OPEN ACCESS

THE POSITION OF HYOID BONE ON LATERAL CEPHALOGRAPHS IN VARIOUS VERTICAL FACIAL PATTERNS

Ghazala, Shahab Adil, Zafar Ul Islam, Gulalai Jan, Sana Riaz, Lalina Taj

Department of Orthodontics, Peshawar Dental College, Riphah International University- Islamabad - Pakistan

Address for correspondence:
Ghazala Wazir
Department of Orthodontics, Peshawar Dental College, Riphah International University- Islamabad - Pakistan

E-mail:
wazir_ghazala@yahoo.com

Date Received:
16th January, 2023
Date Revised:
23rd August, 2023
Date Accepted:
11th September, 2023

ABSTRACT

Objective: To determine the position of hyoid bone on lateral cephalographs in various vertical facial patterns of orthodontic patients visiting Peshawar Dental College.

Methodology: This descriptive study was conducted at Department of Orthodontics, Peshawar Dental College. A total of 75 patients (46% male and 54% female) fulfilling the inclusion criteria were included through non-probability purposive sampling technique. These patients were divided into three groups of 25 patients each on the basis of FMA and Y axis on lateral cephalographs. Six angular, seven horizontal and seven vertical linear measurements were measured to evaluate the position of hyoid bone with its associated structures in different facial heights.

Results: One way ANOVA and post hoc Bonferroni tests showed a statistically significant difference between hypodivergent and hyperdivergent patterns for angular measurement H axis-MP (p=0.021*) and vertical linear measurement H-MP (p=0.025*). In horizontal linear measurements, H-Pog has shown a statistically significant difference (p=0.023*) between normo-divergent and hyperdivergent facial patterns.

Conclusions: Hyoid bone is positioned more infero-anterior in hyperdivergent subjects and superior-posterior in hypodivergent cases. The hyoid bone is positioned anteriorly in hyperdivergent subjects.

Keywords: Cephalometry; Hyoid Bone; Vertical Dimension

INTRODUCTION

Hyoid bone is U shaped, solitary bone, with no bony articulation at level of C3 and is attached to skull, mandible, larynx and cervical spine by various ligaments and muscular connections.[1-3] Its complicated connections can be used as anatomical landmark assessing the location of head with neck.[4] Due to its attachment with mandible it moves with it during swallowing, phonation, respiration and mastication.[5,6] It has been acknowledged that any change in craniofacial anatomical relationships can significantly affect the physiologic function of individuals.

The development of craniofacial region is a complex process which is governed by genetic and environmental elements. The neuromuscular elements which develop around the craniofacial skeleton play significant part in maxillary and mandibular growth.[7] Hyoid bone being near to craniofacial region is associated with direction of mandibular growth.[8] Its position is affected by tongue and can affect pharyngeal airway space, narrowing of which can cause obstructive sleep apnoea.[9,10] Moreover, its unusual position can contribute in mouth breathing and abnormal swallowing pattern, and this can result in formation of a disproportioned face type.[8,11]

Hyoid bone being attached to mandible has effect on mandibular function and growth. It needs to be included in treatment planning. It is one of the etiological factors which is needed to be considered before planning for better long-term stability of treatment.[12]

Previous studies have shown association of hyoid bone location with skeletal malocclusion while some has focused on its association with orthognathic surgery.[13] Its association with vertical facial pattern is controversial and has largely remained unexplored.[14]

Accurate measurement of hyoid bone location by cephalometric means is considerably difficult.[15] Orthodontics have expanded the concept of including the structures near to oral cavity as it has effects on the craniofacial growth.[15] The growth and function of facial skeleton in relation to position of hyoid bone has attracted considerable interest. The position of the hyoid bone in various vertical facial types does not seem to have been studied systematically. The rationale of this study was to evaluate and compare the location of hy-

This article may be cited as
Ghazala, Adil S, IslamUZ, Jan G, Riaz S, Taj L. The position of hyoid bone on lateral cephalographs in various vertical facial patterns. J Postgrad Med Inst 2023;37(4):269-73. http://doi.org/10.54079/jpmi.37.4.3208

oid bone and the relationship with the face and jaws, in individuals with various vertical growth patterns.

