DOI: 10.22037/jds.v39i3.37283

Original Article
ISSN 2645-4351

Hyoid Bone Position in Patients with Class I and Class III Malocclusion by Using Cone-Beam Computed Tomography

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(*Submitted: 10 January 2022 – Revised version received: 6 April 2022 – Accepted: 9 April 2022– Published online: Summer 2022*)

Objectives The hyoid bone has a strategic position in the craniofacial region and has numerous vital functions. This study aimed to assess the hyoid bone position in patients with skeletal class I and class III malocclusion with cone-beam computed tomography (CBCT).

Methods The CBCT images of 30 patients with skeletal class I malocclusion and 30 patients with skeletal class III malocclusion were evaluated. The skeletal malocclusion pattern was determined based on the ANB angle. Horizontal, vertical, and angular measurements were made to determine the hyoid bone position on CBCT images. Independent samples t-test, Mann Whitney U test, and Chi-square test were used for statistical analysis (alpha=0.05).

Results While the distances between the hyoid bone and the genial tubercles and the horizontal distance between the hyoid bone and the roof of the nasopharynx were found to be higher in class III patients ($P<0.05$), the angle between the spina nasalis anterior, sella, and hyoid bone (ASH) was observed to be lower in class III patients, compared with class I patients ($P<0.05$). The distance from the hyoid bone to the posterior nasal spine, its vertical distance from the roof of the nasopharynx, and the length and width of the hyoid bone did not show any significant difference between class I and class III patients ($P>0.05$).

Conclusion The hyoid bone position changed horizontally but not vertically in class III patients. It was also concluded that the hyoid bone dimensions were not affected by skeletal malocclusion.

Keywords Hyoid Bone; Cone-Beam Computed Tomography; Malocclusion, Angle Class III

Introduction

The hyoid bone can be seen in the lower facial region on cone-beam computed tomography (CBCT) images. It is the only bone in the head and neck region that is not articulated with other bones. It is connected to the pharynx, mandible, and head by muscles and ligaments. Applied forces by oral and tongue functions and head and neck movements change the hyoid bone position.[1] The hyoid bone supports the base of the tongue, and takes part in the process of deglutition and respiration due to attachments to active muscles during these processes.[2]

The resting position of hyoid bone is tied to tensional stress between suprahyoid and infrahyoid muscles.[3] Geniohyoid and mylohyoid muscles are the primary suprahyoid muscles. These muscles tolerate varying workloads depending on the position and posture of patient.[4,5] The anatomy of the hyoid bone is composed of one central body, two ventrally located lesser horns, and two dorsally located greater horns. [6]

The hyoid bone has a strategic position and participates in numerous vital functions. It is closely connected to the larynx and takes an active part in speech. The purpose of the hyoid bone is to maintain the pharynx open and preserve the pharyngeal function on the tracheal rings.[7]

The mandible can be a good reference for determining the hyoid bone position since the hyoid bone follows a path similar to the mandible in flection and extension movements of the cervical vertebrae.[8]

Lateral cephalometric imaging, a two-dimensional radiographic modality, has been used in the majority of studies in the literature done on the hyoid bone position.[3, 9, 10] There are also studies in the literature carried out on the hyoid bone position utilizing computed tomography and CBCT.[2,11-13] CBCT is more affordable than computed tomography and has lower patient radiation dose.[14] There are various studies regarding the hyoid bone in the literature.[15-17]

This study aimed to evaluate the position and dimensions of the hyoid bone in patients with skeletal class I and class III malocclusion using CBCT.

Methods and Materials

In this retrospective study, CBCT images of patients who underwent CBCT in the Faculty of Dentistry, Oral and Maxillofacial Radiology Department in 2014-2020 were scanned. The approval of the university Health Sciences Noninvasive Clinical Research Ethics Committee was obtained for this study (1148/2020).

Measurements were made on CBCT images of 30 class I and 30 class III patients aged 15 to 32 years. The skeletal malocclusion pattern was determined based on the ANB angle (class I ANB=1°-5° and class III ANB<1°). Out of 30 class I and 30 class III patients, 16 were females and 14 were males in both groups.

Patients with any systemic disease that could affect their bone metabolism, patients with a syndrome, those using a medication, and patients having undergone a surgical procedure in the area around the hyoid bone in the past were not included in the study.

Individuals that did not meet the eligibility criteria were excluded from the study.

CBCT:

The CBCT images were obtained with the patient in standard supine position (scanning time of 18 seconds, field of view of 18 × 16 cm, exposure time of 3.6 seconds, voltage of = 110 kV, amperage = 1-20 mA, and voxel size of 0.2 mm^3) using NewTom 5G CBCT scanner (QR Verona, Italy). The head of the patient was placed in a horizontal position such that the Frankfurt horizontal plane was perpendicular to the table, and the head was positioned within the circular gantry housing of the X-ray tube to ensure consistent orientation of the sagittal images. The occlusal relationship of each patient's teeth was fixed at centric occlusion. All images were assessed by NNT Viewer software (NewTom, QR Verona, Italy).

