

Effect of different sagittal skeletal pattern and gender on hyoid bone position in Chhattisgarh population

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Citation of this Article: Dr. Sowmiya Narayanan. M, Dr. Virendra Vadher, Dr. Arvind Nair, Dr. Shalabh Baxi, Dr. Chhaya Barapatre, Dr. Shweta Singh, Dr. Gangesh Singh Bahadur, “Effect of different sagittal skeletal pattern and gender on hyoid bone position in Chhattisgarh population”, IJDSIR- April - 2023, Volume – 6, Issue - 2, P. No. 411 – 417.

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Type of Publication: Original Research Article

Conflicts of Interest: Nil

Introduction

Hyoid bone is positioned between the mandibular symphysis and larynx in the front of the neck, it connects the tongue, mandible, cranial base, sternum, scapula, thyroid cartilage, and pharynx together, so that the Hyoid bone position is influenced by all these structures. The function of the Hyoid bone is to maintain positional balance of respiratory passage as well as respiratory sufficiency by anchoring the tongue. It also has an important role in tongue function and maintaining

an upright head position and cranial balance. It has been shown that hyoid bone position is related to the position of the mandible and Hyoid bone adapts to Antero posterior changes in head position². Obstructive sleep apnea is a chronic sleep related breathing disorder. It is best described by repeated narrowing and obstruction of pharyngeal airway during sleep¹¹. This condition is caused by pharyngeal collapsibility, which is due to loss of wakefulness stimulus and changes in neuro muscular control. A large number of factors had an effect on

collapsibility of Pharynx. Among them the position of Hyoid bone is the most important. The hyoid bone location is one of the elements that contribute to pharyngeal collapsibility. An unbalance between both the suprahyoid and infrahyoid muscles can cause a shift in the location of the hyoid, altering airway patency and increasing pharyngeal collapse bility.¹². Different sagittal skeletal patterns have different morphologies and shape of mandible which might be related to the position of the Hyoid bone⁵. There is no information regarding the hyoid bone position in different skeletal patterns in Chhattisgarh population in earlier studies. So, the purpose of the study is to assess the result of different sagittal skeletal pattern and gender on hyoid bone position in Chhattisgarh population.

Materials and Methods

A Cross Sectional Study was conducted to compare the Position of Hyoid Bone in Different Sagittal Skeletal Patterns. 180 lateral cephalograms of patient reporting to Outpatient Department at the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College, Raipur are distributed according to skeletal pattern and gender. 60 Class I, 60 Class II and 60 Class III radio graphs were collected with an equal distribution between males and females.

The ANB angle form the basis of skeletal classification.

1. Angle $0-4^{\circ}$ – Class I
2. Angle $>4^{\circ}$ – Class II
3. Angle $<0^{\circ}$ – Class III

Inclusion criteria

1. No History of previous Orthodontic treatment.
2. Patients having Class I, Class II and Class III Skeletal Patterns.
3. Patients who are willing to participate in the study after giving written informed consent.

Exclusion criteria

1. Patient underwent previous orthodontic treatment.
2. Patient underwent previous orthognathic surgery.
3. Patients with major illness or medical conditions.
4. History of head and neck trauma, vertebral column and craniofacial anomaly or syndrome.

Armamentarium

- Radiographic machine
- Digital lateral cephalogram (Planmeca, Proline XC Dimax 3 Ceph)
- Trimax Printer.
- Digital Lateral cephalogram.
- Acetate tracing paper of 0.003-inch matte finish.
- 0.3mm HB lead pencil.
- Geometry box – (scale, protractor, eraser, sharpener.)
- Illuminator, cello tape.

Cephalometric analysis

The Lateral Cephalogram of the patients were obtained by positioning the patients head in cephalostat with teeth in maximum intercuspation with relaxed lip in order to maintain standardization of radiograph with the Frank fort horizontal plane parallel to the floor and ensured that (NHP) natural head position is obtained by positioning the ear rods and forehead.

Positioning the knobs distance from the tube to patients was standardized at 5 feet. The radiographs were hand traced in lead acetate paper (8" x 10" dimension and 0.003inch thickness) and measured by the same investigator to reduce intra operator errors. The landmarks used in this study was mentioned in Fig: 1.

Statistical analysis

Data were analysed using the statistical package for social sciences version 18.0 for windows (SPSS Inc., Chicago, Illinois, USA). Analysis of variance test was performed to study the relationship between different skeletal patterns and hyoid bone dimensions. Multiple

comparison test was used to further distinguish which skeletal pattern showed the most significant difference. Analysis of variance test was performed to study the relationship between different skeletal patterns and hyoid bone dimensions in both male and female subjects. A student's t-test was used to calculate the mean difference in hyoid bone dimensions between male and female subjects.

