ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 05, pp.30541-30546, May, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

EVALUATION OF UVULO-GLOSSO-PHARYNGEAL CHANGES AFTER THE FUNCTIONAL APPLIANCE THERAPY: A CEPHALOMETRIC STUDY

Dr. P. Narayana Prasad, Dr. Tarun Rana, Dr. Tarun Sharma, Dr. Gaurav Chaudhary, Dr. Yashraj Bahadur and *Dr. Sonia Gera

Department Of Orthodontics and Dentofacial Orthopaedics, Seema Dental College and Hospital, Rishikesh- 249203, Uttarakhand, India

ARTICLE INFO

Article History:
Received 26th February, 2016
Received in revised form
27th March, 2016
Accepted 15th April, 2016
Published online 10th May, 2016

Key words:

Uvulo-glosso- pharyngeal changes,
Hypopharyngeal airway space,
Functional appliance therapy.

ABSTRACT

Introduction: Functional appliances are mostly used in the modulation of mandibular growth and displacement of the tongue, which results in the alteration of the oropharyngeal airway. This study was carried out to evaluate the cepalometric changes in pharyngeal airway space along with the position of hyoid bone, size and position of tongue and soft palate after functional appliance therapy in growing patients.

Aims and objectives: 1.To evaluate the changes in pharyngeal length and width 2.To evaluate hyoid bone position and angulation, and 3. To compare size of tongue and soft palate before and after functional appliance therapy.

Materials and method: The pretreatment and post treatment cephalometric radiograph of 8 growing subjects were considered and the changes in the airway were analyzed by dividing the sample in pretreatment (Group 1) and the post treatment group (Group 2). Cephalometric readings were analyzed using Paired t test and Pearsons correlation to evaluate the changes in the dimensions of pharyngeal airway, position and angulation of hyoid bone, length and width of soft palate and tongue.

Results: Statistically significant changes were found in the anterioposterior dimensions of hypopharyngeal airway space (p=0.004) and hyoid distance from mandibular plane (p=0.046) after the completion of functional appliance therapy.

Conclusion: The functional appliances play a significant role in the improvement of hyphopharyngeal airway space and in the upward movement of the hyoid bone in relation to the mandibular plane, increasing the area of the lower airway and hence decreasing the lower airway resistance.

Citation: Dr. P. Narayana Prasad, Dr. Tarun Rana, Dr. Tarun Sharma, Dr. Gaurav Chaudhary, Dr. Yashraj Bahadur and Dr. Sonia Gera, 2016. "Evaluation of uvulo-glosso-pharyngeal changes after the functional appliance therapy: a cephalometric study", *International Journal of Current Research*, 8, (05), 30541-30546.

INTRODUCTION

Normal respiration requires that air be displaced from external environment into the lungs, where it can contact the alveolar membrane to make oxygen available for gaseous exchange with the blood stream. The simple function of the upper airway is to permit the unimpeded movement of humified air to the tracheobronchial tree (Soghra yassaei, 2012). The commonly encountered impedence of airflow can be due to morphologic, pathologic or functional abnormalities. The growth and function of the nasal cavities, the nasopharynx and the oropharynx are closely associated with the normal growth of the craniofacial structures and the functional appliances, that serves as a modality for modulation of the maxillary and mandibular growth, can also have their effect on the dimensional changes in these structures and thus effecting the airway. The ability of functional appliances to reduce the overjet by modifying dental relationships is not a dispute (Collet, 2000). The controversy surrounds the ability of the appliance to increase the mandibular growth and the stability of the altered growth and positional changes in the mandible. Functional appliances are mostly used in the treatment of skeletal Class II malocclusion by stimulating mandibular growth through its anterior placement (Achilleos *et al.,* 2000). Functional appliances also cause anterior displacement of the tongue, which results in the broadening of the oropharyngeal airway (Jena *et al.,* 2010). Various researchers have reported the effect of mandibular advancement devices and surgeries on improving the airway in patients with Obstructive Sleep Apnea as retrognathic mandible is suggested to be its potential causative factor, hence there is a need to study the treatment effect of functional appliances on the changes in the airway in

Corresponding author: Dr. Sonia Gera,
Department Of Orthodontics and Dentofacial Orthopaedics, Seema Dental College and Hospital, Rishikesh- 249203, Uttarakhand, India.

