ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 7(B), pp. 27836-27841, July, 2018

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

EVALUATION OF UVULO-GLOSSO-PHARYNGEAL DIMENSIONS IN DIFFERENT SKELETAL PATTERNS- A CEPHALOMETRIC STUDY

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DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2342

ARTICLE INFO

Article History:

Received 12th April, 2018
Received in revised form 23rd May, 2018
Accepted 7th June, 2018
Published online 28th July, 2018

Key Words:

uvulo-glosso-pharyngeal dimensions, craniofacial growth, Naso-respiratory function, sexual dimorphism

ABSTRACT

Background: To evaluate the uvulo-glosso-pharyngeal dimensions and to evaluate and compare sexual dimorphism in uvulo-glosso-pharyngeal dimensions in different sagittal skeletal patterns.

Methods and Material: Pre-treatment lateral cephalometric radiographs of 120 subjects between 14 to 25 years of age were taken as sample for this study. All the subjects were divided into three groups according to ANB and Beta angle. Each group had 30 subjects (15 males and 15 females). various parameters for uvulo-glosso-pharyngeal dimensions were traced manually.

Statistical analysis used: Mean, Standard deviation, Standard error, P-value, One Way ANOVA and Fisher's Least Significant Difference (LSD) Test.

Results: Statistically highly significant difference was observed between the four groups for vertical airway length. Vertical airway length is significantly smaller in skeletal Class II group.

Conclusions: Vertical airway length (VAL) is significantly reduced in skeletal Class II subjects as compared to skeletal Class I and Class III subjects. Sexual dimorphism does not exist for airway parameters.

INTRODUCTION

'***Breath is the link between mind and body***'

-Dan Brule

The influence of respiratory function in development of orofacial structures has been widely discussed. According to *Moss's Theory of Functional Matrix*, nasal breathing allows proper growth and development of the craniofacial complex interacting with other functions such as mastication and swallowing[1,2]. This theory is based on the principle that facial growth is closely related to functional activity represented by different components of the head and neck region[3]. By this doctrine, the obstruction of nasal and oro-respiratory airways may have an impact on growth orientation of facial skeleton structure[4].

According to *Balter's philosophy*, backward position of the tongue, causing obstruction of the upper airway and disturbing the cervical region can be a causative factor in skeletal Class II malocclusion[5,6]. Obstruction of the upper airway predisposes a subject to chronic mouth breathing, pathognomonic for respiratory obstruction syndrome[7]. A decreased patency of the oropharyngeal airway can induce some postural adaptations which maintain a constant sagittal dimension at that level. Forward positioning of the head on the neck, and a lowered position of the mandible with low and forward tongue position are commonly described in this context[8]. This muscle modification is a possible cause of a deviant vertical craniofacial growth pattern, as demonstrated by *Angle, Frankel, Harvold, Linder-Aronson* and others. These adaptations have been linked in turn with the long face syndrome. A classic example of possible relationship between airway obstruction and aberrant craniofacial growth is the type of patient described as having '*adenoid facies*[9-11].

Reduced oropharyngeal airway dimensions have been linked to mandibular deficiency. Decreased space between the cervical column and the mandibular corpus may lead to a posteriorly postured tongue and soft palate, increasing the chances of impaired respiratory function during the day and possibly causing nocturnal problems as well such as snoring, upper airway resistance syndrome and obstructive sleep apnoea syndrome[12-14].

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In growing skeletal Class II patients decreased airway dimensions can be significantly increased with myofunctional therapy[13]. Cervical headgear with an expanded inner bow is associated with widening of the maxilla causing upward and forward rotation of the mandible is one of such example which increases upper airway space[15]. Therefore, early diagnosis and management of skeletal Class II patient is desired to avoid developing mouth breathing and aberrant growth pattern.

This study was aimed to determine uvulo-glosso-pharyngeal dimensions in subjects with different anteroposterior jaw relationships having normal breathing pattern. The objectives of this study were to compare the tongue, soft palate, upper airway dimensions in different sagittal skeletal patterns and to evaluate and compare sexual dimorphism in uvulo-glosso-pharyngeal dimensions.

Subjects and Methods

Pre-treatment lateral cephalometric radiographs of 120 subjects between 14 to 25 years of age were taken as sample for this study. Subjects having history of facial trauma, craniofacial anomalies, previous orthodontic treatment were excluded from the study. Subject selected for the study were having normal vertical occlusal relationship and breath comfortably through the nose.

Lateral cephalometric radiographs of the selected subjects were taken with teeth in centric occlusion and the Frankfort horizontal plane oriented parallel to the floor.

