ORIGINAL ARTICLE

Variation of hyoid bone position in different sexes and different types of skeletal malocclusions

Nidhin Philip Jose, Siddarth Shetty, V. Surendra Shetty, Subraya Mogra, Lida Mary[1], Sarvesh Agrawal[2]

Department of Orthodontics, Manipal College of Dental Sciences, Manipal University, Mangalore, Karnataka, [1]Department of Oral Surgery, Government Dental College and Hospital, Goa, [2]Department of Orthodontics, Manubhai Patel Dental College, Vadodara, Gujarat, India

ABSTRACT

Objective: This study was carried out to ascertain if the position of the hyoid bone demonstrates sexual dimorphism. **Materials and Methods:** This was a retrospective cross-sectional study conducted using patient records from the institution. Institutional Ethical Committee approval was obtained prior to the study. A total of 60 subjects were divided into three groups and studied. Hyoid triangle analysis by Bibby and Preston was carried out to determine the position of the hyoid bone. All radiographs were traced by a single operator and they were retraced to check for measurement error. **Results:** Student's *t*-tests and Mann-Whitney U-test were used to find out whether any sexual dimorphism exists. The horizontal distance from the hyoid bone to the retrognathion was found to be significantly larger in males than in females. The hyoid bone is positioned at a lower level in class I and II in males than in females. Also, it was observed that the hyoid angle was significantly greater in males than in females in class II group. **Conclusion:** Sexual dimorphism was observed in the sample studied.

Key words: Hyoid bone, sexual dimorphism, skeletal malocclusion

Introduction

The hyoid bone is connected to the pharynx, mandible and cranium through muscles and ligaments.[1] It is unique because it is the only bone in the body that has no bony articulations. The hyoid bone is responsible for the careful control of functions like airway maintenance, swallowing, preventing regurgitation and maintaining the upright posture of the head.[2] Obstructive sleep apnea/hypopnea syndrome affects mainly middle-aged males and is known to be associated with a low hyoid bone position among others.[3] Determining the changes in the hyoid bone position in normal healthy subjects will help in planning treatment and further investigations into breathing disorder diseases.[4] There have been numerous attempts to study the differences in its position and shape of the hyoid bone between the male and female sexes. However, there remains a great deal of controversy on the subject. The aim of the study is to determine the position of the hyoid bone in class I, II and III skeletal malocclusions in males and females and to ascertain whether any sexual dimorphism exists in the position of the hyoid bone.

Access this article online	
Quick Response Code:	Website: www.jorthodr.org
	DOI: 10.4103/2321-3825.165041

Materials and Methods

This was a retrospective cross-sectional study conducted using patient records from archives of Department of Orthodontics, Manipal College of Dental Sciences, Manipal University, Mangalore, Karnataka, India. Institutional Ethical Committee approval was obtained prior to the study. A total of 60 subjects were divided into three groups on the basis of antero-posterior skeletal relationships (on the basis of the ANB value) and further into two groups each on the sex of the patients.

A. Group 1 Comprising of 20 samples with ANB = 0-3° and SNB = 78-82° (class I skeletal relationship)

Address for correspondence: Dr. Nidhin Philip Jose, Manipal College of Dental Sciences, Manipal University, Mangalore, Karnataka, India. E-mail: nidhin_mcods@yahoo.com

B. Group 2 Comprising of 20 samples with ANB $\geq 4°$ and SNB $< 78°$ (class II skeletal relationship)
C. Group 3 Comprising of 20 samples with ANB $\leq 0°$ and SNB $> 82°$ (class III skeletal relationship).

In order to keep the sample standardized, SNB angle was also included in the selection criteria, such that the subjects with class II base have SNB $< 78°$, and class III subjects have SNB $> 82°$.

Each group is subdivided into two according to gender, with 11 females and 9 males in each sub-group respectively.

Inclusion criteria included healthy patients in the age group of 16-25 years with the normodivergent facial pattern (FMA between 21 and 28).

Patients with gross dental abnormalities, oral habits, previous orthodontic treatment history or history of any diseases affecting the pharyngeal structures were excluded.