Measurements:

A sagittal section passing through the midline of the patients was selected. The distance between the foremost point of the hyoid bone (H) and the most prominent point of the genial tubercles (G) was measured (Figure 1).

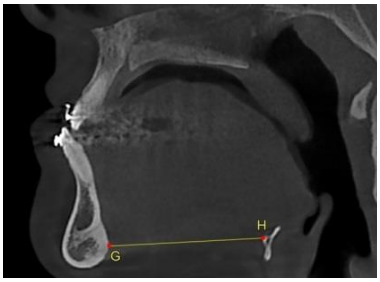

Figure 1: Sagittal plane showing the horizontal distance of hyoid bone and genial tubercle. G: genial tubercle H: hyoid bone

A plane, tangent to the most superior point of the hyoid bone (S) and parallel to the palate, was drawn (X). The distance from the posterior nasal spine to the X plane was measured (Figure 2).

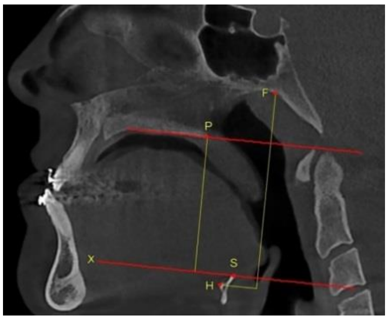

Figure 2: Sagittal plane showing the measurements of hyoid bone position. S: the most superior point of the hyoid bone; X: the plane tangent to the S point and parallel to the palate; F: deepest point of the roof of the nasopharynx; H: the most anterior point of the hyoid bone; P: posterior nasal spine

The distance between the deepest point of the roof of the nasopharynx and the X plane was measured (Figure 2).

The horizontal distance between the foremost point of the hyoid bone (H) and the deepest point of the roof of the nasopharynx (F) was measured (Figure 2).

The angle between the anterior nasal spine (A), the medial point of the sella turcica (S), and the foremost point of the hyoid bone was measured (Figure 3).

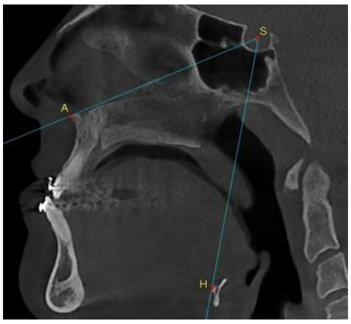

Figure 3: Angular measurements of the hyoid bone position: angle measured between anterior nasal spine - sella and hyoid bone A: spina nasalis anterior S: sella turcica H: the most anterior point of the hyoid bone

On three-dimensional images, the most anteroposterior voluminous region and the most mesiodistal voluminous region of the hyoid bone were measured. The measurement of the horns of the hyoid bone was obtained by combining the medial points of the starting and ending parts of the horns on three-dimensional images (Figure 4).

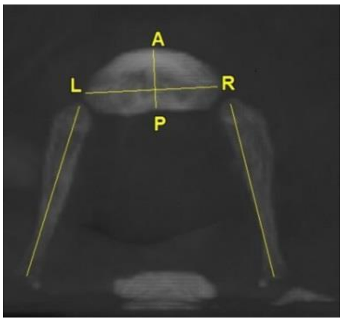

Figure 4: Three-dimensional image showing the measurements of the hyoid bone and horns

Statistical Analysis

The obtained data were analyzed with SPSS Statistics version 22. The Kolmogorov-Smirnov test was used to analyze normal distribution of data.

Independent samples and Mann Whitney U tests were used to analyze the differences between the groups. The Chi-square test was used to analyze the correlation of the groups with nominal variables ($P < 0.05$).-

Results

The mean age of class I patients and class III patients was 20.6±4.19 years and 19.5±2.94 years, respectively.

In this study, the mean distance between the foremost point of the hyoid bone and the genial tubercles was found to be 36.09 mm in class I patients and 40.41 mm in class III patients. The mean distance between the hyoid bone and the genial tubercles was found to be significantly higher in class III patients (P<0.05, Table 1).

The mean distance between the hyoid bone and the posterior nasal spine was found to be 53.91 mm in class I patients and 53.55 mm in class III patients. There was no statistically significant difference (P>0.05, Table 1).

The mean vertical distance between the hyoid bone and the deepest point in the roof of the nasopharynx was found to be 69.33 mm in class I patients and 69.37 mm in class III patients. There was no statistically significant difference between the two groups in this regard (P>0.05, Table 1).

The mean horizontal distance between the hyoid bone and the deepest point in the roof of the nasopharynx was found to be 23.26 mm in class I patients and 29.74 mm in class III patients, which was significantly higher in class III patients (P<0.05, Table 1).

The mean anterior nasal spine-sella-hyoid angle was 52.13 degrees in class I patients and 48.16 degrees in class III patients. This angle was significantly smaller in class III patients (P<0.05, Table 1).