Hard tissue landmarks used

S.no	Landmark	Description
1.	PNS (Posterior Nasal Spine)	Constructed radiological point, the intersection of the continuation of anterior wall of pterygopalatine fissure and floor of the nose. It marks the dorsal limit of maxilla.
2.	Go- Gonion.	A constructed point, the intersection of lines tangent to the posterior margin of the asending ramus and mandibular base
3.	B- Point B, supramentale	The most posterior point in the outer contour of the mandibular alveolar process, between infradentale and pogonion.
4.	H- Hyoid point.	Highest point on anterio superior aspect of hyoid bone.
5.	C3 point	Inferior anterior tip of third cervical vertebra (C3)
6.	Me- Menton.	The most caudal point in the outline of symphysis, it is regarded as the lowest point of the mandible.

Soft tissue landmarks used

S.no	Landmark	Description
1.	P	Tip of soft palate
2.	T	Tip of tongue.
3.	V- Valeculla.	It is the intersection of tongue and epiglottis.

Planes used

S.no	Landmark	Description
1.	Palatal plane	The plane constructed by joining anterior nasal spine(ANS) and posterior nasal spine(PNS)
2.	Mandibular plane	Plane formed by line connecting gonion(Go) and gnathion(gn)
3.	Go- B line	Line joining gonion to point B i.e. suprmentale.

Parameters used to evaluate the airway changes

S.no.	Parameter		Description
	Linear Measurements		
1.	NAS(Nasopharyngeal Airway Space)	:	Measured from the upper pharyngeal wall along palatal plane
2.	SAS(Superior Pharyngeal Airway Space)	:	Horizontal distance from tip of soft palate to pharyngeal wall
3.	PAS(Posterior Airway Space)	:	Horizontal distance from posterior margin of the tongue to pharyngeal wall measured on Go-B line
4.	HAS(hypopharyngeal airway space)	:	Minimum horizontal distance in the hypopharyngeal area measured from point V
5.	Hyoid Distance(MP-H)	:	Perpendicular distance from mandibular plane to anterior aspect of hyoid(H)
6.	Hyoid, c3 vertebrae and menton relationship	:	Perpendicular distance from H to the line inferior- anterior tip of cervical third vertebrae(c3) to menton
7.	Length of soft palate	:	PNS to tip of soft palate(P)
8.	Soft palate thickness	:	Maximum thickness of soft palate measured perpendicular to PNS-P line
9.	Length of tongue	:	Measured from valecula to tip of tongue
10.	Height of tongue	:	Measured as perpendicular distance from H to VT line
	Angular Measurements		
11.	Hyoid Angle	:	Angle from mandibular plane to superior aspect of hyoid.

order to prevent one of the causative factors of this debilitating syndrome that mostly occurs as age advances (Finkelstein *et al.,* 2001). This study was carried out to evaluate the cepalometric changes in pharyngeal airway space along with the position of hyoid bone, size and position of tongue and soft palate after functional appliance therapy in growing patients.

Aims and Objectives

The aims and objectives of the study are

- To evaluate the changes in pharyngeal length and width after functional appliance therapy.
- To evaluate hyoid bone position and angulation before and after functional appliance therapy.
- To compare size of tongue and soft palate before and after functional appliance therapy.

