



## RELATIONSHIP OF THE HYOID BONE POSITION IN VARIOUS SKELETAL MALOCCLUSION - A SYSTEMATIC REVIEW

**Dr. Shruti S. Utpat**

Resident, Dept. of Orthodontics and Dentofacial Orthopedics, Dr. D Y Patil Dental College and Hospital, DPU, Pune.

**Dr. Jayesh S. Rahalkar\***

Professor, Department of orthodontics and Dentofacial Orthopedics, Dr. DY Patil Dental College and Hospital, DPU, Pune. \*Corresponding Author

**Dr. Sachin Durkar**

Professor, Department of Orthodontics and Dentofacial Orthopedics, Dr DY Patil Dental College and Hospital, DPU, Pune

### ABSTRACT

**AIM:** To evaluate the position of hyoid bone in various skeletal malocclusions.

**MATERIALS AND METHODS:** A systematic review of articles selected from PUBMED and Google Scholar was carried out. Additional studies were hand searched. Studies only with the original articles published till 2018 in various skeletal malocclusions in humans were included.

**RESULTS:** A total of 11 articles were identified through electronic database searching. 9 articles were obtained after elimination of duplicates which were then screened. Full-text articles were assessed according to the eligibility criteria.

**CONCLUSION:** After reviewing the available literature, it can be successfully concluded that the position of the hyoid bone is not fixed with no bony articulations, anteriorly its attached to the mandible with the muscular attachment and posteriorly attached to the occipital condyles with muscles, ligaments and fascia through the cervical vertebrae. Thus, maintaining the head posture in upright position and thereby permitting all the circular movements of the head.

**KEYWORDS :** Hyoid bone, Skeletal class I, Skeletal class II, Skeletal class III.

### INTRODUCTION

The hyoid bone is U shaped bone situated on the anterior midline of the neck, which at rest lies at the level of the third cervical vertebrae. It is a unique structure in humans in that, unlike all other bones of the head and neck, it has no bony articulations <sup>[1]</sup> The hyoid bone is an important part of the musculoskeletal apparatus of the craniofacial complex. There are two major groups of muscles which are attached to this bone, the suprahyoid and the infrahyoid. The position of the hyoid bone is affected by biomechanical conditions of these muscles, the elastic membrane of the larynx and the trachea. <sup>[2]</sup>

Brodie points out that as human body assumed an upright posture the head had to be balanced on the vertebral column. This is attained by equal anterior and posterior muscle tension relative to the occipital condyles. In the accomplishment of this delicate cranial balance and posture, the hyoid bone plays an important and active part. <sup>[3]</sup> Changes in the anteroposterior head posture and mandibular inclination can affect the hyoid bone position. Treatment with functional appliances that position mandible downward and forward, may also displace the hyoid bone. Recent orthodontic studies indicate that evaluation of hyoid bone position may play an important role in assessment of dentofacial structures especially in evaluation of relapse prevention after orthodontic treatment and orthognathic surgeries. <sup>[4]</sup>

Function of this bone is to maintain equilibrium of respiratory way by serving as anchoring structure for the tongue and also is to keep normal head posture. <sup>[3]</sup> Precise measurement of hyoid position by cephalometric means is considered difficult. The slight variations in head position in the cephalostat the postural position of the spine, and the state of function, all affects the position of the hyoid bone. <sup>[4]</sup>

Hence, the aim of this systematic review is to evaluate the position of hyoid bone in various skeletal malocclusions.

### FOCUSSED QUESTION:

Is there any co-relation between the hyoid bone position and

various sagittal skeletal malocclusions?

### OBJECTIVE:

To evaluate the position of hyoid bone in various skeletal malocclusions.

### MATERIALS AND METHOD

#### Inclusion criteria:

1. Articles published till 31<sup>st</sup> September 2018.
2. Articles providing information regarding the position of hyoid bone in various skeletal malocclusions.
3. Articles providing information on human studies
4. All articles should be in English
5. Full text articles.

#### Exclusion criteria:

1. Articles having unclear information regarding the position of hyoid bone.
2. Articles showing the relapse of hyoid bone position after BSSO.
3. Articles showing the relapse of the hyoid bone position after myotomy procedures

#### Eligibility criteria

The following selection criterion was applied for the review:

#### PICO

**1. Participants:** Patients with various types of malocclusion.

**2. Intervention:** X-rays, Lateral Cephalograms showing the hyoid bone

**3. Outcome:** Position of hyoid bone in various skeletal malocclusions

#### Information sources, search strategy and study selection.

Two Internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed), Google Scholar, Cochrane Oral Health Groups Trial Register, Cochrane

Central Register of Clinical Trials and manual search using DPU college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study.