The lateral chephalograms were traced manually. Based on ANB angle and Beta angle as given by Baik and Ververidou[16]. 120 subjects were divided into three groups; Group I: skeletal Class I (ANB=1°- 4° and Beta angle=27°-35°), Group II: skeletal Class II (ANB > 4° and Beta angle < 27°), Group III: skeletal Class III (ANB < 1° and Beta angle > 34°). Skeletal Class II was again divided into Class II Div 1 and Class II Div 2.

Each group had 30 subjects (15 males and 15 females). Cephalometric landmarks were recorded as follow[17,18] (figure 1).

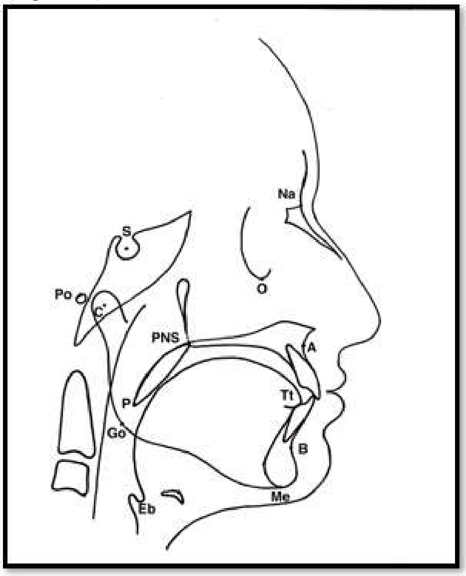


Figure 1 Cephalometric landmarks for evaluation of uvulo-glosso-pharyngeal dimensions

- S-*Sella*-this is the point representing the midpoint of the pituitary fossa (sella turcica); it is a constructed point in the median plane.
- Na-*Nasion*-the most anterior point of the frontonasal suture in the median plane (unilateral).
- A-*Point A (subspinale)*-the point at the deepest midline concavity on maxilla between the anterior nasal spine and prosthion (unilateral).
- B-*Point B (supramentale)*-the point at the deepest midline concavity on the mandibular symphysis between infradentale and pogonion (unilateral).
- C-*The center of the condyle*-found by tracing the head of the condyle and approximating its center.
- Go-*Gonion*-the constructed point of intersection of the ramus plane and the mandibular plane.
- Me-*Menton*-the most inferior midline point on the mandibular symphysis (unilateral).
- PNS-*Posterior nasal spine*-the intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose.
- Tt-*Tip of the tongue*-the most anterior point on the tongue.
- P-Tip of the soft palate or uvula.
- Eb-*Base of the epiglottis*-the most inferior and anterior point of the epiglottis.

various parameters for uvulo-glosso-pharyngeal dimensions were traced manually[17,19,20] (figure 2).

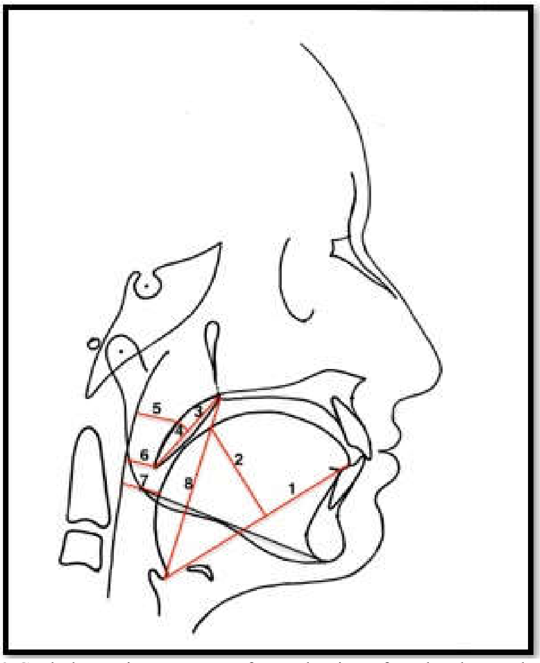


Figure 2 Cephalometric parameters for evaluation of uvulo-glosso-pharyngeal dimensions

1. TGL-*Tongue length*-the linear distance between TT and Eb.
2. TGH-*Tongue height*-maximum height of the tongue along perpendicular line of Eb-TT line to the dorsum of the tongue.
3. PNS-P-*Length of the soft palate*-the linear distance between PNS and tip of the soft palate.
4. MPT-*Thickness of the soft palate*-maximum thickness of the soft palate measured on the line perpendicular to the

line PNS-P.