MATERIALS AND METHODS

A sample of 11 subjects treated with the functional appliance therapy in the department of Orthodontics and Dentofacial Orthopaedics in Seema Dental College and Hospital, Rishikesh were considered for the study. Subjects selected for the study were between the age group of 9 to 15 years with Cervical Vertebral Maturation Stage III and IV with ANB angle greater than 4 degrees, retrognathic mandible, convex profile, positive VTO and full cusp Class II molar relation and there was no particular consideration on the type of functional appliance to be used for the correction of developing skeletal Class II relation. 2 samples were discarded due to the unavailability of post treatment records and 1 sample was discarded due to the inappropriate quality of radiograph. Hence, the cephalometric radiograph of 8 subjects were considered for the evaluation of airway before and after the functional appliance therapy and the changes in the airway were analyzed by dividing the sample in 2 groups in which the group 1 consisted of pretreatment group and group 2 was the post treatment group. The materials used in the study were pretreatment and post treatment cephalograms of 8 patients, all using the same x ray machine, Kodak 8000C Panoramic & Cephalometric unit, lead acetate tracing sheats, 3H pencils, erasers, sharpners, scale, protracter, set squares and view box. The lateral cephalograms considered in the study were taken with patient in his/her Natural head position, posterior teeth in occlusion and lips in rest position with no difference of magnification in the 2 stage radiographs. The cephlometric analysis was carried out by manually tracing the Cephalograms. All cephalometric

readings were repeated after the interval of 10 days by the same person to obviate the possibility of intra-observer errors and no statistically significant difference in the readings was found. Statistical analysis considered for the study was Paired t test and Pearsons correlation were used to analyze the effect of functional therapy on the pharyngeal width, position and angulation of hyoid bone, and the size of tongue and soft palate.

RESULTS

All the parameters were analysed using the paired t test and pearsons correlation coefficient. After the completion of functional appliance therapy, there was a mean increase of 0.56 mm in nasopharyngeal airway space which is found to be statistically non significant (p= 0.75). On evaluation of superior pharyngeal airway space changes after the completion of functional appliance therapy, there was a mean increase of 0.69 mm which again is found to be statistically non significant(p=0.47) and so as the changes in posterior airway space which showed a mean increase of 0.38 mm (p=0.720). On evaluation of hypopharyngeal airway space changes, there was a mean increase of 1.75 mm which is found to be statistically highly significant (p=0.004). On evaluation of change in the hyoid distance from mandibular plane after the completion of functional appliance therapy, there was a mean decrease of 3.81 mm which is found to be statistically significant(p=0.046).

Hyoid angle changes of 5.25 mm was found which is statistically non significant (p=0.28) and so did the relationship of hyoid bone with c3 and menton which showed the change of 1.63mm (p= 0.37). The mean increase in soft palate length and thickness post treatment is 2.63mm and 1mm respectively which is statistically non significant (p=0.34 and 0.121 respectively). The mean increase in the tongue length after the therapy was 4.63 mm which is found to be statistically nonsignificant (p= 0.119) and so as the mean decrease in height of tongue in reference to hyoid point was 5.56mm which was also found to be statistically nonsignificant (p= 0.170). Similar results were found on the pearsons correlation coefficient.

