Hyoid bone in skeletal Class II & skeletal Class III- A cephalometric study

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Abstract

Background & Objective: *The disturbances of orofacial functions lead to abnormal growth and development of the orofacial complex. The objective of the study was to determine the position of the hyoid bone in skeletal Class II & skeletal Class III subjects and it the position was affected by different skeletal patterns.*

Methods: *In the sample size of 102 was calculated using Cohen's formula, 102 lateral cephalograms were taken, (51 girls and 51 boys, aged 14-33 years) which were segregated using five different skeletal parameters into skeletal Class II & Skeletal Class III. All lateral cephalograms were traced and Independent t – test was used for the comparison. SPSS software was used for final analysis.*

Results: *Hyoid bone is anteriorly placed in males ($P<0.05$). Overall comparison between Class II, Class III subjects, Hyoid bone was more posteriorly situated in Class II subjects compared to Class III subjects and is statistically significant ($P<0.001$).*

Conclusion: *The sagittal skeletal pattern may be a contributory factor in variation position of hyoid bone, Hyoid was more posteriorly placed in Class II subjects than in Class III was most.*

Key words: *Hyoid bone, skeletal Class II & skeletal Class III.*

Introduction

The position of the hyoid bone relative to the cranial base and the mandible has been of interest specifically as an indicator of tongue posture and function.[1] More generally, the hyoid bone, supported by its muscular and ligamentous attachments, has broader physiologic ramifications as it provides a functional interface between mandibular, laryngeal and cranial structures and the vital passageways these structures define. The belief that hyoid posture may be correlated with mandibular morphology and position has led to a consideration of various skeletal types. The several studies in this area, however, have disparate results with some authors positively correlating hyoid position to skeletal type.[2,3,4,5] Surgical retrusion of the mandible for correction of mandibular prognathism also results in changes in hyoid position.[6,7,8,9]

Ever since Broadbent introduced radiographic cephalometry in 1918, its being used for research, diagnosis & treatment planning in various medical and dental fields. Roentgenography and cephalometrics has provided the Orthodontist with an ability to see beneath soft tissue, which gave them greater insight into most of the hard and soft anatomical structures that contribute to the facial growth. Pharyngeal airway dimension is an area of interest for many authors. Many articles were published to explore the relationship between nasopharyngeal airway and craniofacial growth.

The pharyngeal airway space can be affected by the position of the hyoid bone also, as it is influenced by the position of the tongue. During the last two decades, considerable attention has been given to the position of hyoid bone in relation to facial skeleton. Studies on various population samples have shown that changes in the hyoid bone seem to be related to changes in the mandibular position.

Materials & Methods

Pre-treatment lateral cephalometric radiographs were selected from Out Patient Department of the Department of Orthodontics & Dentofacial Orthopaedics, Government Dental College & Hospital, Srinagar, between 2012 and 2015.

For the proposed study the probability of type 1 error (α) is fixed at 5% and probability of type 2 error (β) at 20%.

Sample size determination was done using Cohen's d power table. The following formulae was used to calculate Cohen's d,

Cohen's d = where, M1 is mean 1 and M2 is mean 2.

So, for the power of the study as 80% the sample size of minimum of 51 for each group was established. Based on the above calculations, the study included a total of 102 sample with 51 subjects in Class II skeletal pattern and 51 subjects in Class III skeletal pattern. The level of significance was set at 0.05. Total of 102 subjects (ages 14–33 years) were included, 51 were male subjects and 51 were female subjects.

All subjects met the following inclusion criteria:

1. No history of orthodontic treatment.
2. Breathing comfortably through the nose.
3. No wound, burn or scar tissue in the neck region.
4. No deglutition disorder or visual or hearing disorder.

And the following exclusion criteria:

i. Subjects with cleft lip and palate.
ii. Subjects with history of chronic mouth breathing, snoring and tonsillectomy.

To have standardized cephalometric radiographs, it became important that all the radiographs were taken from the same X-ray machine with the subjects in the natural head position, with teeth in maximum intercuspation and lips at repose. All the lateral cephalometric radiographs were taken by the same operator from the standardized Orthophos XG5 DS CEPH (SIRONA) on a standard Konica Minolta 8 × 10 inch film with an anode to mid subject distance of 5 feet by the same operator. Natural head position was obtained by asking the subject to look straight ahead such that the visual axis was parallel to the floor. Thyroid shield and lead apron were worn by the subject to reduce radiation exposure. All the films were exposed with 64 KVp, 8 mA and an exposure time of 9 seconds. Lateral cephalogram were traced upon an A4 size acetate paper with a 2B or 3HB hard lead pencil over well-illuminated viewing screen. The linear measurements were recorded with a measuring scale up to a precision of 0.5 mm.

