Evaluation of hyoid bone position and its correlation with pharyngeal airway space in different types of skeletal malocclusion

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Abstract

Introduction: The hyoid bone and its relation with the pharyngeal space in health and disease has been an intriguing subject for years. **Aim:** This study attempts to evaluate the hyoid bone position and to ascertain any correlations with pharyngeal airway space in skeletal class I, II, and III malocclusions. **Materials and Methods:** McNamara's airway analysis was carried out to assess the upper and lower airway widths and Hyoid triangle analysis by Bibby and Preston was carried out to determine the position of the hyoid bone. **Conclusion:** A positive correlation was found between the lower airway and horizontal distance from the hyoid bone to the retrognathion in class I skeletal pattern with average growth pattern.

Keywords: Hyoid bone, pharyngeal airway, skeletal malocclusion

Introduction

The hyoid bone is a U shaped bone located in the anterior midline of the neck, which at rest lies at the level of the third cervical vertebrae. The hyoid is unique in that, unlike all other bones of the head and neck, it has no bony articulations. It plays an active role in achieving a balance between anterior and posterior muscle tension relative to the occipital condyles, which in turn helps to balance the head in an upright posture. The hyoid bone provides an attachment for the supra- and infra-hyoid muscles which form a part of the oropharyngeal complex.

The position of the hyoid bone postoperatively might reflect stretching of the suprahyoid musculature which could contribute to relapse.[1-3] Patients suffering from obstructive sleep apnea are reported to have narrowing of the airway and a low hyoid bone position.[4] The close relationship between the pharynx and the hyoid bone justifies orthodontic interest to study the interactions, which may occur between them. Few researchers have studied the position of the hyoid bone and tried to correlate its position in various malocclusions, but have reported conflicting results.[5-12]

The present study aims to evaluate the position of the hyoid bone and investigate any correlation between its position and the pharyngeal airway in different types of malocclusion.

Materials and Methods

Inclusion criteria included healthy patients in the age group of 16-25 years with normodivergent facial pattern (Frankfort Mandibular Plane Angle [FMA] between 21 and 28). Patients with gross dental abnormalities, oral habits, previous orthodontic treatment history or history of any diseases affecting the pharyngeal structures were excluded.

Standardized lateral cephalograms that fulfilled the inclusion criteria and exclusion criteria were selected from the departmental archives.

All cephalograms were traced by the same operator. A few weeks later, randomly selected cephalograms were retraced by the same operator and the method error was noted to be within acceptable limits.

All the cephalograms were then divided into three groups based on the skeletal malocclusion as follows.

Group 1 comprised of 20 samples having class I skeletal relationship with A point, nasion, B point (ANB) angle between 0° and 3° and Sella-Nasion-B point (SNB) angle between 78° and 82°.

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Group 2 comprised of 20 samples having class II skeletal relationship with ANB angle ≥4° and SNB angle <78°.

Group 3 comprised of 20 samples having class III skeletal relationship with ANB angle ≤0° and SNB angle >82°.

McNamara's airway analysis was carried out to assess the upper and lower airway widths. Hyoid triangle analysis by Bibby and Preston was carried out to determine the position of the hyoid bone.

Statistical analysis

Descriptive statistics including the range, mean and standard deviation were carried out. Kolmogorov-Smirnov and Shapiro-Wilks test was done to check the normality of data distribution. The results showed normal distribution for all data apart from the ANB angle and the angular and vertical measurements of the hyoid bone. Accordingly the intergroup comparisons of age, SNB, FMA and upper and lower pharyngeal airway and horizontal measurements of hyoid were performed with parametric analysis of variance (ANOVA) followed by multiple comparisons with Bonferroni adjustments as and when required and intergroup comparisons of ANB angle and angular and vertical measurements of hyoid are done using nonparametric Kruskal-Wallis test followed by Mann-Whitney U-test. Karl Pearson correlation coefficient was used to find out the correlation of the hyoid bone position with the pharyngeal airway space. Level of significance is set at $P < 0.05$. All statistical analysis was carried out with SPSS software (SPSS Inc, Chicago, version 13).

