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Comparison of Hyoid Bone Position in Skeletal Class I Subjects with Varying Growth Patterns: A Cephalometric Study

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Abstract

Introduction Hyoid bone plays a significant role in physiological functions of craniofacial region, and its position adapts to changes of the head posture. The objective of this study was to evaluate the hyoid bone position among skeletal Class I subjects with various growth patterns.

Materials and Methods 90 subjects of north Indian origin, aged between 16 to 30 years, having skeletal class I relation were selected for the study. Subjects were then subdivided into three groups, that is, Group I (*n* = 30; normodivergent), Group II (*n* = 30; hypodivergent) and Group III (*n* = 30; hyperdivergent), based on their vertical growth pattern. Lateral cephalograms were traced and analyzed manually for evaluation of hyoid bone position.

Result The sagittal position of the hyoid bone shows no significant difference with varying growth patterns. The vertical relation G-C_3Chor distance showed significant difference in hypodivergent subjects. The axial inclination of the hyoid bone showed no significant difference between different growth patterns.

Conclusion The anteroposterior position of the hyoid bone does not change with different growth patterns in skeletal class I subjects. The G-C_3Chor distance was found to be statistically significant when the three groups were compared.

Keywords
► cephalometrics
► growth patterns
► hyoid bone

Introduction

From the past few decades, significant consideration had been focused on the hyoid bone location with regard to the craniofacial skeleton.[1] Hyoid bone is a horseshoe-shaped bone, present on anterior midline of the neck, situated between chin and thyroid cartilage. Hyoid bone has no osseous joint unlike the various bones of head and neck. Both infra- and suprahyoid groups of the muscles associate the hyoid bone to other structures, for example, tongue, mandible, etc. Gray said any change seen with location of the connecting structures to the hyoid bone will directly affect the position of the hyoid bone in space.[2] Various studies showed that any change in the hyoid bone position was linked with change in mandibular position.[3-5] Hyoid bone position was seen to be affected with anteroposterior changes in head posture.[6,7] Investigators studied various important factors associated with the hyoid bone, for example, its functional anatomy, various features influencing the situation of the hyoid bone, its diagnostic importance in clinical orthodontics, etc. Past investigations have described close association between hyoid bone as well as its nearby hard tissues in subjects with divergent sorts of facial patterns.[1]

Bibby and Preston, Michael and Donald, and Maria et al observed significance of hyoid bone lies with its distinctive anatomic interactions and mentioned that even with the slight motion of the head, a greater variability on the location

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of the hyoid bone was encountered, thus showing their close association to one another. Ceylan and Oktay exhibited that an inverse relation existed between the ANB angle and the distance between the hyoid bone and fourth cervical vertebra.[1] Grant established that the hyoid bone position did not vary among the three classes of malocclusion.[8] Tallgren and Solow studied the position of hyoid bone among three groups of Finnish women aged between 20 to 29, 30 to 49, and 50 to 81 years. They found that an increase in hyomandibular distance was linked with a higher mandibular inclination, and there was less variability seen with the hyoid bone position in relation to cervical column as compared with maxilla and mandible.[8]

Earlier studies have not illustrated much about the sagittal relationship of hyoid bone position with varying growth patterns.[9] So, it is necessary to investigate if any difference exists in the situation of hyoid bone among skeletal class I subjects with different growth patterns.

Materials and Methods

Pretreatment lateral cephalograms of 90 subjects aged between 16 to 30 years with skeletal class I were selected from the archives of Department of Orthodontics and Dentofacial Orthopedics of Bhojia Dental College, Baddi, Solan district, Himachal Pradesh. Only those subjects were included who had skeletal class I relation. Patients having oral habits, pervious orthodontic treatment history, cervical vertebra defect, open bite, and cross bite were excluded.

Parameters used to assess skeletal class I relation were as follows: ANB (0°–4°), Wits appraisal (males = [− 2]–4 mm, females= [− 4.5]–1.5 mm), angle of convexity ([− 8.5°]–[+10°]), AB plane ([− 9°]–0°), and β angle (27°–35°).

The subjects were categorized into three groups (Group I–normodivergent, Group II–hypodivergent, Group III–Hyperdivergent), each having 30 subjects on the basis of their growth pattern. The vertical facial growth patterns were assessed with Frankfort-mandibular plane angle (FMA), Y-axis, Jarabak ratio, sum of posterior angle, and SN-MP angle.

