Changes in Hyoid Position Following Treatment Of Class II Division1 Malocclusions with A Functional Appliance

S.Yassaei */ M. Sorush **

Objective: *The aim of this study was to determine change of hyoid bone position following treatment with functional appliance in patients with class II division 1 malocclusion.* ***Design:*** *This study performed on pre and post treatment lateral cephalograms of 28 patients with class II div I malocclusion treated with Farmand functional appliance on average of 11 months. The range of age of girls was 10–13 years and boys 11–14 years. To study the results, t test and Pearsons correlation coefficient were used.* ***Results:*** *Hyoid bone shifted significantly (P.value < 0.01) forward in horizontal dimension and non significantly upward in vertical dimension. There was no significant difference between three groups in facial growth patterns with respect to hyoid bone position alterations in horizontal dimension but was significant between horizontal and vertical growth pattern in vertical dimension. (P value < 0.05). There was significant correlation between decrease of ANB angle with forward movement of hyoid bone.* ***Conclusion:*** *Following treatment with Farmand functional appliance, significant changes occur in the position and anterior displacement of the hyoid bone.*

Keywords: *Hyoid bone, functional appliance, Farmand*
J Clin Pediatr Dent 33(1): 81–84, 2008

INTRODUCTION

The hyoid bone, unlike all other bones of the head and neck, has no bony articulations. The anteroposterior position of the hyoid bone is determined by the conjoint action of the muscles that are attached to structures above and below it and the resistance provided by the elastic membranes of the larynx and the trachea.[1-2] There are two major groups of muscles, the suprahyoid and the infrahyoid, attaching to the hyoid bone. The suprahyoid muscles suspend the hyoid bone, the larynx, the pharynx, and the tongue. They rely on the hyoid bone for their actions and have certain very important functions. The digastric muscles increase the anteroposterior dimension and the oropharynx during deglutition, while the posterior belly of the digastric and the stylohyoid muscle act to prevent regurgitation of food after swallowing. The geniohyoid and mylohyoid muscles are attached at or near the symphysis of the mandible. The attachments of these muscles may affect the position of the hyoid bone by way of tongue movements and also through mandibular movements. Gross changes in tongue position can be assessed by analyzing changes of hyoid bone position. The suprahyoid muscles depress the mandible by contracting against a fixed hyoid platform, the absence of which may seriously impair mandibular opening.[1-4]

The hyoid bone is the bony origin of the root of the tongue and the site of insertion of the muscles of the hyoid biodynamic system that regulates respiration, mastication, deglutition and phonation. Without the hyoid bone, our facility of maintaining an airway, swallowing and preventing regurgitation, and maintaining the upright postural position of the head could not be well controlled. The hyoid bone and its related musculature are also implicated in the maintenance of airway potency with advancement of the mandible.[1-5]

The position of the hyoid bone is a reflection of the tensions in the muscles ligaments and fascia attached to it, and this environment also changes the position and function of the hyoid bone.[6-8] There is a relationship between mandibular positional changes and the position of the hyoid bone.[9-11] In skeletal class III with mandibular prognathism, the hyoid bone is positioned more anteriorly than in class I and II. In skeletal class II with mandibular deficiency, this bone is positioned more superiorly and posteriorly than the two other groups.[12]

Zhou L. in 2000 reported that following treatment with

* S.Yassaei DDS,MS. Assistant Professor, Department. of Orthodontics, Faculty of Dentistry, Shahid Sadoghi University of Medical Sciences and Health Services, Yazd , Iran.
** M . Sorush DPS .Dentist.

Send all correspondence to: S.Yassaei: Assistant Prof Dept. of Orthodontics, Faculty of Dentistry, Daheye Fajr BLV, Imam Ave, PO Box: 89195/165 Yazd , IRAN

Telephone number: +98-351-6255881
Fax number: +98-351-6250344

E mail: syassaei@yahoo.com

Table 1. Cephalometric measurements for determination of vertical and horizontal groups.

Measurements	Horizontal	Vertical	Normal
Sum of posterior angles	390 or <	398 or >	394± 4
Go Gn-SN	30 or <	34° or >	32
FMA	23 or <	27 or >	25
Jaraback index	65% or >	62% or <	62-65%

Table 2. Mean values and standard deviation of measurements before (T1) and after (T2) treatment and magnitude of their changes.

Measurements	T_1		T_2		Mean changes		
	Mean	SD	Mean	SD	Mean	SD	Significance
ANB	7.07	1.58	4.55	1.45	-2.52	0.56	P<0.001
H⊥CP	32.92	3.06	35.24	3.08	2.32	0.76	P<0.01
H⊥CPh	40.57	5.08	39.56	4.99	-1.006	0.73	NS

Table 3. Mean changes and standard deviation of variables in three growth groups.