The databases were searched up to and including 2018 using the search strategy. The keywords and full electronic search strategy for each database is illustrated in Table 1 and Table 2 respectively.

**Table 2: Electronic search strategy for each data-base**

S. No	Search Strategy	Number of articles	Number of articles selected	Reason for exclusion
SS1	Hyoid bone position in skeletal class I AND skeletal class II malocclusion	50	2	Articles not satisfied the inclusion criteria.
SS2	Hyoid bone position in skeletal class II AND skeletal class III malocclusion	3	1	Not relevant information.
SS3	Hyoid bone position in skeletal class I AND class III malocclusion	35	1	Articles related with various orthognathic surgeries.
SS4	Hyoid bone position AND skeletal class II division I malocclusion	50	1	Articles showing the relapse of class surgeries due to stretched of the muscles attached to hyoid bone.
SS5	Hyoid bone position AND Open bite/Deep bite malocclusion	10	1	Other articles related with the various myotomy procedures.
SS6	Hyoid bone position AND different facial skeletal pattern	27	3	Articles not satisfied the inclusion criteria.

**Study selection:**

Various electronic databases were searched using different search strategies from the above-mentioned key words and the combinations on the title relevant to the systematic review. The number of articles identified through the database searching were 175 in all. Further duplicate articles were removed. After thorough reading of titles, the number of articles found relevant were only 20. Full text thorough reading of these articles was done and 9 articles satisfied the selection criteria and were selected for qualitative synthesis of the systematic review. This comprised 45% of the total articles obtained pertaining to the data search.

**Data collection process:**

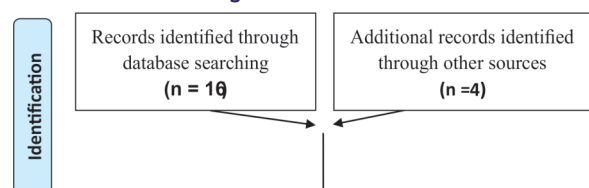
Data collection process was done according to the consultation approved by our expert. First a Microsoft Excel Sheet was filled accordingly and then the expert was consulted for further progress. According to the data collected and the records selected the remaining Excel sheet was filled only with the data that was related to this study and retained.

**Study Characteristics:**

The study characteristics are summarized in Table 2. Hyoid bone position was studied in skeletal class I and skeletal class II malocclusion in 2 studies, 1 study showed the hyoid bone position in skeletal class I and in skeletal class III, another 1 study studied the hyoid bone position in skeletal class II and skeletal class III, 1 study showed the position of hyoid bone in open bite and skeletal class I malocclusion, 2 study showed the position of hyoid bone in different skeletal patterns.

**RESULTS**

**PRISMA 2009 Flow Diagram**



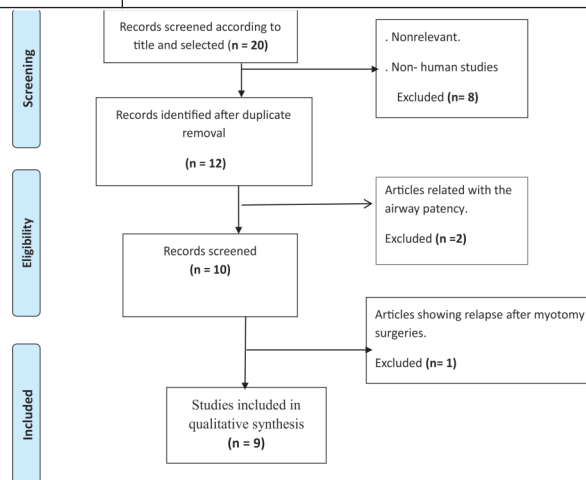
**Keywords**

**Table I – Keywords used for the data search**

PRIMARY KEYWORD	SECONDARY KEYWORD
Hyoid bone	Hyoid bone, lingual bone
Skeletal malocclusions	Class I, Class II, Class III.
Facial divergence	Hypodivergent, Hyperdivergent

**Search strategy**

Search strategy was used for the article search in PUBMED, Google Scholar, and Cochrane Library



