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RESEARCH ARTICLE

POSITION OF HYOID BONE IN DIFFERENT TYPES OF MALOCCLUSION and IT'S CO-RELATION WITH PHARYNGEAL AIRWAY SPACE

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ABSTRACT

Introduction: Human hyoid bone is anunique and important part of musculo-skeletal apparatus of the craniofacial complex. Change in it's position postoperatively might contribute to relapse and affect the dimension of airway.The aim of the present study is to evaluate the position of the hyoid bone and its co-relation with pharyngeal airway space in different skeletal pattern.

Methodology: The study was conducted in-vitro and samples were equally divided in three groups (n=25) based on skeletal pattern.

Result: Skeletal changes affect vertical and horizontal position of hyoid bone but no significant change in pharyngeal airway space.

Conclusion - As limited parameters used in this study we can use these parameters in our regular records for easy evaluation of hyoid bone position and to predict the tendency of relapse in patients treated with functional appliance and orthognathic surgery.

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INTRODUCTION

Human hyoid, U - shapedbone formed by the ossification of cartilages of second and third visceral arches isan important part of craniofacial complex (Pae *et al*., 2014; Tekale, 2014; Jose, 2014 and Durzo *et al*., 2014). It has no bony articulations andsuspended in the soft tissue by ligaments, muscles and fasciae (Urzal, 2014). In early human life it is positioned above the lower borderof mandible but with age, gradually descends to fourth cervical vertebra. Positional change of hyoid occurs with head position, oral function, tongueand other physiologic states (Tarkar, 2016). It plays role in maintaining balance of head in an upright posture. It provides an attachmentand maintains the tonicity for supra and infrahyoid muscleswhich forms a part oforo-pharyngeal complex. The position of the hyoid bone postoperatively might reflect stretching of the suprahyoid musculature which could contribute to relapse (Jose, 2014). Hencemyofunctionaland surgical therapy affect the hyoid bone position by altering the mandibular position (Verma, 2012).

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As the anterior boundary of airway is formed by hyoid hence any change in position of hyoid can adversely affect airway dimensions. Patient with obstructive Sleep apnoea, enlarged tongue, soft palate, retruded maxilla or mandible andhyperdivergent growth pattern have reduce airway space (Batool, 2010 and Allhaija, 2005). Skeletal correction in class III children withorthopaedic appliance changes the airway width (Lee, 2011). The aim of the present study is to evaluate the position of the hyoid bone and its relation to pharyngeal airway space using teleradiographs in different skeletal patterns with average growth pattern.

MATERIALS AND METHODS

The study was conducted in vitro. 75 patients seeking orthodontic treatment in the department of Orthodontics and Dentofacial Orthopaedics in Kothiwal Dental College and Research Centre, Moradabad were randomly selected for this study. Lateral cephalogram were taken for all those patients in the department of Oral Medicine and Radiology. All lateral teleradiographs selected for the present study sized 18 × 24 cm^2. An acetate sheet was laid over the teleradiograph and the following anatomoradiographic points and planes were marked

on the sheet with 4H pencilby same operator. The samples were equally divided (n=25) in skeletal class I, II, III on the basics of ANB angle, Witt's appraisal and Beta angle. Skeletal classification was decided based on the priority among these three angles. Patients between ageof 13 - 26 years with average growth pattern were included. Patients with dental agenesis, congenitally poor oro-facial formation, previous orthodontic treatment, orthognathic, plastic surgery or doubts and imprecision regarding the diagnosis of deglutition were excluded. Following points taken under consideration are - H (most antero-superior point of the body of the hyoid bone), PTM- (Postero-superior point of pterygomaxillary fissure), PNS- (Posterior most point of palatal plane) (Júnior, 2012). Following lines taken under consideration are -MP(mandibular plane),T(tuber -line of intersection between the centre of the PTM and PNS), U-PAS(Width of upper pharyngeal airway), L-PAS(Width of lower pharyngeal airway) (Júnior, 2012 and Ucar, 2011). The point H was joined using a single ruler to MP and T lines, and the distances weremeasured in millimetres. Line joined between point ofintersection of line from soft palate centre perpendicular to posterior pharyngeal wall and from posteriorpoint of lower border of mandible perpendicular to pharyngeal wall (Figure : 1).

Statistical Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 13.0 (SPSS Inc., Chicago, Ill). The normality test of Shapiro-Wilks and Levene's variance homogeneity test were applied to the data, which were found to be normally distributed, and homogeneity of variance was noted among groups. Thus, statistical evaluation of values was performed between test groups using parametric tests. A chi-square test was performed. Arithmetic mean and standard deviation values were calculated for each measurement. Group differences were analyzed with one-way analysis of variance (ANOVA). For multiple comparisons, a post hoc bonferronitest was used. When the P value was less than .05, the statistical test was regarded as significant.