Groups / Variables	Horizontal			Normal			Vertical			F	Signi-ficance
	Mean	S.D	Sig	Mean	S.D	Sig	Mean	S.D	Sig		
ANB	-2.44	0.5	P<0.001	-2.55	0.44	P<0.01	-2.6	-0.69	P<0.001	1.92	0.32
H⊥cp	2.22	0.78	P<0.01	2.35	0.83	P<0.01	2.4	0.7	P<0.01	0.644	0.334
H⊥cph	-1.22	0.6	P<0.05	-1.0	0.5	NS	-0.8	0.73	NS	6.244	0.035

Table 4. Correlation Coefficients between hyoid movement and changes in ANB.

Variable	ANB
H⊥CP	0.752** P=0.073
H⊥CPh	-0.234 P=0.231

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

FR-I, the position of hyoid moved forward in the horizontal dimension and downward in the vertical dimension.[13]

Information on the behavior of the hyoid during mandibular protrusion is both meager and diverse. The aim of this study was to examine the changes in hyoid position following treatment of class II div 1 malocclusion with Farmand functional appliance.

MATERIALS AND METHOD

In this study 28 patients with class II div 1 malocclusion were treated with Farmand functional appliance for an average of 12 months. Farmand is a kind of functional appliance that designed and introduced in 1972 by Farmand S.M and registered in Loyola university.[6]

Inclusion criteria included:

1. Range of age in girls 10–13 years and boys 11–14 years.
2. ANB angle greater than 4.5 degrees.
3. Mandibular deficiency: body length < Se-N +3mm and/or saddle angle > 128°

Cephalograms were taken in the standard position (maximal intercuspation of teeth, lips in light contact, and natural head position) (Moorrees and Kean 1958).[14]

Bilateral ear rods were inserted into the external auditory meatus to stabilize the head during exposure. All cephalograms were taken by the same operator.

Cephalometric landmarks

H: the most antero-superior point on the body of the hyoid bone

Od: the most posterior point of the odontoid process of the second cervical vertebra.

C4p: the most postero- inferior point on the 4th cervical vertebra.

Reference lines:

CL (cervical line): line connecting Od and c4p

CHL (cervical horizontal line): perpendicular line from Od to cervical line.

Hyoid bone position:

H-CL: perpendicular distance from H to the cervical line.

H-CHL: perpendicular distance from H to the cervical horizontal line.

Facial growth pattern

Facial growth in the vertical, normal or horizontal direction determined by satisfying a minimum of three of the four cephalometric measurements listed in Table 1.

Reliability

All the lateral cephalograms were traced twice by hand onto acetate tracing paper. If the difference exceeded 1mm or 1 degree, third measurement was taken and the middle value of the two nearest measurements was used.

Statistics

A paired t-test was used to compare all measurements before (T_1) and after (T_2) mandibular advancement. A value of $P<0.05$ was considered as significant. The relationships among variables were assessed by means of Pearsons product-moment correlation analysis.

RESULTS

The mean values, standard deviations of all cephalometric variables at pretreatment are presented in Table 2.

A change in the antero-posterior position to the cervical line (H-CL) was statistically significant. ($P<0.01$, mean difference 2.32mm.) The change of ANB angle was statistically significant. ($P<0.01$, mean difference 2.52 degree). The mean values, standard deviations of variables in the groups of growth pattern are presented in Table3.

There was no significant difference between three groups of facial growth pattern in respect to hyoid bone position alterations in the horizontal dimension but there was a significant difference between horizontal and vertical growth patterns in vertical dimension ($P<0.05$).

There was a significant correlation between decrease of ANB angle and forward movement of hyoid bone (Table 4).

DISCUSSION

Unlike all other bones of the head and neck, the hyoid bone has no bony articulations. It is connected with the pharynx and mandible only through muscles and ligaments[4,5] The hyoid and its musculature occupy a key role in the regulation of the pharyngeal airway (Van Lunteren *et al* 1987) and its position is affected by the location of the mandible.[15]

In Horizontal dimension:

The results of this study indicate that immediately following treatment with functional appliance, the hyoid bone repositions significantly forward and these results are in agreement with results of Zhou's study.[9]

Ordubazari has stated that the relation of hyoid bone to the cervical vertebra does not change significantly during life.[16]

Therefore, forward reposition of the hyoid is an indication of the effectiveness of the functional appliance. There was no significant difference between three groups of facial growth pattern in respect to hyoid bone position alterations in horizontal dimension.

