lower pharyngeal width was found in normodivergent pattern. The least width being found in hyperdivergent pattern cases.

In skeletal class III malocclusion, highest upper pharyngeal airway width was found in hyperdivergent cases, the least was found in hypodivergent cases.

Highest lower pharyngeal airway width was found in hypodivergent and normodivergent cases and the least being hyperdivergent cases.

On comparing the skeletal malocclusions, highest upper pharyngeal width was found in skeletal class I malocclusion and the least was found in skeletal class II malocclusion.

In hyperdivergent cases, the highest upper pharyngeal width was found in skeletal class III malocclusion and the least was found in skeletal class II malocclusion.

Skeletal class III malocclusion has highest lower pharyngeal width in hyperdivergent cases and the least being the skeletal class I malocclusion. In normodivergent cases, the Highest upper pharyngeal width was seen in skeletal class I malocclusion followed by Skeletal class II and skeletal class III malocclusions.

Skeletal class III malocclusion has highest upper pharyngeal width in normodivergent cases and the least found in skeletal class I and skeletal class II malocclusion.

In hypodivergent cases, the highest upper pharyngeal airway width was found in skeletal class I malocclusion and the least was found in skeletal class III malocclusion followed by skeletal class II malocclusion.

Skeletal class III malocclusion has highest lower pharyngeal width in hypodivergent cases and the least was found in skeletal class II and skeletal class I malocclusion.

**Statistical Result**

Statistical analysis of the data was done using Statistical Package for Social Sciences, IBM Corporation, SPSS Inc., Chicago, IL, USA version 21 software package (SPSS). Descriptive statistics including mean, standard deviation and frequencies were computed for various parameters like age and gender. Normality of the data was assessed using Kolmogorov-Smirnov test. One Way ANOVA test was used to compare the mean difference between different groups.
The level of significance in the present study was kept at p<0.05

Table 1 Mean and standard deviation of upper airway width in various skeletal malocclusion

<table>
<thead>
<tr>
<th>Skeletal malocclusion</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal class I</td>
<td>87</td>
<td>13.13</td>
<td>3.89</td>
<td>.383</td>
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<tr>
<td>Skeletal Class II</td>
<td>45</td>
<td>13.15</td>
<td>2.90</td>
<td>.461</td>
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<td>Skeletal class III</td>
<td>23</td>
<td>13.25</td>
<td>3.41</td>
<td>.608</td>
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Table 2 Mean and standard deviation of lower airway width in various skeletal malocclusion

<table>
<thead>
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<th>Mean</th>
<th>Standard deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>9.93</td>
<td>2.49</td>
<td>.001</td>
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<tr>
<td>Skeletal Class II</td>
<td>45</td>
<td>9.54</td>
<td>2.29</td>
<td>.014</td>
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<tr>
<td>Skeletal class III</td>
<td>23</td>
<td>12</td>
<td>3.64</td>
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Table 3 Mean and standard deviation of upper airway width in various dental malocclusion

<table>
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<th>N</th>
<th>Mean</th>
<th>Std deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angles class 1</td>
<td>109</td>
<td>12.96</td>
<td>3.33</td>
<td>.869</td>
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<tr>
<td>Angles class 2 div 1</td>
<td>38</td>
<td>14.18</td>
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<td>Angles class 3</td>
<td>8</td>
<td>12.75</td>
<td>3.91</td>
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Table 4 Mean and standard deviation of lower airway width in various dental malocclusion

<table>
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<th>Dental malocclusion</th>
<th>N</th>
<th>Mean</th>
<th>Std deviation</th>
<th>P value</th>
</tr>
</thead>
<tbody>
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<td>Angles class 1</td>
<td>109</td>
<td>10.07</td>
<td>2.88</td>
<td>.506</td>
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<tr>
<td>Angles class 2 div 1</td>
<td>38</td>
<td>10.14</td>
<td>2.17</td>
<td>.594</td>
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<tr>
<td>Angles class 3</td>
<td>8</td>
<td>10.75</td>
<td>3.37</td>
<td>.690</td>
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Table 5 Mean and standard deviation of upper airway width by various divergent pattern

<table>
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<tr>
<th>Divergent pattern</th>
<th>N</th>
<th>Mean</th>
<th>Std deviation</th>
<th>P value</th>
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<td>Hyperdivergent</td>
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<td>12.58</td>
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<tr>
<td>Normodivergent</td>
<td>38</td>
<td>14.11</td>
<td>3.84</td>
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<tr>
<td>Hypodivergent</td>
<td>61</td>
<td>13.32</td>
<td>3.23</td>
<td>.079</td>
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</table>

Table 6 Mean and standard deviation of lower airway width by various divergent pattern

<table>
<thead>
<tr>
<th>Divergent pattern</th>
<th>N</th>
<th>Mean</th>
<th>Std deviation</th>
<th>P value</th>
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</thead>
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<td>9.73</td>
<td>2.7600</td>
<td>.255</td>
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<tr>
<td>Normodivergent</td>
<td>38</td>
<td>10.42</td>
<td>3.0570</td>
<td>.262</td>
</tr>
<tr>
<td>Hypodivergent</td>
<td>61</td>
<td>10.31</td>
<td>2.5251</td>
<td>.437</td>
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**DISCUSSION**

