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Cephalometric assessment of the width of pharyngeal airway space and correlation with skeletal malocclusion- A retrospective study

K.V.Swathi
Post Graduate Student
Department of Oral medicine and Radiology,Saveetha Dental College
Saveetha Institute of Medical and Technical Sciences, Chennai, India

G.Maragathavalli
Professor and Head
Department of Oral medicine and Radiology,Saveetha Dental College
Saveetha Institute of Medical and Technical Sciences, Chennai, India

Abstract

Aim- The aim of this study is to assess the width of the pharyngeal airway and correlate with skeletal occlusion by a retrospective analysis of various digital lateral cephalograms.

Objective- To establish any correlation between various skeletal profiles (Class I, Class II, Class III) with the width of the pharyngeal airway measured from digital lateral cephalograms.

Background- Lateral cephalograms can be used to measure the upper and lower pharyngeal airway widths and depending on the dentofacial skeletal malocclusion, this width can vary. Hence appropriate orthodontic treatment for correcting these skeletal malocclusions can also improve the pharyngeal airway constriction which would also play an important role in sleep related apnoeas and other respiratory disorders.

Methods- A retrospective random analysis of 50 digital lateral cephalograms was done following which the cephalometric landmarks were traced.Upper and lower pharyngeal airway widths were measured.The ANB angle was also measured to classify the skeletal class patterns.A correlation was done between the pharyngeal airway widths with skeletal class pattern.

Results- It was found that the mean pharyngeal upper pharyngeal airway measurements were 10.14 mm, 5.50 mm,9.75 mm and the mean lower pharyngeal airway widths were 4.60 mm, 7.00 mm and 5.25 mm in skeletal class I, skeletal class II, skeletal class III patterns respectively. The ANB angle on an average was 1.48, 7.50, 2.83 degrees respectively on correlating with skeletal class I, skeletal class II, skeletal class III occlusions.

Conclusion- One of the most important clinical significance of pharyngeal airway constriction is airway obstruction causing respiratory distress and sleep apneas. Appropriate orthodontic treatment is therefore very essential for improvement of the width of this pharyngeal space for improving the overall quality of life of the individual.

Key words : Nasopharynx, oropharynx, hypopharynx,constriction,skeletal occlusion

BACKGROUND

The pharyngeal airway is an anatomical space that is divided into nasopharynx, oropharynx and laryngeal pharynx.(1) The nasopharynx is an elongated space extending posteriorly from the nasal cavities. It is a base that is formed by the soft palate. The posterior wall of the nasopharynx is the most frequent site of adenoid growth in the pharyngeal tonsils .The oropharynx is the middle compartment of the pharynx which includes the base of the tongue, soft palate, tonsils and the walls of the pharynx. They are the upper most part of the digestive tract. It is bounded anteriorly by the circumvallate papillae of the tongue and the anterior tonsillar pillars. These structures separate the oropharynx from the oral cavity.(2)The hypopharynx is the bottom most part of the pharynx and is a combination of three anatomic sections that is the piriform sinus, posterior hypopharyngeal wall and the posterior cricoid sinus.It is known that for the normal growth of the craniofacial structures, the normal airway is very essential.(3) The nasopharynx and oropharynx form part of the unit from which respiration and deglutition are carried out. There are certain hereditary and environmental factors which influence the size and shape of the human face and the airway space. It has been reported in literatures that the normal upper pharyngeal airway space is 15-20 mm whereas the lower pharyngeal airway space is 11-14mm.(4) Certain skeletal features like retrusion of the maxilla or the mandible, vertical maxillary excess can cause narrowing of the anteroposterior dimension of the airway. There are certain other predisposing factors which may cause airway obstruction which includes allergies, environmental irritants and infections.(5) There are also various studies which report that there is an association between the enlargement of adenoids with nasopharyngeal airway obstruction.(6) These enlarged adenoids can cause posterior crossbite and may cause mouth breathing in children. However a study by Gois et al. in 2007 on the influence of non nutritive sucking habits, breathing pattern and adenoid size on the development of malocclusion in 300 pre school children of 3- 6 yrs of age revealed no association between the hypertrophied adenoids and malocclusion. Surgical modalities like bimaxillary surgery , mandibular setback surgery also influence the pharyngeal airway measurements.(7) A study by Chen et al. in the Japan population was done in 2005 to compare the short-term and long-term effects of bimaxillary surgery with those of mandibular setback surgery with respect to the pharyngeal airway measurements at three levels i.e. the nasopharynx, oropharynx and hypopharynx. Their study included two groups of patients, where group A included 35 patients who underwent bilateral sagittal split osteotomies and group B included 31 patients who underwent Lefort I procedures with bilateral sagittal split ramus osteotomies. In group A patients in both the short-term and long- term follow ups, the pharyngeal airway was constricted significantly at the oropharyngeal and hypopharyngeal levels. In group B patients, during the short term follow up, there was significant changes in the three pharyngeal levels.(8) There have been changes in the dimensions of the airway in certain sleep disorders like obstructive sleep apnea. Obstructive sleep apnea is characterised by upper airway collapse during sleep.(9)