After going through different studies conducted on the parameters used for assessment of antero-posterior discrepancy[10,11,12] it was decided to segregate the radiographs into different antero-posterior skeletal patterns on the following basis.

i) ANB angle.
ii) Beta angle.
iii) Witt's appraisal.
iv) Yen angle.
v) FABA angle.

Keeping in view the limitations of each parameter used individually, five parameters were used to rule out any bais of the sample segregation (Table 1). In order to fall into a particular skeletal pattern, the subject had to agree with atleast three of the five parameters.

Planes and Parameters used: (Fig. 1)

A total of 4 parameters were undertaken in the study .They are as follows: (Table 2)

1. H┴MP, perpendicular distance from hyoid bone to mandibular plane
2. H┴C3RGN, perpendicular distance from hyoid bone to the line connecting C3 and RGN
3. H-RGN, distance between hyoid bone and RGN
4. H-C3, distance between hyoid bone and C3

Landmarks undertaken in the same are as discussed below.

- Me: Menton
- Go: Gonion
- B: point B
- RGN: Retrognathion
- H: Hyoidale
- C3: Antero-inferior limit of third cervical vertebra

SPSS (Version 16.0) and Microsoft Excel software were used to carry out the statistical analysis of data. Data was analyzed with the help of descriptive statistics viz., mean and standard deviation and presented by bar diagrams. Student's independent t-test was employed to test the differences between males and females and two different skeletal patterns. A P-value of less than 0.05 was considered statistically significant.

Results

In Class II, there was no statistically significant difference in position of hyoid in male and female subjects.(Table 3) Although, in Class III it was found that hyoid bone was anteriorly placed in male subjects.($P<0.01$). (Table 4) The hyoid bone was posteriorly placed in Class II female subjects compared to Class III female subjects and is statistically significant ($P<0.01$).

The hyoid bone was posteriorly placed in Class II male subjects compared to Class III male subjects and is statistically significant (P<0.001). Overall comparison between Class II, Class III subjects, Hyoid bone was more posteriorly situated in Class II subjects compared to Class III subjects and is statistically significant (P<0.001). (Table 5)

Discussion

The first parameter used to assess antero-posterior skeletal relationship was ANB angle. The ANB angle is considered the most commonly used cephalometric measurement for evaluation of antero-posterior jaw relationship.[13,14] The validity of this measurement had been investigated by several researchers. Oktay[13] and Ishikawa et al[15] reported that ANB angle is one of the most reliable and accurate measurements of the antero-posterior jaw relationship. On the other hand Jacobson[16] showed that ANB angle does not provide adequate assessment of jaw relationship because rotational growth of the jaws and the antero-posterior position of nasion influence the ANB angle. Furthermore, Hussels and Nanda[17] reported that the vertical lengths from nasion to point B and from point A to point B are usually affected. Furthermore, rotation of the jaws by either growth or orthodontic treatment can also change the ANB reading.[18]

A second most widely used measurement to assess the antero-posterior skeletal relationship, the Wit's appraisal, was introduced by Alxender Jacobson to overcome problems related to the ANB angle.[18] However, the Wit's appraisal relates points A and B to the functional occlusal plane; this generates 2 major problems. First, accurate identification of the occlusal plane is not always easy or accurately reproducible,[19] especially in mixed dentition patients or patients with open bite, severe cant of the occlusal plane, multiple impactions, missing teeth, skeletal asymmetries, or steep curve of Spee. Second, any change in the angulation of the functional occlusal plane, caused by either normal development of the dentition[20,21] or orthodontic intervention, can profoundly influence the Wit's appraisal. Therefore, consecutive comparisons of the Wit's appraisal throughout orthodontic treatment might be of limited value. To overcome these problems, a new measurement was considered. This measurement, the Beta angle, does not depend on cranial landmarks or the functional occlusal plane. It uses 3 points located on the jaws- point A, point B and the apparent axis of the condyle 'point C'. The changes in this angle reflect only changes within the jaws. In contrast to the ANB angle, the configuration of the Beta angle gives it the advantage to remain relatively stable even when the jaws are rotated. Another advantage of the Beta angle is that it can be used in consecutive comparisons throughout orthodontic treatment because it reflects true changes of the sagittal relationship of the jaws, which might be due to growth or orthodontic or orthognathic intervention.[14] However, precisely tracing the condyle and locating its center is not always easy. For that reason, some clinicians might hesitate to use the Beta angle. To accurately use that angle, the cephalometric x-rays must be high quality and it still depends upon point A & point B which according to Holdaway, change the site substantially due to both treatment and growth. Further to overcome all the above mentioned problems, an additional parameter. The Yen angle was considered. It was reported that the Yen angle was not influenced by growth changes and can be easily used in mixed dentition.[22] Another parameter to be considered for the antero-posterior classification of radiographs was FABA which was given by Sang D. Yang & Cheong H. Shur. In spite of knowing the uncertainty of accurately locating porion on a cephalometric film, the Frankfort plane has proved adequate for facial typing. This conclusion was drawn after comparing the several reference planes by the above mentioned authors. Intra - group comparison in male and female subjects when all the 4 parameters where compared within the same skeletal type in male and female subjects it was found that vertical and anteroposterior position of the hyoid bone showed sex differences in III subjects only, which are in agreement with these reported in literature[23,24,25] and may be because of sex difference in neck thickness. Also similar finding was seen by Shen et al in their study and also sex dimorphism in hyoid position was reported by King in his study which could possibly be explained on the basis of different timing of pubertal growth spurts in males & females.