The pharyngeal airway is an irregular lumen. Narrowing in one or more segments of the airway may induce breathing as well as sleeping problems like obstructive apnoea. Cross sectional area is a better indicator than volume with which to evaluate the size of the pharyngeal airway. The size of the pharyngeal airway on lateral cephalograms can be measured as the depth and height in the sagittal plane. So there is an inherent limitation of the study as pharyngeal airway is a three-dimensional structure and it can only be evaluated two dimensionally on lateral cephalometric films. However, Miles et al. reported a high reliability of cephalometric landmarks and measurements. Nasopharyngeal airway area increases rapidly until 13 years of age and after this the growth slows down. An inactive period of growth in pharyngeal structures has been reported beyond 15 years of age. This study was performed to evaluate the pharyngeal airway width in class I class II and class III subjects with moderate to severe crowding using lateral cephalometric radiograph. In the present study subjects of 15 – 30 years of age were evaluated. Prior history about tonsillectomy and respiratory infections were considered. Any one of these factors could have been related to respiratory obstructions. Patients with a positive history of airway obstructions and other craniofacial abnormalities were excluded from the study. All the subjects in this study had normal BMI. Size of the nasopharynx is of utmost important in determining the mode of breathing whether it is nasal or oral. adenoids usually diminishes progressively and becomes stable by the age of 14 to 15 years.

Obstruction of the airway often alters normal breathing, which has a significant impact on the development of craniofacial structures, such as incompetent lips, lower or anterior tongue position, narrow maxillary arch, long face height, crossbites, and posteroinferior rotation of the mandible. The most common reason for obstruction of the airway is adenoid hypertrophy. Adenoids are a collection of lymphoid tissues in the posterior nasopharyngeal wall; they are small at birth but progressively enlarge as a result of increased immunologic activity. Repeated adenoidal infection and inflammation or genetic factors may lead to pharyngeal obstruction, causing mouth breathing, which can in turn result in altered craniofacial development. (HusamettinOktay,1999) and (Hiroyuki Ishikawa et al., 2002) reported that ANB angle was considered to be the reliable indicator of the anteroposterior skeletal discrepancy. Although clinical significance and reliability of the ANB angle to determine the anteroposterior jaw relationship was argued in the literature, it is still a widely used method to describe anteroposterior dentofacial discrepancies and thus was the measurement of choice for this study to group the subjects. In our study, subjects with ANB angle between 2±2º were included in Class I group and subjects with ANB angle >5º were included in Class II group and ANB angle less than <0º were included in Class III group. Many studies have contributed to the knowledge that variations in the skeletal pattern could lead to upper airway obstruction.

In this study, we used two dimensional cephalometric films to evaluate only pharyngeal airway width not airway flow capacity, which would have required a more complex three-dimensional cone-beam computed tomography (CBCT). Cephalometric films were significantly reliable and reproducible in determining the pharyngeal airway dimensions (Malkoc et al, 2005). On comparing computed tomography and cephalometric films in skeletal malocclusion subjects a significantly positive correlation was found in  between nasopharyngeal airway size on cephalometric films and CBCT scan that determined its true volumetric size in adolescents (Aboudara et al, 2009). Our result was in correlation with the work done by Dunn (Dunn et al, 1973) and Proffitt (Proffitt et al, 2007) who showed that the Class I and Class II malocclusions with vertical growth pattern had significantly narrower upper pharyngeal width than with normal growth pattern.

Narrow upper pharyngeal airway width was found in Class II patients as in correlation with work done by Kerr who reported
that the narrow nasopharyngeal airway space in Class II when compared with Class I malocclusion.

This result is also in correlation with the study carried out by Mergen and Jacobs who reported the narrower nasopharyngeal space in Class I malocclusions. Subjects with Class II malocclusions and hyperdivergent growth patterns have significantly narrower upper pharyngeal airway space when compared to the other growth patterns reported by Shreyas S Iyengar is in accordance with the result obtained in our study.

Feng in his study concluded by saying that lateral cephalograms can be used as an initial screening method to estimate the nasopharynx volumes of younger patients (Xin et al.,2015).

CONCLUSION

Evaluation of pharyngeal airway width using McNamara analysis resulted in the following conclusions:

1. In skeletal Class I and Class II cases narrow upper pharyngeal airway width was found in hyper divergent pattern cases
2. In skeletal Class III cases narrow upper pharyngeal airway width was found in hypo divergent pattern cases
3. In skeletal Class I, Class II and Class III cases lower pharyngeal airway width was found in hyper divergent pattern patients.
4. Narrow upper pharyngeal width was found in Skeletal Class III hypo divergent pattern patients.
5. Narrow lower pharyngeal airway width was found in Skeletal Class I hypo divergent pattern patients.

Lateral cephalogram can be used as an initial diagnostic tool for the early diagnosis of Obstructive sleep apnea and adenoid hypertrophy which requires further complex investigation methods like cone beam computed tomography and MRI to further probe in to the pathology.

Even though lateral cephalogram is a two dimensional image that represent the three dimensional structure, it serves as an excellent technique to identify the pathology as CBCT, CT and MRI are not considered on routine orthodontic purpose because of their high cost and radiation.

References


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