In vertical dimension:

According to the results of this study, immediately following treatment with Farmand appliance, the position of hyoid moved significantly upwards.

Considering the anatomic peculiarities of the hyoid bone, the reason that it moves upwards could be that as the bone is attached to the mandible by the geniohyoid, myelohyoid and the anterior component of the digastric's muscles which are responsible for downward movement of the mandible, treatment with functional appliance for pulling down the mandible results in hyperactivity of these muscles. Therefore, the balance between the suprahyoid and infrahyoid muscles is upset resulting in upward movement of the hyoid bone.

These results do not support Zhou's study,[13] who showed a downward displacement of the hyoid bone. Graber[17] and Yamaoka[18] reported that both stability and potency of the pharyngeal airway were primary factors in hyoid bone positioning. On the other hand, upward elevation of the hyoid bone occurs with mandibular advancement and this change is transitory in nature.[17]

Robertson studied the changes in hyoid position following treatment with functional mandibular advancement both short term and long term.[17] He reported that immediately following treatment, the hyoid bone moved upwards, but in the long term, (30 +/- 4 months following treatment) the hyoid moved downwards again towards its original position and this was because of possible increase in the length of the supra hyoid musculature tendons and compensatory actions of the infrahyoid muscles. It is therefore possible that the results were different in the present study as measurements were taken immediately following treatment and in the long run, the hyoid bone could move downward as a compensatory action. Also, upward elevation of the hyoid bone is transitory in nature and later, the hyoid bone moves downward as a compensatory action. Surely, this requires further study with longer time period of follow up in the future.

On comparison of the mean values of the vertical changes in the three developmental groups, the upward displacement of the hyoid was significant in the horizontal growth group, (P value < 0.05) but this was not so in the normal and vertical groups. Also, there was a significant difference between the vertical and horizontal growth patterns (P value < 0.05), and keeping in view the role of the hyoid bone in regulation of the pharyngeal airspace, is worth considering. As the size of the pharyngeal space in vertical growth is lesser than that in horizontal growth,[9] the hyoid bone has least amount of displacement in the upward direction in vertical growth pattern and less damaging to the pharyngeal space. In contrast to this, maximum anterior displacement of the hyoid bone in vertical growth pattern results in increased pharyngeal space.