**Figure 1: PRISMA flow chart of article identification and selection**

**DISCUSSION**

The hyoid is the only bone of the human body which does not establish any kind of bony articulations and it is kept in position by the action of muscles and ligaments attached on it. There are two major groups of muscles-the suprahyoid and the infrahyoid-attaching to this bone. These muscles rely on the hyoid bone for their actions and have certain very important functions. The importance of the hyoid bone should now be self-evident. Without it, our facility of maintaining an airway, swallowing and preventing regurgitation, and maintaining the upright postural position of the head could not be as well controlled.<sup>[5]</sup>

First study<sup>2</sup> demonstrated the position of hyoid bone on lateral cephalogram in skeletal Class I and skeletal Class II subjects. The angular measurements of hyoid bone showed no significant differences between skeletal Class I and skeletal Class II subjects. Linear measurements of the hyoid bone were found to be less in skeletal Class II subjects with retrognathic mandible as compared to skeletal Class I subjects.

Study concluded that, the position of the hyoid bone was closer horizontally to the cervical spine in skeletal Class II subjects as compared to skeletal Class I subjects. In males, the hyoid bone position was closer to the cervical vertebra horizontally both in skeletal Class I as well as in skeletal Class II subjects. The natural head posture showed no significant gender differences in both skeletal Class I and in skeletal Class II subjects.<sup>[2]</sup>

A similar study done by the another author<sup>6</sup> found proximity of hyoid bone with dentofacial structures and its muscular attachments. Horizontal and vertical position of hyoid bone were evaluated, there is no statistically significant difference between the hyoid bone position in skeletal class I and skeletal class II patients. Study concluded that, the hyoid bone position is similar in skeletal class I and class II patients, the skeletal pattern is not the only determinant of the position of hyoid bone.<sup>[6]</sup>

One of the author studied the position of hyoid bone in skeletal class II with different facial types and<sup>[7]</sup> concluded that, vertical position of the hyoid bone is concerned, higher for Class II malocclusion patients than for those in Class I and, as regards the facial types in the experimental group (brachyprosopic, mesoprosopic, and dolichoprosopic), there was no statistically significant difference of the hyoid bone in the sagittal relationship nor in the vertical relationship.<sup>[7]</sup>

Two authors<sup>[8]</sup> investigated the hyoid bone position and inclination on the cephalometric radiographs of two groups of patients exhibiting Class I and Class III malocclusions. The radiographs were taken in both centric occlusion and wide-opened mandibular position, and 17 measurements were performed on both tracings. Significant differences in the position and the orientation of the hyoid bone were found in two groups of patients who had Class I and Class III malocclusions.

Study concluded that, in patients who had Class III malocclusions, in general, but also more specifically in the boys we observe a reverse inclination of the long axis of the hyoid bone to the mandibular plane and to the ramus in both the centric occlusion and the wide-opened position.

As this difference in inclination is also noted with regard to the palatal plane and the cranial base, it gives a strong indication that the orientation of the hyoid bone is altered for the whole craniofacial complex. Also, in the patients who had Class III malocclusions, the hyoid bone tends to be more anteriorly positioned, especially in the boys.

Finally, study postulated that there is a distinct differences in the position and the orientation of the hyoid bone in the two groups of patients studied cannot be interpreted on the simple basis of spatial anatomic relationships coincident with the skeletal pattern of the craniofacial complex. As the hyoid bone is a very important element for the function of both the suprahyoid and infrahyoid groups of muscles, its role in contributing to a specific orientation and function of these muscles might be instrumental in the establishment of specific structural elements of the jaws and the occlusion of the teeth.

Further investigation on different types of malocclusions, as well as other craniofacial anomalies, might be useful in clarifying the role of hyoid bone in growth in magnitude and direction. Study revealed that a significant difference in the position of the hyoid bone found between class I and class III malocclusions, Class III group especially boys, showed a more anterior position of the hyoid bone as well as a decreased inclination.<sup>[8]</sup>

Two author<sup>9</sup> determined the position of hyoid bone in skeletal

class II and class III pattern on lateral cephalograms. Hyoid bone is anteriorly placed in males than females. Overall comparison between Class II and Class III subjects, hyoid bone was more posteriorly situated in Class II subjects compared to Class III subjects and is statistically significant.