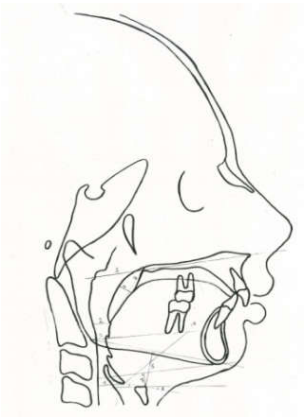


Fig. 1. Parameters for airway analysis

Table 1. Results of statistical analysis using paired t test

	Mean	Std. Deviation	Std. Error Mean	Mean difference	t-test value	p-value
NAS Pre	27.81	3.93	1.39	-0.56	-0.332	0.750
NAS Post	28.38	4.63	1.64			
SAS Pre	9.94	2.34	0.83	-0.69	-0.763	0.470
SAS Post	10.63	3.07	1.08			
PAS Pre	11.69	3.63	1.29	0.38	0.367	0.724
PAS Post	11.31	2.28	0.81			
HAS Pre	15.69	1.67	0.59	-1.75	-4.141	0.004*
HAS Post	17.44	1.59	0.56			
Hyoiddistance Pre	13.75	2.49	0.88	3.81	3.081	0.046*
Hyoiddistance Post	9.94	5.87	2.08			
Hyoidangle Pre	17.75	10.14	3.58	5.25	1.157	0.285
Hyoidangle Post	12.50	6.99	2.47			
HyoidC3M Pre	-0.88	4.29	1.52	-1.63	-0.957	0.370
HyoidC3M Post	0.75	3.51	1.24			
Splength Pre	29.63	8.21	2.90	-2.63	-1.027	0.339
Splength Post	32.25	2.12	0.75			
SPthickness Pre	8.06	0.78	0.27	-1.00	-1.764	0.121
SPthickness Post	9.06	1.47	0.52			
Tonguelength Pre	68.13	5.67	2.00	-4.63	-1.776	0.119
Tonguelength Post	72.75	5.04	1.78			
Tongueheight Pre	11.75	9.71	3.43	5.56	1.528	0.170
Tongueheight Post	6.19	1.13	0.40			

Paired t-test, * Significant difference

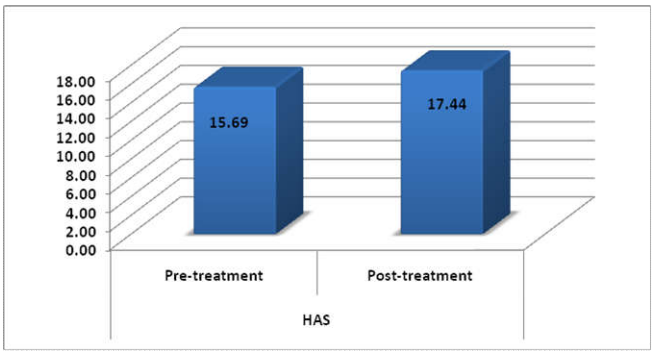
Table 2. Results of statistical analysis using Pearson's Correlation

	Number	Correlation	p-value
NAS Pre& NAS Post	8	0.382	0.351
SAS Pre& SAS Post	8	0.584	0.128
PAS Pre& PAS Post	8	0.608	0.110
HAS Pre& HAS Post	8	0.732	0.039*
hyoiddistance Pre&hyoiddistance Post	8	0.672	0.047*
hyoidangle Pre&hyoidangle Post	8	-0.093	0.827
hyoidC3M Pre& hyoidC3M Post	8	0.254	0.544
Splength Pre&Splength Post	8	0.564	0.145
SPthickness Pre&SPthickness Post	8	0.090	0.833
tonguelength Pre&tonguelength Post	8	0.056	0.895
tongueheight Pre&tongueheight Post	8	-0.476	0.233

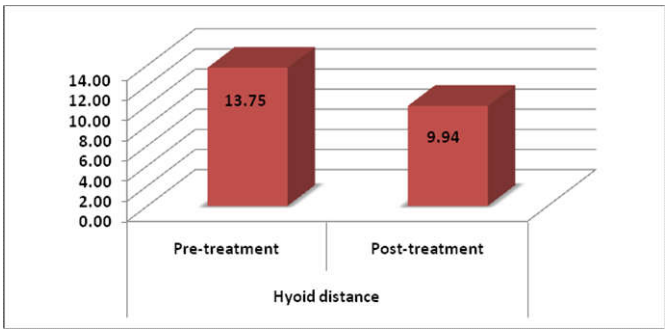
Pearson's correlation test, * Significant difference

DISCUSSION

Obstructive sleep apnea (OSA) is a problem resulting from repeated obstruction of the upper respiratory tract during sleep.