MATERIALS AND METHODS

A retrospective analysis of 50 digital lateral cephalograms were done. The normal cephalometric landmarks were traced.

Cephalometric reference points used were

N = nasion, the most anterior point of the frontonasal suture in the midsagittal plane

Point A= subnasale, the deepest midline point on the anterior outer contour of the maxillary alveolar process

Point B= supramentale, the deepest point on the outer contour of the mandible

ANS = anterior nasal spine, the most anterior point of the tip of the anterior nasal spine in the midsagittal plane

PNS = posterior nasal spine

Go = gonion, a point at the intersection of lines tangent to the posterior border of the ramus and the lower border of the mandible

Me = menton, the most inferior point of the outline of the symphysis in the midsagittal plane

After the cephalometric landmarks were traced, the ANB angle was measured. The ANB angle measures the relative position of the maxilla to the mandible and is the angle formed by joining point A, nasion and point B. (10) A study by Oyonarte et al. in 2016 states that the ANB angle decreases during craniofacial growth.(11)

The upper and lower pharyngeal airway widths were measured.(12)

Upper Pharyngeal Airway Width(UPAW): This was measured from a point on the posterior outline of the soft palate to the closest point of the pharyngeal wall.

Lower Pharyngeal Airway Width(LPAW): This was measured from a point at the intersection of the posterior border of the tongue with the inferior border of the mandible to the closest point on the posterior pharyngeal wall.

The mean values of the pharyngeal airway dimensions were recorded and it was correlated with the skeletal occlusion type.

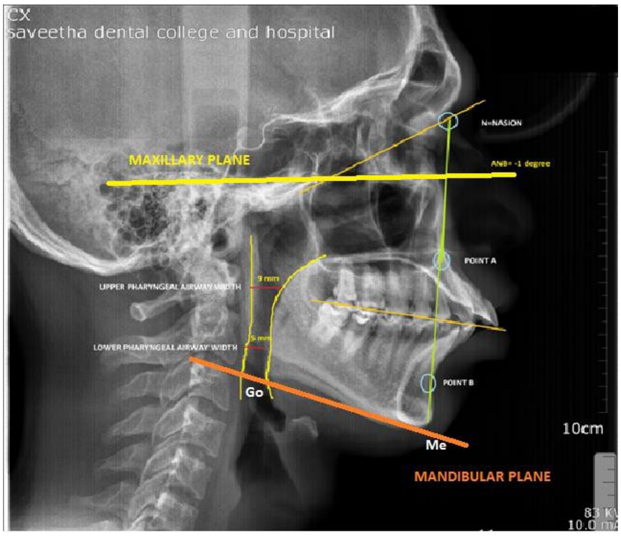

Fig 1: Cephalometric tracing of the landmarks for measurements of the upper and lower pharyngeal airway widths and ANB angle .

RESULTS

The results of the study indicate that the mean upper pharyngeal airway widths were 10.14 mm, 5.50 mm and 9.75mm in skeletal Class I,II,III occlusions respectively. Similarly the mean lower pharyngeal airway widths in skeletal Class I, II, III ooclusions were found to be 4.60 mm, 7.00 mm and 5.25 mm respectively. The mean ANB angle was found to be 1.48, and 2.83 degrees respectively.