Results

The results showed significant difference in the sagittal plane of Hyoid bone among different skeletal patterns by measuring the distance from the hyoid bone to the retrognathion (i.e H-RGN). The distance was shorter in Class II (35.46 ± 6.01) patients and longer in Class III (38.87 ± 5.06) patients as the hyoid bone moved backward when the mandible moved forward (table 1,2; $P=0.003$)

- **H-MP, H-PP & H-C3** distance was significantly more in males (10.21 ± 6.98 , 58.53 ± 7.56 & 36.4 ± 4.91 respectively) than females (6.81 ± 4.67 , 51.11 ± 5.84 & 33.1 ± 3.94 respectively) in class I skeletal pattern, it indicates that hyoid position was superior and more posterior in females than males in class I skeletal pattern (table 3; $P=0.031$, 0.001 & 0.007 respectively)
- **H-MP, H-PP & H-C3** distance was significantly more in males (11.28 ± 8.66 , 57.38 ± 11.3 & 36.21 ± 5.81 respectively) than females (7.41 ± 6.01 , 51.35 ± 6.15 & 33.0 ± 4.62 respectively) in class II skeletal pattern, it indicates that hyoid position was superior and more posterior in females than males in class II skeletal pattern (table 3; $P=0.049$, 0.013 & 0.021 respectively)
- **H-PP** distance was significantly more in males (59.3 ± 7.97) than females (53.93 ± 6.88) in class III skeletal pattern (table 3; $P=0.007$)
- **H to C3** distance was more in skeletal class III (36.07 ± 4.91) compared to class II (34.6 ± 5.45) but not

significant, it indicates that hyoid position was more posterior in class II than class III (table 1,2; $P=0.221$)

- The H-RGN distance is significantly more in class III (39.9 ± 5.6) and lower in class II (35.7 ± 6.21) skeletal pattern in female subjects, as the hyoid bone moved backward when the mandible moved forward (table 4,5; $P=0.008$)
- **Long axis of hyoid (LAH) to mandibular plane (MP) angle** is significantly more in class II (11.01 ± 8.05) than class III (7.68 ± 5.86), suggests that the angle increases when mandible moved backward (table 1,2; $P=0.036$)
- **Long axis of hyoid (LAH) to mandibular plane (MP) angle** is significantly more in males compared to females in class II skeletal pattern. (Table 3; $P=0.027$)
- **Long axis of hyoid (LAH) to mandibular plane (MP) angle** is significantly more in class II (13.3 ± 8.73) than class III (7.91 ± 5.99) in female subjects (table 4,5; $P=0.036$)

Discussion

Lateral cephalograms are routinely used radiograph in Orthodontics for diagnosis, treatment planning and assessment of skeletal maturation. A lateral cephalogram is one of the orthodontic records that provides information about the sagittal and vertical relationships of the craniofacial skeleton, the soft tissue profile, the dentition, the pharynx and the cervical vertebrae. These structures and their relationships to each other are calculated by means of linear and angular measurements as well as by the ratios based on the various cephalometric land marks.

The Position of hyoid bone was measured to determine various linear and angular dimensions in different sagittal skeletal patterns. The hyoid is a horseshoe-shaped bone located in the anterior midline of the neck between the chin and the thyroid cartilage. The

importance of hyoid bone lies in its unique anatomic relationship because it has no bony articulations but provide attachment for muscles ligaments and fascia of the pharynx, mandible, tongue and cranium. Due to these attachments with the mandible may influence the position of hyoid bone in different sagittal skeletal patterns. The hyoid bone position is of major therapeutic relevance because it is crucial in preserving the measurements of the upper airway as well as an upright natural head posture.

In this article landmarks of bibby's hyoid triangle are used to evaluate the horizontal position of hyoid bone¹⁰. Hyoid bone in relation to mandibular plane and palatal plane used to evaluate the vertical position of hyoid bone.

Hyoid bone is a unique bone because of not having joints with any other bone and floating with the help of muscles and ligaments attachments. When the linear dimensions and angular dimensions of hyoid bone in the present study were compared with other investigations among different sagittal skeletal patterns.

In the present study, H-MP, H-PP, and H-C3 linear dimensions are significantly more in males when compared to females. Mortazavi S, et al (2018)¹ conducted study on 110 lateral cephalograms (59 females and 51 males) from different skeletal patterns (class I, II and III) and he concluded that the mean distance from the hyoid bone (H) to mandibular plane (MP), to palatal plane (PP), as well as to a third cervical vertebra (C3) was more in males than females. These results are similar with the results obtained by Mortazavi S, et al (2018)¹, Aynur Medine, et al (2006)⁴, Adesina BA, et al (2016)⁷, imply that the hyoid bone is more superiorly and posteriorly positioned in females than in males. Given the increased size of male skeleton, it is predicted that the length from the hyoid bone to

surrounding landmarks will be significantly greater in males in comparison to females. The result was consistent with the result of our study. On the other hands, smaller distances in females from the hyoid bone to craniofacial structures is simply due to the difference in average gender size.