Results

Descriptive statistics done for the sample selected concluded that there were no significant differences between the groups with regards to sex and age distribution. The groups were divided on the basis of ANB into skeletal class I, class II, and class III with the mandible positioned forwardly in class III and backwardly in class II malocclusions. This was verified by the fact that ANB and SNB were significantly different in the three groups. The sample was selected such that all the patients were normodivergent and this was evident by the FMA value not showing any significant difference in between the three groups.

The Karl Pearson test found a statistically significant positive correlation between the lower airway and the horizontal distance from the hyoid bone to the retrognathion in class I skeletal pattern cases. There was no correlation found between the airway and hyoid bone positions in class II and III skeletal bases.

The results of the ANOVA test done to compare the horizontal position of the hyoid bone between the three groups concluded that the horizontal position of the hyoid was very stable and the difference between the groups is not statistically significant. The results of the Kruskal-Wallis test done to compare the angular and vertical position of the hyoid bone between the groups concluded that the angular and vertical position of the hyoid bone is not affected by a change in skeletal base relationship.

Discussion

The precise measurement of the hyoid bone position by cephalometric means is considered difficult. Previous investigators have found that the hyoid bone has a highly variable position not only from person to person, but also at different time intervals in the same person.[6,13] Such variability in results could be attributed to the fact that most analysis has employed cranial structures to define the plane from which the hyoid bone position is measured and that a small variation in the position of the reference plane results in a much greater apparent variation of the hyoid bone irrespective of whether the hyoid bone changed or not. The present study attempts to minimize this effect by using the hyoid triangle analysis which employs planes between the mandibular symphysis and the vertebrae.

The assessment of the horizontal position of the hyoid bone as evident from the ANOVA test results revealed that the hyoid bone is relatively constant. The hyoid bone was found to be less variable in its anteroposterior position and was found to be located almost centrally between the symphysis and the third cervical vertebrae in all the three groups. This is in accordance with the findings reported by Bibby and Preston[14] and Kumar.[15] The hyoid also maintains a very constant relationship to the cervical vertebrae as shown by the C3-H values in the three groups. This finding is in agreement with previously published results by Bibby and Preston,[14] Tourné[16] and Haralabakis *et al*.[17]

The factors that might play a role in the anteroposterior positioning of the hyoid include the relative lengths of the muscles running from the base of the skull, mandible, and tongue to the hyoid bone and maintenance of the patency of the pharyngeal airway space.

The hyoid angle represents the angular measurements between the C3-RGn plane and the hyoid axis. The angular position of the hyoid bone as evident from the results of the Kruskal-Wallis test exhibits no significant difference between the three groups. The vertical position of the hyoid bone was highly variable as shown by the value of H-H1. This is in agreement with the findings of Bibby and Preston[14] and Kumar.[15]

Opdebeeck,[18] Graber[7] and Adamidis and Spyropoulos[19] studied the relation of hyoid bone rotation and mandibular inclination and concluded that the hyoid bone follows the rotation of the mandible and this helps to maintain airway patency.

In this study, the hyoid bone position was assessed using the hyoid triangle analysis. However, some individual variations may have to be accepted in the hyoid bone measurements.

Under the effect of musculature, the hyoid bone changes its position under normal physiologic manifestations of head posture, cervical spine position and craniofacial angulation. An understanding of the factors involved in its position is crucial to understanding stability following mandibular orthognathic surgery, myofunctional treatment, and conditions like obstructive sleep apnea. The hyoid bone might have a role in morphophysiologic manifestations of extreme dentoskeletal malocclusions like anterior open bite and in growth aberrations resulting from nasal obstruction. Further studies could be undertaken to study the change in hyoid bone position in subjects with different growth patterns.

Conclusion

A positive correlation was found between the lower airway and horizontal distance from the hyoid bone to the retrognathion in class I skeletal pattern with average growth pattern. However, there were no correlation found in the horizontal and vertical position of the hyoid bone in class II and III skeletal pattern with normal growth pattern. The hyoid bone maintains a relatively constant position anteroposteriorly in class I, II, and III subjects with average growth pattern. It does not exhibit any significant rotation in subjects with average growth pattern.

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