Evaluation of upper airway in different malocclusions among Dravidian population - A cephalometric study

S. Sruthi*, K. Saravana Pandian

INTRODUCTION

The upper airway is the first component of the significant structure, which provides respiration - one of the vital functions of the human body. Disturbed breathing function could lead to life-threatening situations. One of the conditions associated with breathing disturbances is obstructive sleep apnea (OSA), which is characterized by recurrent episodes of upper airway obstruction during sleep resulting in reduced oxygen saturation and is associated with increased morbidity and mortality.[3] Several studies have shown the distinct differences between the upper airway dimensions of OSA patients and normal subjects.[2,3] The posterior airway space (PAS) (space behind the base of the tongue) of patients with OSA is smaller than that of normal individuals,[4,5] and their craniofacial morphology is characterized by short cranial base,[6,7] posteriorly positioned maxilla and mandible,[16,19] retrognathia or micrognathia,[6,19] and increased upper and lower face heights.[6,19] Since a close relationship between the upper airway patency and craniofacial structures has been shown in OSA patients,[10,11] an association could be expected to exist between the airway dimensions and the craniofacial pattern. Orthodontists deal with various kinds of malocclusions, including severe skeletal Class II and III deformities, and advancement and setback operations are standard procedures for correction of the jaw discrepancies. Orthognathic procedures are designed to correct dentofacial deformities, but they also inevitably affect the size and the position of the surrounding soft tissues. Although there are a lot of studies reporting changes in the dimensions of the upper airway following surgical repositioning of the mandible and the maxilla, the estimations about the changes in the PAS after mandibular setback and advancement surgeries remain controversial.[12] Despite a few case reports of mandibular setback surgery in skeletal Class III patients inducing OSA associated with airway narrowing,[13-15] prospective studies[16,17] failed to demonstrate disturbances of respiration during sleep after mandibular setback even though retropalatal airway size was reduced. These findings might be explained by the observation that pre-operative airway size in patients with Class III deformity was larger than values in normal population.[17,18] To predict possible changes of the upper airway after diverse orthognathic procedures, with regard to possible development of OSA, it would be advantageous to have the data about the upper airway dimensions in untreated population.[19]
MATERIALS AND METHODS

Pre-treatment lateral cephalometric radiographs of 60 (both males and females) were categorized into three classes (Class I-III) and studied for upper airway dimension.

Three groups were formed: Class I (25), Class II (25), and Class III (25).

Inclusion Criteria
All the subjects were normodivergent and belonged to the age group between 15 and 30 years.

Exclusion Criteria
Patients with craniofacial disorders were excluded from the study.

RESULTS
1. There was no statistically significant difference in all three classes in upper airway dimensions ($P > 0.005$) [Table 1].
2. There was no significant correlation between ANB angle and upper airway dimensions [Table 2].

DISCUSSION

Most of the times, the malocclusion was evaluated only by the occlusal relationships and the skeletal pattern was assessed later or not at all. The dental anteroposterior relationships were not reliable predictors of the underlying skeletal pattern.[31,32] Almost all of the included investigations used ANB angle to establish the anteroposterior jaw relationships, and it should be recognized that it has well-known limitations as it is influenced by many variables such as morphology of the nasion area, the vertical dimensions of the face, the inclination of the anterior cranial base, and the inclination of the jaws.[33] If only the ANB angle is used to measure the relative position of the maxilla and mandible to each other, the location of points A and B in the vertical plane will have an influence on the size of the angle and not the actual sagittal relation of the jaws.[34] However, it is still acknowledged as a traditional way of determining the anteroposterior skeletal pattern and was accepted also in this review. Among various studies, we took into account the vertical skeletal pattern of the individuals included in the investigation.[20,22,25,28,29] Previously described influence of vertical pattern on ANB angle and studies, which have shown distinct differences in the airway dimensions between brachyfacial, normal, and dolichofacial subjects,[20,25,35] suggests that misleading conclusions could be made without incorporating vertical growth type in the evaluation of the upper airways. Most of the studies used natural head position or Frankfurt horizontal during image taking procedures, but one of the included studies reported using head stabilization with head strap and chin put on the platform.[26] The authors[26] discussed that a more prominent chin could lead to changes in the extension of the head and sequent increase of the upper airways. Several studies have found a significant correlation between the PAS and head extension or craniocervical angulation.[36,37] Muto et al. stated that $10^\circ$ of head extension increases PAS by 4 mm.[36] Therefore, the imaging of the airway should be recorded with the head in natural position. The age of individuals included in the investigations varied from 8 to 46 years. Sheng et al. found a significant increase of airway dimensions between the age of 10 and 22.[38] Martin et al. investigated individuals aged 16–74 years and concluded that almost all upper airway dimensions decreased with increasing age in both men and women.[39] In long-term follow-up studies, it has been established that, between 20 and 50 years of age, there is a progressive decrease of the oropharyngeal sagittal dimension both behind

<p>| Table 1: Comparison of upper airway measurements between different malocclusion types |
|---------------------------------|-----------------|----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Upper airway dimension</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean square</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups</td>
<td>13.003</td>
<td>2</td>
<td>6.502</td>
<td>0.530</td>
<td>0.591</td>
</tr>
<tr>
<td>Within groups</td>
<td>698.667</td>
<td>57</td>
<td>12.257</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>711.670</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multiple comparisons