METHODOLOGY

This descriptive cross-sectional study was conducted on cephalometric radiographs taken from past records present in Department of Orthodontics in Peshawar Dental College. The inclusion criteria were patients of both genders having comfortable nasal breathing and normal swallowing pattern. The patients with visual or hearing disability, previous orthodontic treatment, scar tissue in head and neck area and those with major illness or syndromes were excluded from the study.

The sample size was calculated using Cochrane's formula ($n = Z\alpha^2 \times SD^2$ /precision^2) at 95% confidence interval by taking standard deviation of 2.06 and 25 subjects (sample size) from previous study.[10] Sample size turned out to be 24.96 for each group which was rounded to 25. So, for three groups the total sample size turned out to be 75. Group 1 consisted of hypodivergent, Group 2 normo-divergent, and Group 3 hyperdivergent on basis of Frankfort to mandibular plane angle (FMA). Therefore, lateral cephalogram of 75 adult patients seeking orthodontic treatment were taken.

Lateral cephalograms were traced manually on acetate paper. The axial inclination of hyoid bone was evaluated by hyoid axis angulation with MP, PP, FH, OP, MP and C3C horizontal plane. The anteroposterior position was evaluated by linear measurement of hyoid to Sella perpendicular (Sperp) and PTR perpendicular (PTR perp), when H point was anterior to PTRper and Sperp the values were marked as positive and when the H point was posterior it was marked as negative. Other linear measurement recorded were the perpendicular distance (millimetres) of hyoid to Pogonion, Nasion and A point.

The vertical position was evaluated by linear measurement of vertical distance from H point to SN plane, FH plane, PP, OP, MP and the distance (Millimetres) from H and G point to C3C horizontal plane, when the H and G points were above the C3C horizontal plane the values were considered as positive whereas when H and G points were below C3C plane they were recorded as negative. Cephalographic values of vertical face height and different measurements of hyoid were recorded as shown in figure 1.

The data were analysed using SPSS version 20 for windows. Descriptive statistics were generated for the data. One way ANOVA was used to determine the difference in linear and angular measurements of hyoid bone among the three vertical facial patterns. Post Hoc Bonferroni test was applied to further elaborate the significant variables among the three vertical facial patterns. Level of significance was set at ≤ 0.05.

RESULTS

The sample comprised of 54 % female and 46 % male subjects. The mean differences in angular and linear values are shown in table1. The axial inclination of hyoid bone

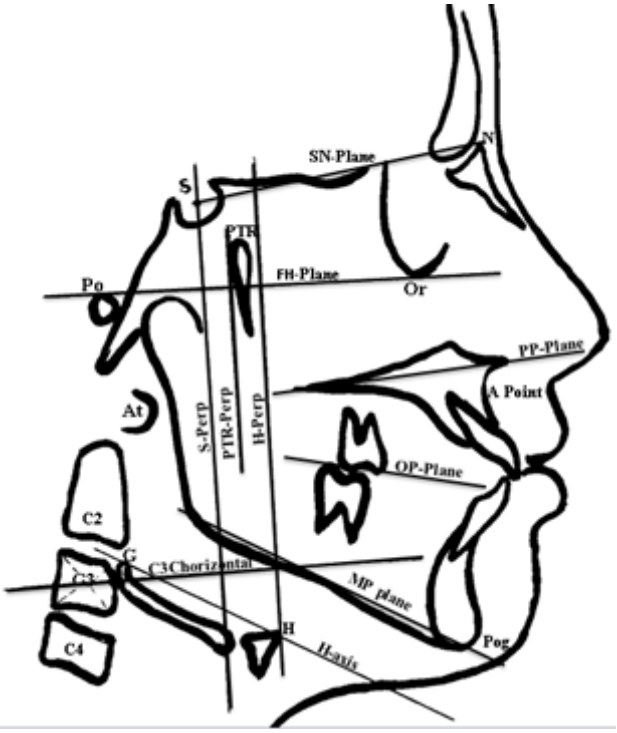

Figure 1: Cephalometric landmarks for assessment of hyoid bone position.
Sella (S): Geometric center of the pituitary fossa.
Orbitale (Or): The inferior point on the lower border of orbit.
Porion (Po): The point at upper margin of the external auditory meatus.
Pterygoid vertical reference (PTR): The most posterior point on the pterygomaxillary fissure.
Center of third cervical vertebra (C3C): The geometric center of the third cervical vertebra.
Hyoidale (H): The most anterior and superior point on the body of the hyoid bone.
G-point (G): The most posterior point of the greater horn of the hyoid bone.
Cephalometric reference planes were used for the assessment of hyoid bone position.
Frankfort horizontal plane (FH-plane): The plane that intersects both 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 (C3Chor): The horizontal plane perpendicular to the Sper at C3C.
Hyoid axis (Haxis): The line that connects points H and G
Palatal plane (PP): The plane from ANS to PNS

Table 1: Angular and linear measurements of hyoid bone in vertical facial patterns.