Study concluded that, there was a positive association between hyoid position and different skeletal patterns. The sagittal skeletal pattern may be a contributory factor in variation position of hyoid bone. Hyoid was more anteriorly placed in Class III male subjects. Hyoid was more posteriorly placed in Class II subjects than in Class III. Hyoid was superiorly placed in Class III subjects.<sup>[9]</sup>

Nikos B.Haralabakis and et al<sup>10</sup> studied position of the hyoid bone in adult subjects with long face syndrome and an open bite and with normal Class I occlusion. Several measurements for horizontal, vertical and axial orientation of the hyoid bone position done.

Most of the horizontal measurements showed no difference in the position of the hyoid bone in both male and female open bites when related to normal. As far as vertical measurements only the distance from hyoid bone to palatal plane was found significantly greater in the male open bite group due to the position of the palatal plane in the development of this dentoskeletal malocclusion.

The hyoid axis formed significantly higher angles with the basion-nasion plane as well as with the palatal plane in the open bite groups, while there was no difference in the angle formed by hyoid axis and mandibular plane. The findings strongly suggest that hyoid bone moves in close conjunction with the pharynx, cervical spine, and mandibular plane in patients with entirely different skeletal pattern.

Study also observed that in open bite groups the hyoid bone moves in conjunction with adjacent anatomical structures, which are connected with the hyoid bone through muscles and ligaments. Possibly this movement is due to the functional formation of the muscles that are attached to the hyoid bone, so that open bite patients can breathe comfortably.

Finally, study assumed that the need to maintain patency of the upper respiratory tract, is one of the major functional factors which controls the movement of the hyoid bone in patients with different skeletal patterns.<sup>[10]</sup>

Several author<sup>[11]</sup> revealed a significant difference existed among the position of hyoid bone in skeletal Class I, skeletal Class II and skeletal Class III in both sagittal and vertical planes. The hyoid bone moved backward in Class II malocclusion cases ( $91.21 \pm 4.86$ ) and moved forward in class III cases ( $87.65 \pm 3.38$ ), as compared to the Class I control group.

Significant difference in the position of the hyoid bone between Class I and III malocclusions as the hyoid bone laid more anteriorly in Class III than in Class I. This finding could be attributed to the muscular attachment to the hyoid bone and the mandible, so it is moving backward and forward following the mandibular movement in the sagittal plane. The hyoid bone position was lower in Class III malocclusion than in Class I and Class II malocclusions in relation to the anterior cranial base (SN plane) and the Frankfort plane (P-Or plane) in the vertical plane.

This could be justified that the hyoid bone did not follow completely the mandibular movements.<sup>[11]</sup>

Similar study<sup>[1]</sup> concluded that, 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<sup>(11)</sup>

This study<sup>(12)</sup> concluded that, the hyoid bone is positioned more superior and posterior in females compared to males in the studied subjects of Persian ethnicity. The location of hyoid bone differs among different skeletal classes. The horizontal distance of hyoid bone to adjacent landmarks (third cervical vertebra and retrognathion) was less in class II subjects compared to the other skeletal classes, indicating that the hyoid bone is placed more posterior in skeletal class II pattern. Moreover, the hyoid bone is positioned more inferior and anterior in skeletal class I pattern. The angular measurements of the hyoid bone do not show any significant difference among three skeletal classes.

After studying the available literature, this systematic review concludes that the hyoid bone position is not constant with respect to various skeletal malocclusion and further study is required to evaluate its position<sup>(12)</sup>

### CONCLUSION:

According to the review of the available literature regarding the position of hyoid bone in various types of skeletal malocclusion and various other conditions it has been observed that-

1. The hyoid bone is not a fixed structure, with no bony articulation, its unique in anatomic position, Various analyses and studies conducted to evaluate the position of hyoid bone.
2. As the hyoid bone is attached to various muscles, ligaments, and fascia there is a variability in the position of hyoid bone under standard conditions or even the slightest movement of the head.
3. The position of hyoid bone is a reflection of the relative strain of the mutually interconnected muscles, ligaments and fascia's, considering the position of the hyoid.
4. There is no evidence to suggest that the hyoid bone position has any association with the skeletal malocclusion.

### Limitations:

This review presented with certain limitations. A flaw noted during the course of compiling this systematic review was the limited number of studies fulfilling our selection criteria, indicating that the vast majority of published studies have investigated position of hyoid bone only two dimensionally not the three dimensional (CBCT).

Another inherent flaw is that it's a movable bone with no muscular attachments, so surgical procedures may change the position of the hyoid bone

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