Dependent variable: Upper airway dimension Bonferroni

<table>
<thead>
<tr>
<th>(I) Groups</th>
<th>(J) Groups</th>
<th>Mean difference (I-J)</th>
<th>SE</th>
<th>Significance</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.00</td>
<td>0.92500</td>
<td></td>
<td>1.0713</td>
<td>1.000</td>
</tr>
<tr>
<td>2.00</td>
<td>1.00</td>
<td>-0.92500</td>
<td></td>
<td>1.0713</td>
<td>1.000</td>
</tr>
<tr>
<td>3.00</td>
<td>2.00</td>
<td>1.04000</td>
<td></td>
<td>1.10713</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Lower bound 3.6559
Upper bound 2.6159
Table 2: Pearson’s correlation between upper airway dimensions and ANB angle

<table>
<thead>
<tr>
<th>Descriptive statistics</th>
<th>Mean±SD</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper airway dimension</td>
<td>15.850±3.473</td>
<td>60</td>
</tr>
<tr>
<td>ANB angle</td>
<td>1.9167±4.28652</td>
<td>60</td>
</tr>
</tbody>
</table>

Upper airway dimension

- Pearson correlation: 1, Significance (two-tailed): 0.264
- Sum of squares and cross-products: 711.670, −128.650
- Covariance: 12.062, −2.181
- n: 60

Anbangle

- Pearson correlation: −0.146, 1
- Significance (two-tailed): 0.264
- Sum of squares and cross-products: −128.650, 1084.083
- Covariance: −2.181, 18.374
- n: 60

...the soft palate and behind the tongue.[40] All of these studies suggested that the samples should be selected with subjects of approximate ages to avoid the effect of different ages on the airway measures. This aspect was not taken into account in one investigation.[29] The upper airway can be assessed by multiple imaging techniques, including cephalometry, computed tomography, cone-beam computed tomography, and magnetic resonance. Lateral cephalometry (LCR) was used in 5 of 11 included studies as only imaging tool for the upper airway dimensions.[21,25-27,29,30] LCR has been the basic imaging technique for orthodontic investigations from the year 1931 when it was first described by Broadbent and was proven to provide valuable information of the upper airway morphology.[33] However, it offers only a two-dimensional (2D) illustration of a 3D structure and provides no information about the lateral structures, volume, and cross-sectional area of the upper airway. A study comparing airway dimensions on the lateral cephalometric radiographs and CT reported a significant correlation between the PAS measured on LCR and the volume of the upper airway on CT.[41] On the contrary, others have claimed that accurate determination of the airway size from LCR may give doubtful results,[42] and sagittal linear measurements used in LCR are weakly correlated with cross-sectional area measurements in CBCT, which are more important to describe airway patency.[43,44] The findings of the most of the studies (75%) included in this review[21,24-26,28,30] suggested that the dimensions of the nasopharynx do not differ among sagittal skeletal patterns. However, one study,[22] which was judged as having high-quality standard, suggested that individuals with Class II pattern had smaller nasopharyngeal dimensions compared to Class I. The nasal volume was rendered as whole structure including nasopharynx, turbinates, and nares in this study,[22] which could be a reason for notably diverse results. Reported findings for the differences in the oropharyngeal dimensions among the 11 articles were significantly controversial. The quality analysis showed 7 of 11 studies[23-27,29,30] describing the oropharyngeal dimensions being of low or low/medium quality. Not considering the possible influence of previously described significant confounding factors or not using adequate statistical analysis could have a considerable impact on the results. Since opposing views exist regarding the accuracy of upper airway assessment in LCR, also results of 2D studies[20,25,27,29,30] must be evaluated with care. Probably the best insight could be given by 3D investigations with good methodological soundness.[21,22,28] Alves et al.[21] and EI and Palomo[22] found significant evidence that subjects with retruded mandibular positions are prone to smaller oropharyngeal dimensions, which, however, was not supported by the findings of Alves et al.[24] and Memon et al.[29] Inconsistencies of the findings suggest that clear differences in the upper airway dimensions among sagittal craniofacial patterns could not be established.

CONCLUSIONS

This study was undertaken to answer the question:
- “Is there any difference in the upper airway dimensions in patients with different skeletal pattern?” The following conclusions could be made.
  - 75% of the studies did not find any differences in the nasopharyngeal airway dimensions among different skeletal anterioposterior patterns.

Almost half of the investigations found no differences in oropharyngeal airway volume and/or sagittal linear measurements among various skeletal sagittal patterns; however, 5 of 11 articles concluded that the oropharyngeal airway dimensions were smaller in Class II compared to Class I and/or Class III subjects. 6 of 11 studies found evidence that Class III sample had larger oropharyngeal dimensions than Class I and/or Class II groups; the vertical growth type of the subjects was not considered in five investigations, and 45% of the included studies used LCR as only tool for airway assessment. Currently, there is insufficient evidence that the upper airway dimensions differ in various sagittal skeletal patterns. There is a need for high-quality research with well-defined methodology; the use of 3D imaging techniques should be preferred for evaluation of the upper airway. We conclude by saying that there was no significant difference among different malocclusion patterns in upper airway dimension.

REFERENCES

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