Graph 1. Graph showing dimensional changes in Hypopharyngeal airway space



Graph 2. Graph showing dimensional changes in Hyoid Distance

It is diagnosed as sleep disorderd breathing in children (with Apnea Hypopnea Index, AHI >1) (Finkelstein *et al.,* 2001). Even though the exact pathology of OSA is not recognized completely, mandibular retrognathism is one of the proposed causes. After the completion of growth, the only modality for correction of mandibular retrognathism is mandibular advancement surgery and various researchers have reported the improvement in the condition of adult OSA after mandibular advancement surgeries. However, dealing with this causative factor during growth phase with the functional appliance therapy not only prevents the patients, with less than normal airway space, from adding to the potential risk factors of OSA, it also minimises the risk of mandibular advancement surgeries after growth completion. Hence functional appliances can be utilized for growth modulation and anterior positioning of mandible and hence obviating one of the causes of OSA (Ozbek *et al.,* 1998). It has been determined that the anterior displacement of the mandible by the functional appliances influences the position of hyoid bone and, consequently, the position of the tongue and thus improves the morphology of the upper airways (Yassaei Bahrololoomi, 2007). If these reported effects are stable, functional therapy can be very important in the improvement of airway. Soghra *et al.,* 2012 evaluated the changes in the tongue position hyoid bone and the airway dimensions following treatment with faramund appliance and concluded that functional appliance has the potential to increase pharyngeal airway dimensions and changes in tongue and hyoid position and these changes seemed to be stable for upto 4 years on average. The present study evaluate the anterioposterior changes in the nasopharyngeal airway space, superior, posterior and hypopharyngeal airway space changes after the functional appliance therapy and also the changes in the vertical positioning of the hyoid bone, changes encountered in its angulation, changes in the length and height of the tongue and length and width of the soft palate, if any, after the functional appliance therapy.

The growing patients with the CVMI 3 and 4 were considered in the study as the greatest increament of mandibular and craniofacial growth is determined to occur during this stage and clinical research has demonstrated that the greatest effect of functional appliances takes place when the peak in mandibular growth is included in the treatment period (Collet, 2000). although the airway changes can be best evaluated by the 3D imaging modalities, specially the CBCT, as the increament in the airway is evaluated by both transverse as well as anterioposteior changes , that is the net increase in the volume but it accounts for the increment in the radiation dose and also the additive cost of the procedure. Hence the lateral cephalogram is chosen to evaluate the airway changes as it is the routine radiograph obtained for any orthodontic treatment and it gives the assessment of the cervical vertebral maturation stage, hence obviating the need for additive radiographs such as hand wrist or MP3 for assessing the growth status of the individual. There was no categorization of any particular functional appliance as the basic aim of the study was to evaluate the airway changes by modulation of the mandibular and craniofacial growth utilizing the best treatment modality for the patient. There is a mean increase of 0.56 mm in the nasopharyngeal airway space which is statistically non significant ($p= 0.750$) as coinciding with the study by Ashok Kumar Jena, Satinder Pal Singh, and Ashok Kumar Utreja (Jena *et al.,* 2010), that also suggests the minimal, non significant increase in depth of nasopharynx. However, in contrast to our observation, Restrepo *et al.* reported a significant increase in the nasopharyngeal airway dimensions among Class II subjects treated by Klammt or bionator appliance. Also the study shows the significant increase in the depth of hypopharynx which again is coincident to our study ($p<0.005$) that shows a significant average increase in hypopharyngeal airway space by 1.75mm. The study by Ordubazari *et al.,* 1998 showed that oropharyngeal space changes during growth period is minimal hence the significant increase in the hypopharyngeal airway space in our study might be the effect of functional appliance as a forward movement of the mandible could be responsible for such a change. Similarly, Schutz *et al.,* 2008 also found a volumetric increase at the hypopharynx region following Class II treatment by Herbst appliance, and they explained that this improvement was due to mandibular repositioning. However there is no significant increase in the superior pharyngeal airway space (SAS) ($p>0.005$) in our study which is contradictory to the study by Ashok Kumar Jena *et al.,* 2010 that shows a significant change. There is an improvement in the SAS by an average of 0.69mm in our study but that is not significant as indicated in various other studies. The improvement of the airway is caused by the forward relocation of the tongue following various functional appliance therapy (Ozbek *et al.,* 1998; Yassaei *et al.,* 2007). Orthodontic