Variable	Hypodivergent mean±SD	Normodivergent	Hyperdivergent	P value	F value
Haxis-C3C plane angle	25.2±9.1	26.5±9.01	26.8±8.1	0.795	0.230
Haxis-MP angle	6.38±8.4	3.08±9.6	-1.1±10	0.021*	4.029
Haxis-OP angle	16.2±9.6	18.02±9.7	13.9±9.1	0.306	1.202
Haxis-PP angle	23.9±8.9	24.9±10.60	26.1±10.31	0.736	0.308
Haxis-FH angle	24.8±9.5	25.6±9.4	26.6±8.07	0.780	0.249
Haxis-SN angle	30.3±8.7	32.08±10.30	33.04±10.1	0.609	0.498
H-At horizontal linear	22.8±6.93	20.9±7.65	19.4±6.2	0.231	1.494
H-PTR perp	-1.61±5.89	-2.97±6.64	-4.2±6.69	0.362	1.028
H-S perp	11.9±5.8	-9.6±6.8	8.16±5.8	0.101	2.357
H-A point	48.9±6.4	-50.4±5.7	50.12±6.58	0.639	0.450
H-N	50.9±6.9	-52.7±5.55	52.16±7.6	0.575	0.557
H-Pog	44.96±5.21	45.64±4.29	42.36±4.14	0.023*	3.966
H-CVT	44.57±4.16	43.70±6.37	43.52±4.39	0.737	0.307
H-C3C plane vertical	-11.69±5.89	-13.73±7.39	-14.52±6.19	0.288	1.264
G-C3C plane vertical	.19±5.91	-.41±5.18	-2.12±6.08	0.324	1.143
H-SN Vertical	90.61±9.81	90.82±7.29	91.48±8.75	0.931	0.072
H-FH Vertical	71.1±8.53	71.29±6.02	72.16±8.27	0.868	0.142
H-PP Vertical	50.34±9.24	51.67±4.73	52.12±7.45	0.650	0.433
H-OP Vertical	34.65±6.81	34.23±4.69	36.88±6.79	0.229	1.501
H-MP vertical	10.76±5.24	13.32±6.12	14.96±4.55	0.025*	3.871

One Way Anova, Level of significance ≤ 0.05*

Table 2: Difference among linear and angular measurements in vertical facial patterns.

Dependent variable	Vertically	Vertically	Significance
Haxis-MP angle	hypodivergent	normodivergent	.561
	normodivergent	hyperdivergent	.281
	hyperdivergent	hypodivergent	.017*
H-Pog horizontal	hypodivergent	normodivergent	1.000
	normodivergent	hyperdivergent	.023*
	hyperdivergent	hypodivergent	.134
H-MP Vertical	hypodivergent	normodivergent	.225
	normodivergent	hyperdivergent	.770
	hyperdivergent	hypodivergent	.022*

Post Hoc Bonferroni Test, Level of significance ≤ 0.05*

with C3C horizontal plane and palatal plane was statistically insignificant in all three groups, while its inclination with mandibular plane (Haxis-MP) was marked as significant (p=0.021*). The post hoc bonferroni test showed a comparable statistically significant difference in Haxis-MP (p=0.017*) among hyperdivergent and hypodivergent group.

The anteroposterior position of hyoid to Sella perpendicular and PTR perpendicular shows no statistically significant difference. Hyoid to pogonion (H-Pog) were found statistically significant (p=0.023*), the comparable difference by post hoc bonferroni test shows its significant difference among normo-divergent and hyperdivergent group (p=0.023*). Vertically the statistically significant difference was seen only in vertical distance of Haxis-MP (p=0.025*), and comparable difference by post hoc banferroni test further showed a statistically significant difference among hypodivergent and hyperdivergent group (p=0.022*).