Standardized lateral cephalograms that fulfilled the inclusion criteria were selected from the departmental archives.

The same cephalostat (PLANMECA proline EC machine) was used for all the radiographs. The radiographic technique was standardized, and the exposure parameters were maintained at 68 kV and 12 mA with a maximum exposure time of 0.5 s, with the focal spot to the mid sagittal plane distance at 5 feet. All cephalograms were developed using high-speed polyester based 18 cm × 24 cm Kodak X-Omat lateral head films and fixed under standardized conditions by the same operator maintaining a magnification of (8%) in all radiographs.

The cephalograms were traced the same operator. A few weeks later, randomly selected cephalograms were retraced by the same operator and the error was noted. During the tracing, in case of discrepancy in bilateral structures, the mean shadow of the bilateral structures is traced in order to minimize minor errors in head positioning and minor skeletal asymmetry.

Hyoid triangle analysis by Bibby and Preston[1] was carried out to determine the position of the hyoid bone.

Statistical analysis

Descriptive statistics including the range, mean and standard deviation were carried out. Kolmogorov-Smirnov and Shapiro-Wilks test was done to check the normality of data distribution.

The results showed the normal distribution for all data apart from the ANB angle and angular and vertical measurement of the hyoid bone.

Student's *t*-tests and Mann-Whitney U-test were used to find out whether any sexual dimorphism exists. The level of significance is set at $P < 0.05$. All statistical analysis was carried out with SPSS for windows software (version 13, SPSS Inc., Chicago, III).

Results

The preliminary Kolmogorov-Smirnov test and Shapiro-Wilks test was used to check the normality of data distribution. The results showed the normal distribution for all data apart from the ANB angle and angular and vertical measurement of the hyoid bone.

The results of the Student's *t*-test [Table 1] revealed that the horizontal distance from the cervical vetebrae to the hyoid bone was significantly larger in males than females in both class I and III groups. However, no significant sexual dimorphism was found in the class II group and in the horizontal distance from the hyoid bone to the retrognathion.

The Mann-Whitney test [Table 2] done to check for sexual dimorphism suggested that the hyoid bone is positioned at a lower level in class I and II in males than in females. Also, it was noted that the hyoid angle was significantly greater in males than in females in class II group. Nevertheless, no other significant differences were found in class I and II groups.

Discussion

The precise measurement of the hyoid bone position by cephalometric means is considered difficult. Previous investigators have found that the hyoid bone has a highly variable position not only from person to person, but also at different time intervals in the same person.[5,6] Such variability in results could be attributed to the fact that most analysis has employed cranial structures to define the plane from which the hyoid bone position is measured and that a small variation in the position of the reference plane results in a much greater apparent variation of the hyoid bone irrespective of whether the hyoid bone changed or not. The present study attempts to minimize this effect by using the hyoid triangle analysis which employs planes between the mandibular symphysis and the vertebrae. The results of the hyoid triangle analysis are therefore more accurate compared with using other reference planes.[7]

Table 1: Student's t-test to check for sexual dimorphism

	Parameter	Sex	N	Min	Max	Mean	Std Dev	Median	*T* value	d.f	*P* value
Class I	C_3-H	Female	11	29	42	35.45	3.830	35.00	4.77	17	.000
		Male	9	39	48	43.63	3.462	44.00			HS
		Total	20	29	48	38.89	5.476	39.00			
	H-Rgn	Female	11	32	47	39.00	4.940	38.00	2.05	17	.056
		Male	8	26	40	34.13	5.357	33.00			NS
		Total		19	26	47	36.95	5.553	38.00		
Class II	C_3-H	Female	11	31	39	35.36	2.767	35.00	1.77	18	.093
		Male	9	23	51	39.56	7.265	40.00			NS
		Total	20	23	51	37.25	5.552	38.00			
	H-Rgn	Female	11	32	41	37.09	2.625	37.00	.37	18	.719
		Male	9	30	45	37.67	4.359	38.00			NS
		Total	20	30	45	37.35	3.422	37.50			
Class III	C_3-H	Female	11	32	44	36.36	3.414	35.00	3.51	18	.003
		Male	9	38	45	41.11	2.421	41.00			HS
		Total	20	32	45	38.50	3.804	38.50			
	H-Rgn	Female	11	31	43	39.27	3.379	40.00	.25	18	.807
		Male	9	30	47	39.78	5.652	40.00			NS
		Total	20	30	47	39.50	4.419	40.00			