myofunctional therapy has the potential to affect the hyoid bone by altering the mandibular position. Several studies (Pae *et al.,* 2008; Eggensperger *et al.,* 2005; Gale *et al.,* 2001; Hayes *et al.,* 1994; Schendel and Epker, 1980; La Banc and Epker, 1984; Wessberg *et al.,* 1982) have tried to determine the actual position of the hyoid bone relative to cervical spine and hyoidal functional relationships with the craniomandibular system. These studies have shown changes in the position of the hyoid bone and in pharyngeal size with the mandibular advancement (La Banc and Epker, 1984). There is a decrease in the angulation of the hyoid bone after the functional appliance therapy which is suggested to be due to the forward positioning of the tongue. In this study, there was a mean decrease of 3.81 mm in the hyoid distance from mandibular plan after the completion of functional appliance therapy, which is found to be statistically significant($p=0.046$). This is consistent with the study by Verma *et al* who found the highly significant upward displacement of hyoid bone in relation to mandibular plane following treatment with Twin block appliance. There is a mean increase of 2.63mm in soft palate length after the functional appliance therapy and the soft palate thickness was also found to be increased by 1mm, although neither of the two shows the significant changes ($p=0.339$ and 0.121 respectively). The change in the thickness is coinciding with the study by Ashok Kumar Jena, Satinder Pal Singh, and Ashok Kumar Utreja, which shows the significant increase in the thickness of soft palate($p<0.001$) however the study also suggests the significant reduction in the length of soft palate($p< 0.001$) which is non coinciding with our study. There is the backward position of the tongue among subjects with mandibular retrognathism that cause pressure on the soft palate and results in decreased thickness and increase its length and inclination.[4] The positive impact of functional appliance therapy on the airway dimension cannot be explained simply by the established skeletal change; the difference in the posture of the tongue caused by increased genioglossus muscle and tonus or soft tissue changes may play an important role and is probably induced by forward positioning of the mandible during the treatment (Schutz *et al.,* 2011). Another possible explanation for the improvement could be the "catch-up growth,' of the mandible whereby children with small oropharyngeal dimensions would have a greater intrinsic stimulus to increase their capacity for respiratory function (Hänggi *et al.,* 2008) according to Pouseille's law, which states that as the radius increases and heigh decreases, resistance decreases. Therefore upward positioning of the hyoid bone as a result of the functional appliance therapy might decrease the airway resistance (Ozbek *et al.,* 1998).

Limitations of the study

This study accounts for the airway changes in the anterioposterior direction but the changes in the transverse direction could not be evaluated due to the choice of two dimensional modality in order to keep the exposure of the growing children to the minimum of X ray radiations by obviating any additive radiographs. This study shows the significant increase in the hypopharyngeal arway space and decreased airway resistance due to the upward movement of the hyoid bone but there is still a need to evaluate the long term effects of the functional appliances on the stability of the skeletal and muscle changes and their correlation with the changes in the airway dimensions. Furthermore the study was limited by the small sample size and more work is needed to be done in this area in order to expand the options for prevention of Obstructive sleep apnea by diagnosing and treatment of one of the predisposing factor by a non invasive modality utilizing the functional method of growth modulation.

Conclusion

The functional appliances play a significant role in the improvement of hyphopharyngeal airway space and in the upward movement of the hyoid bone in relation to the mandibular plane, increasing the area of the lower airway and hence decreasing the resistance in the lowe airway. Also, there is a non significant but positive change in the anterioposterior dimensions of the nasopharyngeal airway space, superior pharyngeal airway space, thickness of soft palate and the length and height of the tongue. These factors collectively forms a cascade that improves the uvuloglossopharyngeal airway space obviating the potential of negative factors of reduced upper airway.

REFERENCES

Achilleos, S., Krogstad, O., Lyberg, T. 2000. Surgical mandibular advancement and changes in uvuloglossopharyngeal morphology and head posture: a short- and long-term cephalometric study in males. *Eur J Orthod.*, 22:367–381.