DISCUSSION

Hyoid bone is solitary bone that has no bony articulation it is connected to the craniofacial structures and moves along with mandible during masticatory functions, the stability of hyoid bone position is influenced by the direction of mandibular growth.[16] The face height play an important role in diagnosis, treatment planning and prognosis of treatment. There is a relationship between vertical growth of maxilla and mandible with the vertical growth of condyles. When the vertical growth in posterior condyles is greater there is tendency toward an open bite and increase facial height whereas, when there is decrease growth there is short face height and a deep bite tendency. Abnormal facial growth result in different facial heights.[17]

A comparative study between long face and short face on Caucasian population shows that many characteristics of long and short face can be explained by rotation of mandible along with the structures associated with it like the hyoid bone and tongue. They suggested that hyoid bone is positioned more anteriorly in long face syndrome as compare to short face syndrome.[18] Another study showed that although hyoid bone is associated with the basal mandibular bone still it does not reflect the vertical relationship of face. The study shows the hyoid position is near to mandibular plane in short face and is positioned lower in long face height.[15] In the present study, the vertical position shows same statistically significant results that hyoid bone is inferiorly positioned in hyperdivergent as compare hypodivergent cases.

A study conducted in Turkiye evaluated linear distance from H-Pog in hypodivergent group, and shows that it is positioned more posteriorly in hypodivergent subjects.[15] In the present study, we also found the same statistically significant results. Hyoid bone is located posteriorly in hypodivergent and anteriorly in hyperdivergent cases. Another comparative study on open bite and normal occlusion suggested that angle between Haxis-PP is significantly increased due to anticlockwise rotation of palatal plane. While the angle Haxis-MP shows no difference as hyoid moves along with the mandibular plane. This strongly suggested that hyoid bone moves along with its associated structures like the pharynx, cervical vertebrae and mandibular plane.[19]

A study has shown that the axial inclination of Hyoid bone position is assessed vertically by PTR perpendicular plane and horizontally by C3C horizontal plane. The high angle subjects have increased SN-Haxis and have no significant difference in Haxis-MP which shows that hyoid bone moves along with the rotation of movable craniofacial parts.[18] In this study it is analysed that hyoid bone do not move significantly with MP as significant difference in Haxis-MP can be seen. The axial inclination of hyoid bone with its MP was found statistically significant. The Hyoid bone is inclined clockwise in hypodivergent subjects and counter clock in hyperdivergent subjects. This finding will aid in diagnosis of the vertical facial patterns.

Overall, these studies[15-19] shed light on the importance of the hyoid bone's position and movement in different facial patterns, which can be valuable for diagnosis, treatment planning, and understanding the prognosis of treatments related to facial height and occlusion issues. Further research in this area can potentially enhance diagnosis, treatment planning, and prognosis of various facial height, relapse and occlusion issues.

CONCLUSION

Hyoid bone is positioned more inferoanterior in hyperdivergent subjects and superoposterior in hypodivergent cases. The linear distance from hyoid to pogonion shows its anterior position in hyperdivergent group. Though attached to mandible, hyoid bone does not move significantly with MP and has significant difference in Haxis-MP.