All the lateral cephalograms were acquired. Various landmarks and reference planes were identified and marked by the same operator (►**Table 1** and ►**Fig. 1**). In this study, two reference planes were taken for estimation of anteroposterior and vertical position of hyoid bone. Vertical reference planes include pterygoid vertical reference (PTR) perpendicular (PTRper) and Sella perpendicular (Sper), whereas horizontal reference planes include C_3Chorizontal (C_3Chor) and Hyoid axis (Haxis) (►**Table 2** and ►**Fig. 2**).

Statistical Method

Statistical analyses were performed with the help of the SPSS software program. Descriptive statistics for (mean, range and standard deviation) were calculated for each variable. One-way ANOVA, posthoc test (Bonferroni), and Kruskal–Wallis test were used. $p < 0.05$ was considered statistically significant.

Table 1 Cephalometric landmarks and reference planes used in the study

Landmarks	
Sella (S)	Geometric center of the pituitary fossa located by visual inspection
Orbitale (Or)	The lowest point on the inferior rim of the orbit
Porion (Po)	The most superiorly positioned point of the external auditory meatus
Pterygoid vertical reference (PTR)	The most posterior point on the distal radiographic outline of the pterygomaxillary fissure
Center of third cervical vertebra (C3C)	The intersection point of diagonal lines drawn between the anteroinferior and posterosuperior corners and between the anterosuperior and posteroinferior corners of the third cervical vertebra
Hyoidale (H)	The most superior anterior point on the body of the hyoid bone
G-point (G)	The most posterior point of the greater horn of the hyoid bone
Reference planes	
Frankfort horizontal plane (FH-plane)	The horizontal plane that joins Po and Or
Sella perpendicular (Sper)	The perpendicular line drawn on the FH-plane at S
PTR perpendicular (PTRper)	The perpendicular plane drawn on the FH-plane at PTR
C3C horizontal (C_3C)	The horizontal plane perpendicularto the Sper at C3C
Hyoid axis (Haxis)	The line that connects points H and G

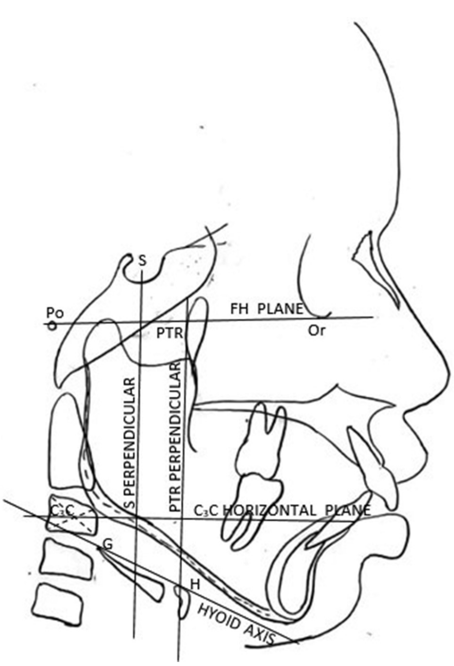

Fig. 1 Cephalometric landmarks used for estimation of hyoid bone position.

Table 2 Linear and angular parameters used in the study

H-PTRper distance	Perpendicular distance from H-point to PTRper plane
H-Sper distance	Perpendicular distance from H-point to Sper plane
H-C_3Chor distance	Perpendicular distances from H-point to C_3Chor plane
G-C_3Chor distance	Perpendicular distance from G-point to C_3Chor plane
Haxis-PTRper angle	Angle between H-axis and PTRper plane
Haxis-C_3Chor angle	Angle between hyoid axis and C_3C horizontal plane