Changes of hyoid bone position following treatment of Class II div 1 malocclusion with Farmand functional appliance. *J Dent Med*., 2007;19:51–56.

Collet, A.R. 2000. Current concepts of functional appliance and mandibular growth stimulation. *Aus. Dent. Jour.,* 45(3):173-177

Eggensperger, N., Smolka, K., Johner, A., Rahal, A., Iizuka, T. 2005. Long-term changes of hyoid bone and pharyngeal airway size following advancement of the mandible. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.*, 99: 404-410.

Finkelstein, Y., Wexler, D., Horowitz, E. 2001. Frontal and lateral cephalometry in patients with sleep-disordered breathing. *Laryngoscope*, 111:634–641.

Gale, A., Kilpela¨inen, P. V., Laine-Alava, M. T. 2001. Hyoid bone position after surgical mandibular advancement. *Eur J Orthod.*, 23: 695-701.

Hänggi, M. P., Teuscher, U. M., Roos, M., Peltomäki, T. A. 2008. Long-term changes in pharyngeal airway dimensions following activator-headgear and fixed appliance treatment. *Eur J Orthod*., 30:598–605

Hayes, R. J., Sarver, D. M., Jacobson, A. 1994. The quantification of soft tissue cervicomental changes after mandibular advancement surgery. *Am J Orthod Dentofacial Orthop.,* 105: 383-391

Jena, A. K., Singh, S. P., Utreja, A. K. 2010. Sagittal mandibular development effects on the dimensions of the awake pharyngeal airway passage. *Angle Orthod*., 80:1061–1067

LaBanc, J. P., Epker, B. N. 1984. Changes of the hyoid bone and tongue following advancement of the mandible. *Oral*

Surg Oral MedOral Pathol Oral Radiol Endod., 57: 351-356.

Ordubazari, M., Farokhnia, F., Tuki, Z., Ezzati, F. 1998. comparison of pharyngeal oral space in 9-14 years and 18-30 years old Iranian group. Dental Journal of Shahid Beheshti Medical University, 19(2):95-100

Ozbek, M. M., Memikoglu, U. T., Gogen, H., Lowe, A. A., Baspinar, E. 1998. Oropharyngeal airway dimensions and functional-orthopedic treatment in skeletal Class II cases. *Angle Orthod*., 68:327–336.

Ozbek, M. M., Memikoglu, U. T., Gogen, H., Lowe, A. A., Baspinar, E. 1998. Oropharyngeal airway dimensions and functional-orthopedic treatment in skeletal Class II cases. *Angle Orthod*., 68:327–336.

Pae, E. K., Quas, C., Quas, J., Garrett, N. 2008. Can facial type be used to predict changes in hyoid bone position with age? A perspective based on longitudinal data. *Am J Orthod Dentofacial Orthop.,* 134: 792-797.

Schendel, S. A., Epker, B. N. 1980. Results after mandibular advancement surgery: an analysis of 87 cases. *J Oral Surg.,* 38: 265-281.

Schutz, T.C.B., Dominguez, G. C., Hallinan, M. P., Cunha, T. C. A., Tufik, S. 2011. Class-II correction improves nocturnal breathing in adolescents. *Angle Orthod*., 81:222–228.

Soghra yassaei, T. Zohre, Ghafurifad R. 2012. Stability of functional airway dimensions: tongue and hyoid changes after treatment with the functional appliance. *Int J orthod*., 23(1);

Wessberg, G. A., Schendel, S. A., Epker, B. N. 1982. The role of suprahyoid myotomy in surgical advancement of the mandible via sagittal split ramus osteotomies. *J Oral Surg.,* 40: 273-277.

Yassaei, S., Bahrololoomi, Z., Sorush, M. 2007. Changes of tongue position and oropharynx following treatment with functional appliance. *J ClinPediatr Dent*., 31:287–290

****