Table 2: Mann-Whitney U-test to check for sexual dimorphism

Vertical	Class I	Female	11	-5	6	1.82	2.960	2.00	2.16	.031
		Male	8	0	12	5.75	3.845	5.50		Sig
		Total	19	-5	12	3.47	3.821	3.00		
	Class II	Female	11	-6	10	.82	5.250	.00	2.06	.040
		Male	9	-2	15	6.33	5.568	7.00		s1g
		Total	20	-6	15	3.30	5.957	3.00		
	Class III	Female	11	-5	7	2.18	3.868	1.00	.73	.467
		Male	9	-5	7	1.00	4.359	1.00		NS
		Total	20	-5	7	1.65	4.030	1.00		
HyAngle	Class I	Female	11	4	46	21.64	14.888	22.00	.46	.649
		Male	8	12	32	21.88	6.446	22.50		NS
		Total	19	4	46	21.74	11.803	22.00		
	Class II	Female	11	1	24	14.64	6.249	15.00	2.26	.024
		Male	9	15	49	24.78	11.563	23.00		Sig
		Total	20	1	49	19.20	10.180	16.50		
	Class III	Female	11	4	32	15.45	9.427	15.00	1.26	.209
		Male	9	5	29	19.78	7.596	21.00		NS
		Total	20	4	32	17.40	8.714	19.00		

Previous studies by Tsai[2] and Sheng *et al*.[4] concluded that the effects of gender on the hyoid bone position might begin during the period of adolescence due to the active growth of teenagers. In the present study also, only adult patients having permanent dentition were selected to avoid the effects of growth on the position of the hyoid bone.

It was seen that linear measurement from C_3 to the hyoid bone (C_3-H) was significantly larger in males than in females in all the groups except the class II group. This was similar to results obtained by Kollias and Krogstad,[8] Adamidis and Spyropoulos[9] and Marsan.[10]

We did not note any significant differences in the linear distance between hyoid and the mandible (H-RGn) in any of the skeletal bases. This was in accordance with previously published results of Sahin Saglam and Uydas,[11] Muto and Kanazawa,[12] Taylor *et al*.,[13] Marsan[10] and Haralabakis *et al*.[14]

The hyoid bone is positioned at a lower level in class I and II in males than in females which is in accordance with results obtained by Kollias and Krogstad[8] and longitudinal studies by Sheng *et al*.[4] Furthermore, it was noted that the hyoid angle was significantly greater in males than in females in class II group which was not reported in earlier studies.

Tsai[2] investigated the developmental changes of the hyoid bone position in children from deciduous dentition to early permanent dentition and concluded that there was no sexual dimorphism in hyoid bone position during that period. Bibby and Preston also concluded that there is no sexual dimorphism in the hyoid bone position,[1] however they too studied early adolescent patients having class I malocclusion only.

Adamidis and Spyropoulos[15] compared the hyoid bone position in class I to that in class III malocclusion and concluded that the latter patients, especially boys showed a different hyoid bone position and opinioned that the suprahyoid muscle might affect mandibular growth and that there may be different ways of regulating them between males and females.

Understanding the factors that affect the differential positioning of the hyoid bone in males and females would help in diagnosis, prediction and treatment of respiratory illness like obstructive sleep apnea where a definite male predilection is seen.

Conclusion

Sexual dimorphism was observed and the horizontal distance from the hyoid bone to the retrognathion was found to be significantly larger in males than in females. The hyoid bone is positioned at a lower level in class I and II in males than in females. Also, it was noted that the hyoid angle was significantly greater in males than in females in class II group.

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How to cite this article: Jose NP, Shetty S, Shetty VS, Mogra S, Mary L, Agrawal S. Variation of hyoid bone position in different sexes and different types of skeletal malocclusions. J Orthod Res 2015;3:166-9.

Source of Support: Nil. **Conflicts of Interest:** No.