Inter-group comparison between female subjects, Hyoid bone was found to be posteriorly and highly placed in Class III than in Class II subjects. This finding is supported by Marson and Ayunum et al in their finding.

Inter-group comparison between male subjects, in this study while making inter-group comparisons amongst males we found that , Hyoid position was found to be posteriorly placed in Class II subjects when compared to Class III subjects and at the same time posteriorly placed in Class II in comparison to Class I subjects. Which was on agrrement with the syudy conducted by Abu Allhaija and Al- Khateeb[26].

Overall comparison between Class II, Class III groups. In this study we found that, Hyoid bone was higher in relation to line joining C3- RGN in Class III than in Class II. Hyoid bone is more posteriorly placed in Class II when compared to Class III These finding can be supported by findings in literature by Graber[27], Issa[28], Yemaoka[29]. The relationship between the distance between the third cervical vertebra and the hyoid bone (C3Hy) and mandibular length would appear logical, because as the body of the mandible lengthens, the attachments of the genioglossus and geniohyoid muscles move forward away from the oropharynx, changing the position of the hyoid bone along with it. This could be explained as a more posterior positioning of the temporomandibular joint, requires a longer mandible to maintain a normal relationship with the maxilla, as such affecting the position of tongue as well as hyoid bone. The facial pattern can be suggested as potential explanation for the discrepancy in the position of hyoid bone as a result of mandibular size and position.

Battagel et al concluded that mandibular advancement is associated with subsequent hyoid bone displacement that improves the airway's permeability. Turnbull and Battagel demonstrated a significant decrease in the retro lingual airway dimension after mandibular setback surgery and a significant increase in this dimension after mandibular advancement surgery. The use of lateral cephalometric radiographs to evaluate the upper airway is somewhat limited as they provide only 2-dimensional images of the hyoid bone and adjoining structures, which consists of complex 3-dimensional anatomical structures. Linder-Aronson[30] found a high level of correlation between the results of posterior rhinoscopy and radiographic cephalometrics in the assessment of adenoid size. This observation was made also by earlier authors who found that lateral skull radiographs provide a good picture of the size of the nasopharyngeal airway in children of all ages. The position of the hyoid bone should always be evaluated fully, making use of all of the appropriate diagnostic means. In addition, despite imaging limitations of lateral cephalometry especially in the transverse plane, this technique can provide assessment of the relationship between craniofacial characteristics and hyoid position, plus is radially available with the Orthodontist as it forms as important part of diagnosis and treatment planing.

Skeletal type and hyoid have rarely been investigated with a large sample size. This study was conducted with a sample of 102 subjects and with more than one parameter was used (ANB angle, Beta angle, Wit's appraisal, Yen angle and FABA angle) to segregate the sample.

Conclusion

In **conclusion** of this study that was undertaken, following points can be made.

- The null hypothesis was rejected and it was established that there was a positive association between hyoid position and different skeletal patterns.
- The sagittal skeletal pattern may be a contributory factor in variation position of hyoid bone.
- Hyoid was more anteriorly placed in Class III male subjects.
- Hyoid was more posteriorly placed in Class II subjects than in Class III.
- Hyoid was superiorly placed in Class III subjects.

Although the sample size of 101 was taken in the present study to rule out bais, further studies with a bigger sample size and latest imaging techniques like CBCT are warranted for future research purposes.