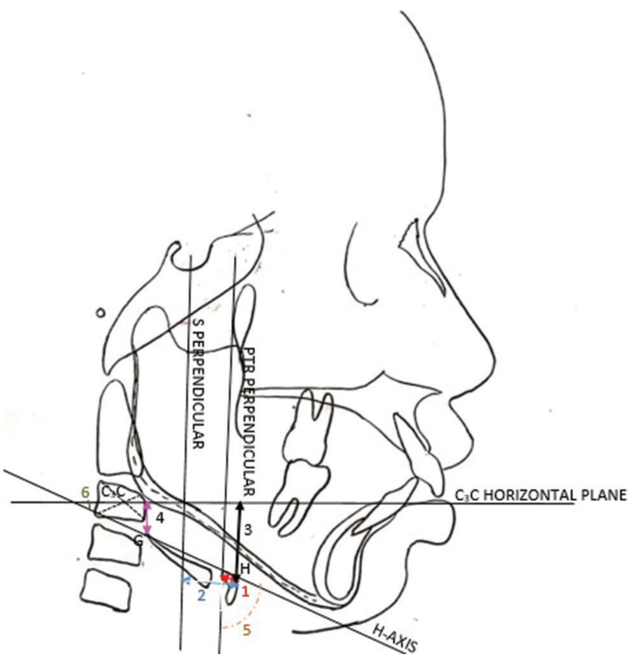

Fig. 2 Linear and angular parameters used for estimation of hyoid bone position. (1) H-PTRper distance; (2) H-Sper distance; (3) H-C_3Chor distance; (4) G-C_3Chor distance; (5) Haxis-PTRper angle; (6) Haxis-C_3Chor angle.

Results

Various linear and angular parameters were measured to evaluate the hyoid bone position in the three groups (►**Table 3**).

G-C_3Chor distance was found to be statistically significant ($p < 0.05$).

Discussion

Hyoid bone essentially performed a substantial role in various physiological functions of the craniofacial skeleton. The purpose of the study is to evaluate the hyoid bone position among skeletal class I subjects with varying growth patterns. Ninety subjects of north Indian origin, aged between 16 to 30 years and having skeletal class I relation, were chosen for the study. Subjects were then subdivided into three groups, that is, Group I (n = 30; normodivergent), Group II (n = 30; hypodivergent) and Group III (n = 30; hyperdivergent) based on their vertical growth pattern. After tracing, lateral cephalograms were evaluated manually for hyoid bone position. Graber believed that the location of hyoid bone was largely affected by change in head and cervical spine position.[5] King also observed that the changes in head position are in absolute synchronization with the alterations in the situation of the hyoid bone in an individual. For example, if one moved his head backward, then the hyoid bone also moved backward.[10]

Kumar et al found no significant difference in the position of the hyoid bone in persons with normodivergent and hyperdivergent growth patterns. In both groups, the hyoid bone was moved in posteroinferior direction. However, Haralabakis et al found no distinction in the location of the hyoid bone anteroposteriorly on comparing with adult individuals having anterior open bite and normal bite. Opdebeeck et al found no substantial variation in the hyoid bone position anteroposteriorly among individuals having altered vertical jaw dysplasias.[10] In this present study, results revealed that there was no anteroposterior change in the hyoid bone position with varied growth patterns. The vertical position

Table 3 Descriptive statistics for hyoid bone parameters in various groups and their corresponding "p" value

Parameters	Group I		Group II		Group III		p-Value
	Mean	SD	Mean	SD	Mean	SD	
H-Sper distance (mm)	15.17	4.942	15.88	5.209	14.25	5.306	.472
H-C_3Chor distance (mm)	− 12.07	4.906	− 10.05	5.723	− 11.73	3.624	0.228
Haxis-C_3Chor angle (degrees)	11.28	8.817	12.77	6.616	13.62	5.586	0.443
H-PTRper distance (mm)	4.233	2.3735	4.400	3.7906	5.250	3.5544	0.419
G-C_3Chor distance (mm)	− 7.85	5.742	− 4.78	4.956	− 5.97	5.068	0.044[a]
Haxis-PTRper angle (degrees)	66.12	44.155	77.55	7.239	84.13	51.747	0.471

[a] $p < 0.05$.

of the hyoid bone in individuals with hypodivergent growth pattern was slightly upward compared with the individuals having hyperdivergent growth patterns and those with normodivergent growth patterns. This could be due to pull occurring from the suprahyoid group of muscles, which are due to the rotation of the mandible in a forward and upward direction. The hyoid bone was positioned more downward among hyperdivergent individuals, as rotation of the mandible was observed in backward and downward direction. Low-hyoid bone posture was seen to be attributed to low tongue posture, larger craniocervical inclination, and narrow pharyngeal airway passage.

Many previous studies[7,11] revealed close relationship of hyoid bone position with mandibular inclination, which was in contrast to the present study. Tourneobserved that hyoid bone position was maintained by high patency of pharyngeal airways. He found that the hyoid bone and its adjacent structures are directed to an inferior position, so as to avoid impinging on the vital oropharyngeal and laryngeal spaces.[1]

Conclusion

- The position of hyoid bone does not change with different growth patterns in skeletal class I subjects.
- The vertical position of hyoid "u-shaped" bone was found to be similar in subjects with varied vertical jaw dysplasias.

Conflict of Interest
None declared.

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