RESULT

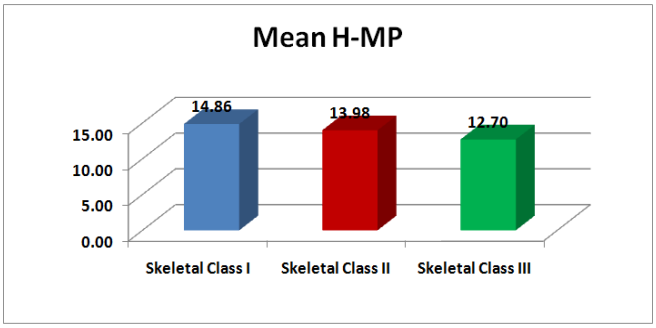
All values obtained from different skeletal groups were subjected to statistical analysis. Ethical committee clearance was obtained from institutional ethics and review board KDCRC, Moradabad.

Table 1. Mean of H-MP in different skeletal patterns (values in mm)

	H-MP				
	Number	Mean	Std. Deviation	F-value	p-value
SK CL I	25	14.86	2.71	5.480	0.006*
SK CL II	25	13.98	2.04		
SK CL III	25	12.70	2.15		

One-way ANOVA test* Significant difference

Table.1 shows the mean of H-MP inskeletal class I (14.86 ± 2.71), class II (13.98± 2.04) and class III (12.70±2.15)with no significant difference of .006. All the values are represented in graph 1.The inter-group comparison shows significant value (p = .005) among classIand classIII and no significant difference between classIand classII (p = .552), class II and class III (p = .165).



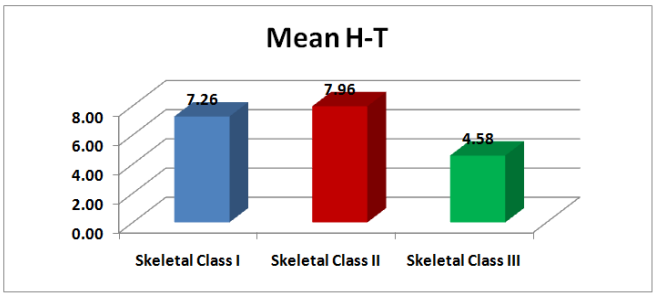
Graph 1. Mean of H-MP in different skeletal patterns (values in mm)

Table 2. Mean of H-T in different skeletal patterns (values in mm)

	H-T				
	Number	Mean	Std. Deviation	F-value	p-value
SK CL I	25	7.26	0.81	42.799	< 0.001*
SK CL II	25	7.96	2.07		
SK CL III	25	4.58	0.81		

One-way ANOVA test* Significant difference

Table.2 shows the mean of H-T in skeletal class I (7.26±0.81), class II (7.96± 2.07) and class III (4.58± 0.81) with significant difference of < .001. All the values are represented in graph 2.The inter-group comparison shows significant values (p < .001) among class III and class I, class II and non-significant (p = .221) among class I and class II.



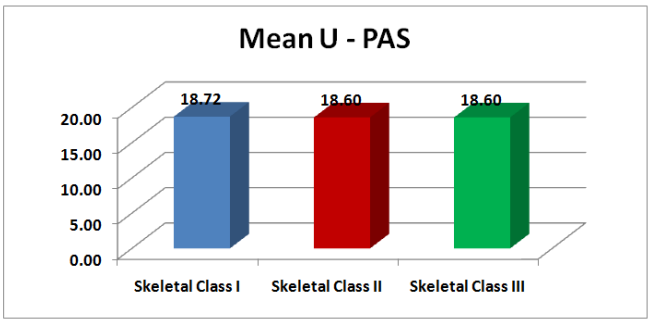
Graph 2. Mean of H-T in different skeletal patterns (values in mm)

Table 3. Mean of U - PAS in different skeletal patterns (values in mm)

	U - PAS				
	Number	Mean	Std. Deviation	F-value	p-value
SK CL I	25	18.72	1.06	0.095	0.910#
SK CL II	25	18.60	1.19		
SK CL III	25	18.60	1.12		

One-way ANOVA test# Non-significant difference

Table.3 shows the mean of upper pharyngeal airway space (U-PAS) in skeletal class I (18.72± 1.06), class II (18.60± 1.19) and class III (18.60±1.12) with no significant difference of .910. All the values are represented in graph 3.The inter-group comparison shows no significant values (p < 1.000) among all groups. Table.4 shows the mean of lower pharyngeal airway space (L - PAS) in skeletal class I (10.92 ± .70), class II (11.20 ± .87) and class III (11.28±.94) with no significant difference of .289. All the values are represented in graph 4.The inter-group comparison shows no significant values (p < 1.000) among all groups.