In the present study, H-MP and H-PP linear dimensions did not show any significant between different sagittal skeletal patterns. This agrees with results obtained by Mortazavi S, et al (2018)¹, as he don't find any significant difference in mean H-MP and H-PP angle between different skeletal classes.

When hyoid bone dimensions were compared with different sagittal skeletal pattern, present study show that H-RGN was significantly more in class III skeletal pattern when compared to class I and class II. It indicates that hyoid is positioned more posteriorly to mandible in class II skeletal pattern than class I and class III skeletal patterns. Same result is seen in studies of Amayeri. M, et al (2014)⁶, conducted study on 65 lateral cephalograms were randomly selected from a pool of radio graphs for Lebanese patients admitted to the orthodontic clinic in the Faculty of Dentistry, Beirut Arab University. The age of participants ranged between 12-17 years with average of 14 years. His results showed statistically significant data by measuring the distance from the hyoid bone to the retro gnathion. It was smaller in Class I patients and larger in Class III group.

In the present study, H-C3 dimension was more in class III skeletal pattern than class II and class I skeletal pattern. Amayeri. M, et al (2014)⁶ concluded that the distance between the hyoid bone and the third cervical vertebra in Class III respectively, was larger than the distances in Class I and Class II. Similar results obtained by Amayeri. M, et al (2014)⁶ and Sivakumar A, et al (2017)⁸ indicates that Hyoid is positioned more anterior

to C3 in class III skeletal pattern than class I and class II skeletal pattern.

In the present study, Long axis of hyoid (LAH) to mandibular plane (MP) angle is significantly more in class II than class III and class I, suggests that the angle increases when mandible moved backward. Contrary results were obtained in study of Mortazavi S, et al (2018)¹ concluded that Class I and Class III subjects has the lowest and highest mean LAH-MP angles respectively. However, there was no statistical difference among the three skeletal classes.

In the present study, long axis of hyoid (LAH) to mandibular plane (MP) angle doesn't show any statistical difference between different skeletal patterns. Similar results found in results obtained by Mortazavi S, et al (2018)¹ concluded that LAH-MP difference among three skeletal classes was not found to be statistically significant

Rohit Khanna et al. (2011)⁵ analysed 92 pre-treatments lateral cephalograms and divided them into two groups, Group A and Group B, based on the presence of Angle's Class I and Angle's Class II molar relationships. He concluded that positional alteration of hyoid bone is prevalent in skeletal mal-relationship rather than Dentoalveolar mal-relationship. Chauhan A et al (2022)¹⁴ found that there wasn't any variation in the anterior posterior dimension of the pharyngeal airway or the location and connection of the hyoid bone and tongue between Class I and Class II Division I patients. Adamidis IP et al (1992)¹⁵ concluded that, In Class III patients, especially the boys, show a more anterior position of the hyoid bone. This might have an implication on the function of the suprahyoid and in Fra hyoid muscles and thus on the direction of mandibular growth. Kawakami M et al (2005)¹⁶ suggest that long-term care for the pharyngeal Airway change is required

following mandibular setback surgery. According to Deljo E et al (2012), the positioning of the hyoid bone is also not consistent and seems to be dependent on the maxillo mandibular anterior and posterior connections. Because of the danger of airway blockage, Shokri A et al (2020)¹⁸ found that the location of the hyoid bone was connected with airway dimensions and should be considered during orthognathic surgery. Jung-Hsuan Cheng et al (2020)¹⁹ concluded that the pharyngeal airway dimension is more in class III than class II skeletal pattern.

Kitahara T et al (2010)²⁰ concluded that pharyngeal airway space significantly reduced in patients underwent mandibular setback surgery along with downward and backward positioning of hyoid bone.

The limitations of present study are the absence of functional assessment of hyoid bone. As a result, we propose that future study look at the position of the hyoid bone during tasks including swallowing, talking, and breathing. Since present study has been performed retrospectively on lateral cephalogram which is 2D image of 3D structures, future studies can be planned on recent CBCT and MRI modalities to make study more relevant in long term. Present study does not evaluate the pharyngeal airway dimension related to hyoid bone position. Further study can be performed on larger scale in longitudinal pattern to provide more clinical data.