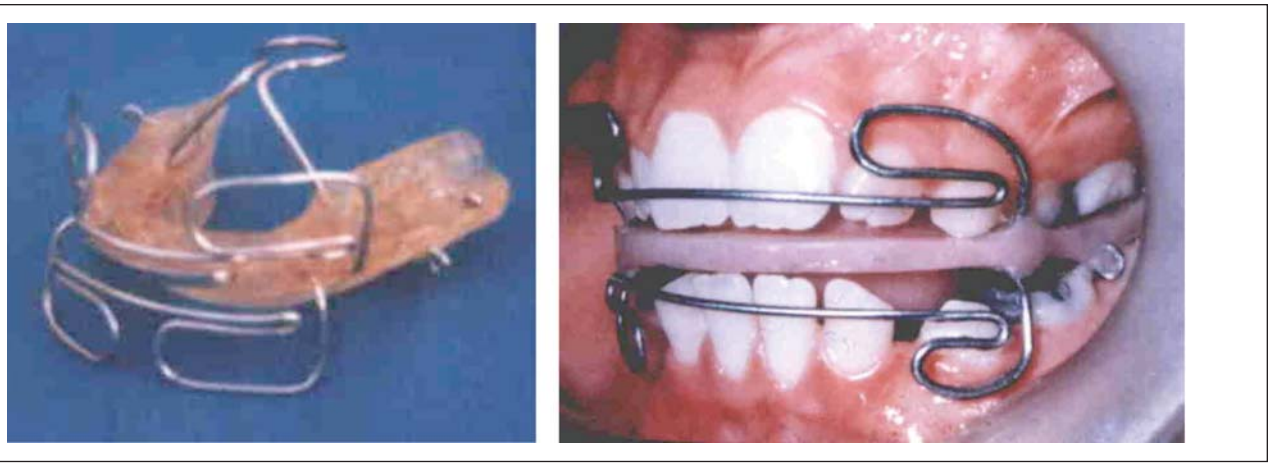

Fig 1 : Farmand functional appliance

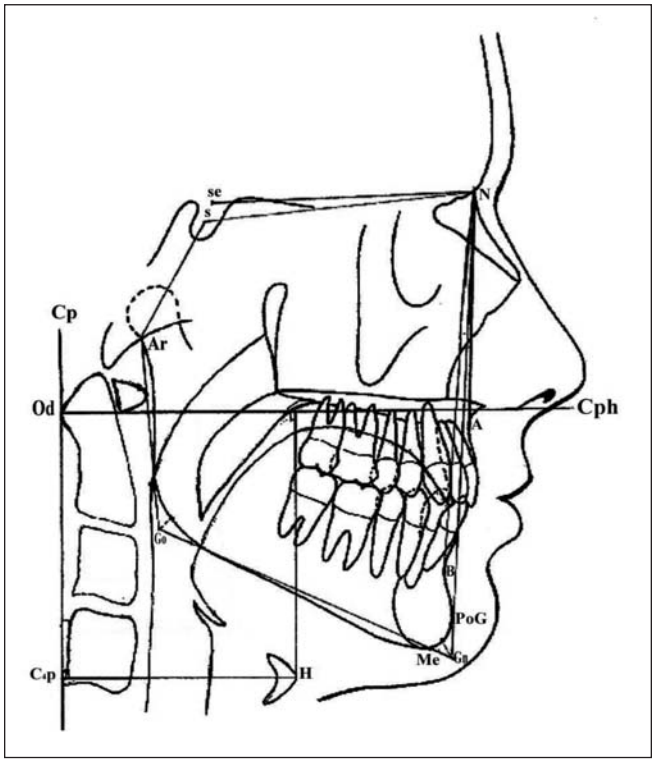

Fig2:cephalometric reference points and planes

CONCLUSION

Following treatment with Farmand functional appliance type II (Fa II), significant changes occur in the position and anterior displacement of the hyoid bone.

REFERENCES

1. Bibby RE, Preston CB. The hyoid triangle. *Am J Orthodont*, 1981; 80: 92–97.
2. Hung-Huey Tsai. The positional changes of hyoid bone in children. *J Clin Pediatr Dent*, 2002; 27(1): 29–34.
3. Peter LW, Roger W. Grays anatomy. 37th ed. New York:Churchill Livingstone; 1989.
4 Hagazi R. Head and Neck anatomy, Tehran, Tehran university publication, 1992.
5. Stepovich M: A cephalometric positional study of the hyoid bone. *Am J Orthod*, 1965; 51(12): 882–86.
6. Rocavado M. Biomechanical relationship of the cranial, cervical, and the hyoid bone regions. *Journal of Craniomandibular Practice,* 1983; 1: 61–66.
7. Wenzel A, Williams S, Ritzau M. Change in head posture and nasopharyngeal airway following surgical correction of mandibular prognathism. *European Journal of Orthodontics,* 1989; 11: 37–42.
8. Winnberg A, Pancherz H. Head posture and masticatory muscles function. An EMG investigation. *European Journal of Orthodontics,* 1983; 5: 209–217
9. Ertan Erdinc A M, Dincer B, Sabah M E. Evaluation of the position of the hyoid bone in relation to vertical facial development.*The Journal of Clinical Pediatric Dentistry* 2003; 27(4): 347–352.
10. Opdebeeck H, Bell WH, Eisafield J, Mishelevich D. Comparative study between the SFS and LFS rotation as a possible morphogenic mechanism. *Am J of Orthod,* 1978; 74: 509–521.
11. Winnberg A, Pancherz H, Westesson P L. Head posture and hyomandibular function in man.A synchronized electromyographic and videofluorographic study of the openclose-clench cycle. *Am J Orthodontics Dentofacial Orthopedics,* 1988; 94: 393–404.
12. Ravanmehr H, Abdollahi D. The position of hyoid bone in skeletal class I, II and III. *Journal of Dentistry Tehran University of Medical Sciences*, 2001; 13(4): 27–36.
13. Zhou L, Zhao Z, Luo D: The analysis of the changes of tongue shape and position, hyoid position in class II, division I malocclusion treated with functional appliances (FR-I). *Hua Xi KouQing*, 2000; 18(2): 123–5.
14. Moorrees C, Kean M. Natural head position: a basic consideration in the interpretation of cephalometric radiographs. *Am J Phy Anthro,* 1958; 16: 213–34.
15. Bttagel J M, Johal A, Kotecha B: changes in airway and hyoid position in response to mandibular protrusion in subjects with obstructive sleep apnoea (OSA). *European Journal of Orthodontics,*1999; 21(4): 363–376.
16. Ordubazari M, Farokhnia F, Tuki Z, Ezzati F. Comparison of pharyngeal oral spaces in 9-14 years and 18-30 year old Iranian groups. *Dental journal of Shahid Beheshti Medical University*, 1998, 19(2): 95–100.
17. Robertson J. The effect of long term mandibular advancement on the hyoid bone and pharynx as it relates to the treatment of obstructive sleap apnoea. *Aust Orthod J*, 2000; 16: 157–66.