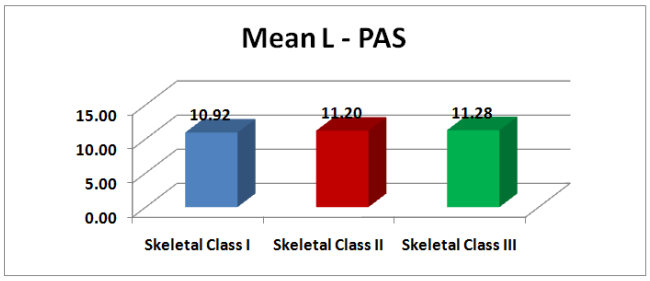


Graph 3. Mean of U - PAS in different skeletal patterns (values in mm)

Table 4. Mean of L - PAS in different skeletal patterns (values in mm)

	L - PAS				
	Number	Mean	Std. Deviation	F-value	p-value
SK CL I	25	10.92	0.70	1.264	0.289#
SK CL II	25	11.20	0.87		
SK CL III	25	11.28	0.94		

One-way ANOVA test# Non-significant difference



Graph 4. Mean of L - PAS in different skeletal patterns (values in mm)

DISCUSSION

In our study, vertical position of hyoid bone shows significant difference amongall three groups. It also shows significant difference among skeletal class I with class III. Amayeri[13] *et al.*(2014) documented that the position of hyoid bone was lower in class III than in class I and class II malocclusion in relation to the anterior cranial base(S-N plane) and F-H plane vertically. Hyoid bone didn't follow completely the mandibular movement. This result is not in agreement with our resultbut the intergroup difference is non-significant among class I with class II, class II with class III but significant result between class I with class III, as we have taken average grower and a certain age group in our study. Thus it appears that mandible moved posteriorly in relation to the other craniofacial structures, but the tongue and hyoid bone do not otherwise it would encroach upon vital oro-pharyngeal and laryngeal spaces. As a functional compensation, hyoid bone and related structures are guided to an inferior position to avoid compromising the airway space. This suggests that stability and patency of pharyngeal airway are primary factors in the hyoid bone positioning. This is in consistency with other studies of Tourne, (1991), Battagel *et al.* (1999). Opdebeeck, Adamidis and Spyropoulos (Adamidis, 1992), and Graber (Graber, 1978), studied the relation of hyoid bone rotation to mandibularinclination and concluded that it follows the rotation of the mandible and helps to maintain airway patency. Allhaija, Al-khateeb (Allhaija, 2005) documented different positions of hyoid bone in different skeletal patterns. Yamaoka *et al* (Yamaoka, 2003), found that tongue root was situated more posterior in Class II than Class III females. In our study, mean horizontal position of hyoid bone shows significant difference in different skeletal groups. It shows significant difference among class III with class I and class II. Ceylan and Oktay, (1995) related the distance among hyoid bone and cervical vertebra and concluded that it is reversely affected by ANB angle changes. The result was similar to the study conducted by Michael and Donald, (1999), Abu Al Haija and Al Khateeb, (2005), who reported that hyoid bone moves more posterior with increase in ANB angle. The explanation of this phenomenon could be the genioglossus muscle as the main protruder of the tongue will generate upper airway dilating forces to maintain upper airway patency and as the hyoid bone moved forward would pull the tongue anteriorly en mass, leading to increase in tongue pressure and maintaining the pharyngeal space at the level of the base of the tongue. In contrast to other studies using lateral cephalometry, Maria *et al*. (2006), reported a constant relation between the hyoid bone and the third cervical vertebra in a study conducted to establish normal values for the position of the hyoid bone in a Brazilian group which is similar to the studies of Bibbyand Preston, (1981), Bibby, (1984) and Kolias and Krogstad, (1999).