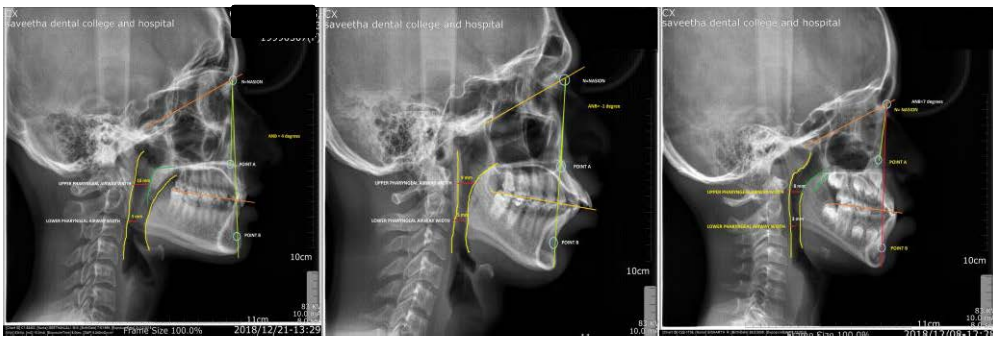

Fig 2: Measurements of UPAW,LPAW & correlation with the ANB angle in skeletal class I,II,III patterns

Table 1: Mean values of the upper and lower pharyngeal airway dimensions and ANB angle in skeletal class I, II, III patterns

S.no	Skeletal type	Mean upper	Mean lower	Anb angle
1.	CLASS I	10.14 mm	4.60 mm	1.48 degrees
2.	CLASS II	5.50 mm	7.00 mm	7.50 degrees
3.	CLASS III	9.75 mm	5.25 mm	2.83 degrees

DISCUSSION

The association between the width of the pharyngeal airway and skeletal growth pattern plays a very important role in assessing the amount of pharyngeal airway constriction. The narrowing of the pharyngeal airway is mainly due to etiological factors . This constriction mainly occurs in the nasopharyngeal region.(13) The features of the upper airway obstruction includes excessive anterior facial height, narrowed upper dental arch, high palatal vault, steepness of the mandibular plane angle, protrusion of the maxilla and incompetency of the lips.(14) In a study by Lopatiene et al. in 2016 to assess the relationship between malocclusion, soft tissue profile and pharyngeal airways, they found that the ANB angle was decreasing with an increasing width of the upper pharynx. The airways had also statistically significant negative correlation between the width of the lower pharynx and distance from the pper and lower lips.(15)

A study by Silva et al. in 2015 on the assessment of upper airway measurements in patients with mandibular skeletal class II malocclusion. This was done using 80 lateral cephalograms. They found that in class II individuals, the sizes of the oropharynx and nasopharynx as well as the mandibular position and length were found to be reduced.(16)

A study on the comparison of airway dimensions in skeletal class I malocclusions with different vertical facial heights by Blancas et al. in 2017 revealed statistically significant differences in several nasopharyngeal widths among different vertical facial heights. It was found that the subjects with brachyfacial pattern presented with larger nasopharyngeal widths in comparison to those with mesofacial ($p= 0.030$) or dolichofacial ($p= 0.034$) patterns .(17)

A similar study Shastri et al. in 2015 on the pharyngeal airway parameters with class I malocclusion with different growth patterns.They found that there was significant difference in pharyngeal airway measurements and dentofacial pattern of Class I subjects with different growth patterns were identified.(18)

Apart from the usage of 2-Dimensional imaging modalities , literature states that there have been various studies wherein the width of the pharyngeal airway and occlusion correlation have been done using 3-Dimensional imaging and it has increased advantages of image resolution and accuracy in measurements. A study was done by Wen et al. in 2017 to asses the upper airway morphology in skeletal class III malocclusions with and without mandibular asymmetry using three dimensional analysis with cone beam computed tomography(CBCT). It was found that In Class III subjects with severe mandibular asymmetry, the pharyngeal airway had constrictions and presented with a more elliptical shape as there was increased mandibular deviation ($P < .01$).(19)

A study by Li et al. in 2014 using CBCT for the evaluation of morphological changes in the upper airway in growing patients with class II division 1 malocclusion with mandibular retrusion using twin block appliance. They found that the upper airway of growing patients with Class II division 1 malocclusion and mandibular retrusion demonstrated a significant enlargement in the oropharynx and hypopharynx in comparison to those patients with class II malocclusion who did not undergo any treatment. After treatment with twinblock appliance, the oropharynx had demonstrated a more elliptic transverse shape and the hyoid bone was in a more anterior position.(20)

CONCLUSION

The constriction of the pharyngeal airway has many clinical implications such as increasing the occurrence of respiratory distress and also increases the onset of sleep apneas. In general skeletal malocclusion can cause variations in the width of the pharyngeal airways. Hence it is recommended that necessary orthodontic interventions need to be performed at the right time for preventing long term complications due to airway constriction in these patients.

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