No significant difference was found between class I and class III patients in dimensional measurements regarding the hyoid bone (Table 1).

Table 1- Independent Samples and Mann Whitney U test results regarding the difference between groups in hyoid bone dimensions

		Class 3 and Class 1					
		N	Mean	Minimum	Maximum	SD	P value
H-G (mm)	Class 3	30	40.41	26	52	5.867	0.013*a
	Class 1	30	36.09	24	56	7.101	
H-PNS (mm)	Class 3	30	53.55	42	68	6.498	0.820a
	Class 1	30	53.91	42	68	5.440	
F-X (mm)	Class 3	30	69.37	58	85	7.174	0.965b
	Class 1	30	69.33	58	93	7.496	
F-H (mm)	Class 3	30	29.74	14	52	8.824	0.004*a
	Class 1	30	23.26	11	38	7.951	
A-S-H angle	Class 3	30	48.16	36	57	4.764	0.001*a
	Class 1	30	52.13	45	61	4.302	
Hyoid length (mm)	Class 3	30	21.54	18	28	2.045	0.358a
	Class 1	30	20.94	17	29	2.875	
Hyoid width (mm)	Class 3	30	6.55	3	11	2.251	0.054a
	Class 1	30	7.64	3	13	2.028	

SD**:** standard deviation
[*] Statistically significant
[a] Independent samples t-test
[b] Mann Whitney U test

Discussion

In this study, the hyoid bone position was evaluated in patients with skeletal class I and class III malocclusion whose CBCT images were obtained in supine position and centric occlusion.

Haralabakis et al.[16] assessed lateral cephalograms of patients with dentoskeletal malocclusions (long-face patients and patients with class I malocclusion) and found that the hyoid bone moved along with the adjacent anatomical structures connected to it by the muscles and ligaments. Grant analyzed the position of hyoid bone by using cephalometric techniques in class I, II, and III malocclusions, and concluded that the position of hyoid bone was the same in all three types of malocclusions and determined not by the occlusion of teeth, but by the muscular system.[17]

In a study carried out with cephalometric radiography, Mortazavi et al.[9] compared the horizontal distances between the hyoid bone and the lingual points of the mandibular symphysis in skeletal class I, II, and III patients. They found no statistically significant difference among the groups.[9] In our study, the distance between the hyoid bone and the genial tubercle in the posterior part of the symphysis was found to be significantly greater in class III patients. This may be caused by increased mandibular length and anterior position of the mandible. They also found that the vertical distance between the hyoid bone and the palatal plane passing through the anterior nasal spine and the posterior nasal spine in class I, II, and III patients was the lowest in class III, and the highest in class I patients, reflecting a significant difference among the groups. In our study, the distance between the hyoid bone and the posterior nasal spine, and the distance between the hyoid bone and the deepest point of the roof of the nasopharynx were measured, and no significant difference was found between the groups. Based on this result, it may be concluded that no change probably occurs in vertical position of the hyoid bone in patients with class III malocclusion.

The ANB angle, which is used to determine skeletal discrepancies between the maxilla and mandible, was defined by Riedel[14] and is the most commonly used cephalometric measurement.[18] In our study, the anterior nasal spine-sella-hyoid bone angle was found to be significantly smaller in class III compared with class I patients. Smaller size of this angle in class III patients demonstrates that the hyoid bone is sagittally fore-positioned in patients with mandibular prognathism, as their anterior nasal spine and sella points are fixed. As far as we know, this angle has been used for the first time in the literature to evaluate skeletal jaw relations. It is recommended to be used in future studies even though variations of the hyoid bone cause a limitation for this angle to be used for detection of skeletal relations.

Comparisons between males and females have been conducted in studies on the hyoid bone dimensions by using direct and two-dimensional radiography, photographs, and three-dimensional imaging modalities in the literature.[11, 19-22] There are studies in the literature that state greater mandibular length in class III patients compared with individuals with normal occlusion.[23,24] However, there are no studies on hyoid bone dimensions in patients with class III malocclusion. In this study, no difference was found in any of the dimensional measurements of the hyoid bone between class III and class I patients. Based on this result, it was found that there was no correlation between class III malocclusion and hyoid bone dimensions.

Conclusion

The hyoid bone position was found to change horizontally but not vertically in patients with class III malocclusion. The anterior nasal spine-sella-hyoid angle, which was measured for the first time in the literature in this study, was found to be lower in class III patients. The variations in the hyoid point used in this angle were deemed as a limitation. Further studies are recommended on this topic. None of the hyoid bone dimensions were found to be affected by the skeletal correlations between the maxilla and mandible.

Conflict of Interest

No Conflict of Interest Declared ■

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How to cite:
Arıkan B, Dedeoğlu N,. Hyoid Bone Position in Patients with Class I and Class III Malocclusion by Using Cone-Beam Computed Tomography. J Dent Sch 2021;39(3):79-83.