REFERENCES

1. Wang X, Wang C, Zhang S, Wang W, Li X, Gao S, et al. Microstructure of the hyoid bone based on micro-computed tomography findings. Medicine (Baltimore). 2020;99(44):e22246. DOI: 10.1097/MD.0000000000022246.
2. Zhou X, Xiong X, Yan Z, Xiao C, Zheng Y, Wang J. Hyoid Bone Position in Patients with and without Temporomandibular Joint Osteoarthrosis: A Cone-Beam Computed Tomography and Cephalometric Analysis. Pain Res Manag. 2021:4852683. DOI: 10.1155/2021/4852683.
3. Soyoye OA, Otuyemi OD, Newman Nartey M. Cephalometric evaluation of hyoid bone position in subjects with different vertical dental patterns. Niger J Clin Pract. 2021;24(3):321-8. DOI: 10.4103/njcp.njcp_430_20.
4. Bilal R. Position of the hyoid bone in anteroposterior skeletal patterns. J Healthc Eng. 2021:7130457. DOI: 10.1155/2021/7130457.
5. Mortazavi S, Asghari-Moghaddam H, Dehghani M, Aboutorabzade M, Yaloodbardan B, Tohidi E, Hoseini-Zarch SH. Hyoid bone position in different facial skeletal patterns. J Clin Exp Dent. 2018;10(4):e346-51. DOI: 10.4317/jced.54657.
6. Saeed A, Farid F, Shaheed S, Mushtaq N. Assessment of Hyoid bone position in different anteroposterior skeletal relationships: A Cross Sectional study. Pak Orthod j. 2021;13(1):19-24.
7. Chen W, Mou H, Qian Y, Qian L. Evaluation of the position and morphology of tongue and hyoid bone in skeletal Class II malocclusion based on cone beam computed tomography. BMC Oral Health. 2021;21(1):1-7. DOI: 10.1186/s12903-021-01839-y.
8. Chen TP, Rodhisky F, Jiang SS, Cangialosi TJ. Hyoid Bone Position as an Etiological Factor in Mandibular Divergence and Morphology. Open J Orthop. 2022;12(1):10-25. DOI: 10.4236/ojo.2022.121002.
9. Adamidis IP, Spyropoulos MN. The effects of lymphadenoid hypertrophy on the position of the tongue, the mandible and the hyoid bone. Eur J Orthod. 1983;5(4):287-94. DOI: 10.1093/ejo/5.4.287.
10. Gundawar AP, Rawlani DM, Patil AS, Sabane A. Assessment and correlation of the position and orientation of the hyoid bone in Class I, Class II, and Class III Malocclusions. Int J Orthod Rehabil. 2019;10(4):161-7. DOI: 10.4103/ijor.ijor_18_19.
11. Acharya A, Mishra P, Shrestha RM. Pharyngeal airway space dimensions and hyoid bone position in various craniofacial morphologies. J Indian Orthod Soc. 2022;56(2):150-7. DOI: 10.1177/03015742211007621.
12. Jiang C, Yi Y, Jiang C, Fang S, Wang J. Pharyngeal airway space and hyoid bone positioning after different orthognathic surgeries in skeletal class II patients. J Oral Maxillofac Surg. 2017;75(7):1482-90. DOI: 10.1016/j.joms.2017.02.021.
13. Wu S, Wang T, Kang X, Wang X, Jiao Y, Du X, et al. Hyoid bone position in subjects with different facial growth patterns of different dental ages. Cranio J Craniomandib Pract. 2023;41(5):454-60 DOI: 10.1080/08869634.2020.1867471.
14. Jena AK, Duggal R. Hyoid bone position

in subjects with different vertical jaw dysplasias. Angle Orthod. 2011;81(1):81-5. DOI: 10.2319/092208-491.1
15. Ertan Erdinc A, Dincer B, Sabah M. Evaluation of the position of the hyoid bone in relation to vertical facial development. J Clin Pediatr Dent. 2003;27(4):347-52. DOI: 10.17796/jcpd.27.4.v619q30222674w30.
16. Graber LW. Hyoid changes following orthopedic treatment of mandibular prognathism. Angle Orthod. 1978;48(1):33-8. DOI: 10.1043/0003-3219(1978)048<0033: HCFOTO>2.0.CO;2.
17. Schudy FF. Cant of the occlusal plane and axial inclinations of teeth. Angle Orthod. 1963;33(2):69-82. DOI: 10.1043/0003-3219(1963)033<0069:COTOPA>2.0.CO;2.
18. Opdebeeck H, Bell WH, Eisenfeld J, Mishelevich D. Comparative study between the SFS and LFS rotation as a possible morphogenic mechanism. Am J Orthod. 1978;74(5):509-21. DOI: 10.1016/0002-9416(78)90026-x.
19. Haralabakis NB, Toutountzakis NM, Yiagtzis SC. The hyoid bone position in adult individuals with open bite and normal occlusion. Eur J Orthod. 1993;15(4):265-71. DOI: 10.1093/ejo/15.4.265.

Author's Contribution

GW conceived the idea, collected the data and write up of the manuscript. SA and ZUI performed and contributed in data analysis and write up of the manuscript. GJ, SR and LT helped in data collection, designed the study and contributed in data analysis and write up of the manuscript. Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

Authors declared no conflict of interest

Grant Support and Financial Disclosure

None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.