Conclusion

Females have superior and posteriorly positioned Hyoid bone compared to men. The Hyoid is positioned more posteriorly to mandible in class II skeletal pattern than class I and class III skeletal patterns. The Hyoid is positioned more anterior to C3 in class III skeletal pattern than class I and class II skeletal pattern. Care should be taken prior to mandibular setback surgery of patients with class III malocclusion, as this procedure

results in posterior movement of the hyoid bone and can constrict the airway. Due to the risk of sleep apnoea and airway obstruction, the airway condition in such patients should be evaluated prior to any surgical intervention to prevent unwanted complications.

References

1. Mortazavi S, et al (2018). Hyoid bone position in different facial skeletal patterns. *J Clin Exp Dent.* 10(4):346-51.
2. Arslan SG, Dildeş N, Kama JD (2014). Cephalometric investigation of first cervical vertebrae morphology and hyoid position in young adults with different sagittal skeletal patterns. *Scientific World Journal.* 159784.
3. Chauhan R, Bagga DK, Agrawal P, Kalra H, Kumar P, Singh A (2019). Radio graphic Evaluation of the Hyoid Bone Position and Pharyngeal Airway Depth in Anteroposterior Dysplasia. *Int J Clin Pediatr Dent.* 12(2):101-6.
4. Sahin Saglam AM, Uydas NE (2006). "Relationship between head posture and hyoid position in adult females and males" *Journal of Cranio – Maxillo facial Surgery.* 34:85–92
5. Rohit Khanna and Tripti Tikku (2011). "Position and Orientation of Hyoid Bone in Class II Division 1 Subjects: A Cephalometric Study" *J Ind Orthod Soc.* 45 (4): 212-218.
6. Mohammed Amayeri (2014). "The Position of Hyoid Bone in Different Facial Patterns: A Lateral Cephalometric Study" *European Scientific Journal.* 10 (15):19-34.
7. Adesina Ba and Otuyemi Od (2016). "Cephalometric Assessment of Hyoid Bone Position in Nigerian Patients with Bimaxillary Incisor Proclination" *Journal of the West African College of Surgeons.* 6(4)
8. Sivakumar A, et al (2017). Assessment of hyoid bone position among different skeletal patterns, *Orthod Waves.* 276:1-5.
9. Jaipal Singh Tarkar and Sandeep Parashar (2016). "An Evaluation of Upper and Lower Pharyngeal Airway Width, Tongue Posture and Hyoid Bone Position in Subjects with Different Growth Patterns" *Journal of Clinical and Diagnostic Research.* 10(1):79-83.
10. Bibby RE, Preston CB (1981). The hyoid triangle. *Am J Orthod.* 80(1):92-7.
11. Osman AM, Carter SG, Carberry JC, Eckert DJ (2018). Obstructive sleep apnea: current perspectives. *Nat Sci Sleep.* 10:21-34.
12. Sforza E, Bacon W, Weiss T, Thibault A, Petiau C, Krieger J (2000). Upper airway collapsibility and cephalometric variables in patients with obstructive sleep apnea. *Am J Respir Crit Care Med.* 161(2):347-52.
13. Jose NP, Shetty S, Mogra S, Shetty VS, Rangarajan S, Mary L (2014). Evaluation of hyoid bone position and its correlation with pharyngeal airway space in different types of skeletal malocclusion. *Contemp Clin Dent.* 5:187.
14. Chauhan A, Autar R, Pradhan KL, Yadav V (2015). Comparison of pharyngeal airway dimension, tongue and hyoid bone position based on ANB angle. *Natl J Maxillofac Surg.* 6:42.
15. Adamidis IP, Spyropoulos MN (1992). Hyoid bone position and orientation in Class I and Class III malocclusions. *Am J Orthod Dentofacial Orthop.* 101:308-12.
16. Kawakami M, Yamamoto K, Fujimoto M, Ohgi K, Inoue M, Kirita T (2005). Changes in tongue and hyoid positions, and posterior airway space following mandibular setback surgery. *J Cranio maxillofac Surg.* 33:107-10.
17. Deljo E, Filipovic M, Babacic R, Grabus J (2012). Correlation Analysis of the Hyoid Bone Position in

Relation to the Cranial Base, Mandible and Cervical Part of Vertebra with Particular Reference to Bimaxillary Relations/Teleoroentgenogram Analysis. *Acta Inform Med.* 20:25.

18. Shokri A et al (2020). Position of the hyoid bone and its correlation with airway dimensions in different classes of skeletal malocclusion using cone-beam computed tomography. *Imaging Sci Dent.* 50: 105-15)

19. Jung-Hsuan Cheng et al (2020). Relationship between hyoid bone and pharyngeal airway in different skeletal patterns. *Journal of Dental Sciences.*15:286-293

20. Kitahara T et al (2010). Changes in the pharyngeal airway space and hyoid bone position after mandibular setback surgery for skeletal Class III jaw deformity in Japanese women. *American Journal of Orthodontics and Dentofacial Orthopedics.* 138(6): 708 e1-e9