The angular and linear measurements showed no significant difference in relation to hyoid bone and mandible in the vertical plane. Saleh F, (1996) conducted a study in Lebanese population and measured the sagittal effect of the mandibular growth on the hyoid bone position in the anteroposterior and vertical planes and documented that position of the hyoid bone is more determined by the musculature rather than the mandibular position. Adamidis and Spyropoulos, (1992) reported a significant difference in the position of hyoid bone between class I and class III malocclusion as the hyoid bone laid more anteriorly in class III than in class I. This finding could be attributed to the muscular attachment of the hyoid bone and mandible. Battagel *et al*. (1999) and Kuroda *et al*. (1966) documented more posterior position of hyoid bone in skeletal class II maloclusion subjects. According to the study of Jose *et al*. (2014) (Jose, 2014), 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. Bibbyand Preston (Bibby, 1981) and Kumar (Kumar, 1983) reported same findings. 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 study by Bibby and Preston (Bibby, 1981), Tourne (Tourné, 1991) and Haralabakis (Haralabakis, 1993), *et al*. Position of hyoid bone is never evaluated while doing any regular pre-treatment procedures in patients. The factors that might play a role in the antero-posterior position of the hyoid include the relative length of the muscles running from the base of the skull, mandible, and tongueto the hyoid bone. During the last two decades, considerable attention has been given to the position of the hyoid bone in relation to the facial skeleton.

The position of the hyoid bone postoperatively might reflect stretching of the suprahyoid musculature which could contribute to relapse. Hyoid bone had been studied by many researchers and they used plenty of parameters to evaluate the position but in our study we used very limited parameters to evaluate the exact position. Hence we can use these parameters

in our regular pre-treatment records for easy evaluation of hyoid boneposition andpredict the tendency of relapse in patients treated with functional appliance and orthognathic surgery. In a study conducted by Milena (Cabral, 2013) *et al*. change in the position of the hyoid bone in the horizontal direction observed, probably due to a stretching of the suprahyoid muscles resulting from chin advancement surgery. In a study conducted by Armando *et al*. hyoid bone follow the advancement of mandible after surgical procedure and moves closer to the body ofmandible due to tensile strength of musculature. Hence, more studies should be conducted to evaluate the positional stability of hyoid bone post surgically or post functionally. In our study, there was no significant difference in pharyngeal airway spaceamong different skeletal patterns. Allhaija *et al*, 2005 reported antero-posterior pharyngeal airway dimensions were not affected by the changes of the ANB angle.

This was in agreement with our study. Because the hyoid bone is located more posterior in Class II skeletal pattern, the genioglossus, the main protruder of the tongue, generates upper airway dilating forces to maintain upper airway patency (Júnior, 2012), However, Kerr (Kerr, 1985) reported that Class II subjects had a larger nasopharyngeal area than Class I malocclusion. The vertical airway length was affected by the change of ANB angle. Pae (Pae *et al*., 1997) *et al*. reported that as hyoid bone moves inferiorly, the pharyngeal length become longer because the hyoid bone and epiglottis are in a close anatomical relationship. Reddy *et al*. (2011), reported that subjects with different skeletal patterns and different growth patterns when compared with each other had shown statistically significant differences for both the upper and lower pharyngeal airway widths. Subjects with a Class II malocclusion and normal growth pattern had a larger upper pharyngeal airway when compared with a Class I normal grower. However the comparison of the upper and lower pharyngeal airway space in a normal and vertical grower in different skeletal pattern when done independently, showed no significant difference.Ceylanand Oktay (Ceylan, 1995) demonstrated the pharyngeal structures were not affected by changes in the ANB angle. Kerr (Kerr, 1985) stated that there was a low correlation between the nasopharyngeal and dentofacial structures when the nasal functions were normal. All these study are in agreement with our result. Wenzel *et al* (Wenzel, 1989) reported no correlations between airway size and mandibular morphology, although a significant relationship was found between changes in nasopharyngeal airway size and maxillary prognathism. Paul and Nanda (Paul, 1973) found greater prevalences of mouth breathing and nasopharyngeal airway obstruction in subjects with Class II malocclusions. In a study done by Zhe Zhong (Zhong, 2010) *et al*. the results seemed to suggest that the dimension of the oropharynx decreased markedly from Class III to Class Iand to Class II subgroups, in the normodivergent facial pattern. It shows statistically significant differences in lower pharyngeal airways between a normal and vertical growth pattern among different skeletal groups. This result is not in agreement with our result.

Conclusion

- Patients with different skeletal pattern in average grower showed significant difference in the position of hyoid bone vertically and horizontally.
- As ANB increases position of hyoid bone shows downward and backward migration.
- Patients with different skeletal pattern in average grower showed no significant difference in size of upper and lower pharyngeal airway space.
- Position of hyoid bone plays an active role in achieving balance between anterior and posterior muscle tension and postoperatively might stretch the musculature which can cause relapse, hence it should be evaluated in pre, post treatment and follow up records in regular basis.

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