5. SPAS-*Superior airway space*-width of the airway behind soft palate extending from the center of the soft palate, parallel to Go-B line to posterior pharyngeal wall.
6. MAS-*Middle airway space*-width of the airway extending from tip of the soft palate (P) and parallel to Go-B line to posterior pharyngeal wall.
7. IAS-*Inferior airway space*-width of the airway extending from root of the tongue to posterior pharyngeal wall, parallel to Go-B line.
8. VAL-*Vertical airway length*-distance between PNS and Eb.

These parameters were also assessed for sexual dimorphism.

RESULTS

Descriptive statistics including the mean and standard deviation for each group were computed using SPSS PC (SPSS Inc., Chicago, Ill). The differences between males and females were tested using Student's t-test. Analysis of variance was used to determine whether significant differences existed between the groups. Least significant difference multiple comparison test was applied to identify which of the groups were different.

Table 1-3 & Graph 1-3 shows Mean, S.D, and S.E. for different parameters of the tongue, soft palate, upper airway. Various mean values were obtained for uvulo-glosso-pharyngeal dimensions in Class I, Class II Div 1, Class II Div 2 and Class III groups. One Way ANOVA test was then performed to compare whether these differences were significant (table 4 to 11). Whenever ANOVA test showed significant difference between these groups, post hoc LSD test was carried out to find the degree of significance between two groups.

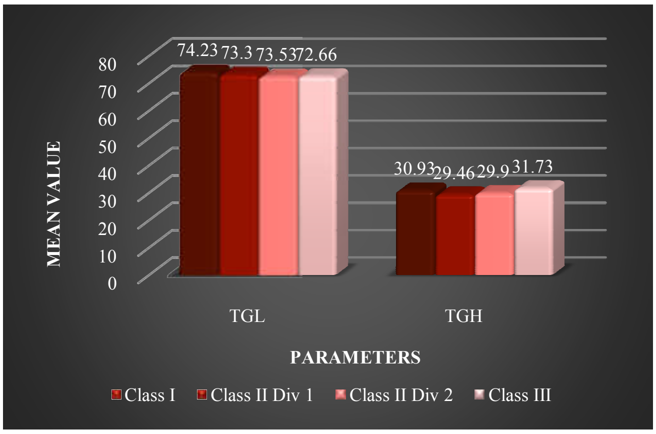
Table 11(A) shows One Way ANOVA test to compare Vertical airway length (VAL) in Class I, Class II Div 1, Class II Div 2 and Class III groups. Statistically highly significant difference (p=0.000**) was observed between the four groups. VAL is significantly smaller in skeletal Class II group. Since ANOVA shows significant difference between four groups, a post hoc LSD test was performed to find out how the significant difference varies in between the groups. *Table 11(B) & Graph 4* shows statistically highly significant difference between Class I and Class II Div 1 (p=0.003**), between Class I and Class II Div 2 (p=0.007**), between Class II Div 1 and Class III (p=0.001**) and Class II Div 2 and Class III (p=0.002**). These statistics show that vertical airway length is significantly reduced in skeletal Class II subjects as compared to skeletal Class I and Class III subjects. This is in accordance with the study carried out by P. Kapoor *et al*[21], Elham Saleh Abu Allhaija *et al*[19]and Darrell C. Mergen *et al*[22], who observed smaller nasopharyngeal area leading to reduced vertical airway length in skeletal Class II malocclusion. This is supported by Balter's philosophy[5,6], which proposes that reduced vertical airway length in skeletal Class II malocclusion might be due to cervical underdevelopment.

Table 12 shows gender difference in various uvulo-glosso-pharyngeal dimensions. However, statistically non-significant difference was observed when males ware compared with females. These findings are supported by P. Kapoor *et al*[21] and Elham Saleh Abu Allhaija *et al*[19].

Table 1 Graph 1: Mean, S.D. And S.E. For Tongue Length and Height in Skeletal Class I, Class II Div 1, Class II Div 2 and Class III

Variables	Group	N	Mean	Standerd deviation	Std. Error
TGL	Class I	30	74.23	4.87	0.890
	Class II Div 1	30	73.30	4.45	0.812
	Class II Div 2	30	73.53	3.67	0.670
	Class III	30	72.66	6.74	0.232
TGH	Class I	30	30.93	3.55	0.648
	Class II Div 1	30	29.46	3.32	0.607
	Class II Div 2	30	29.90	3.14	0.574
	Class III	30	31.73	4.30	0.786

All the parameter's values are in millimetres (mm).

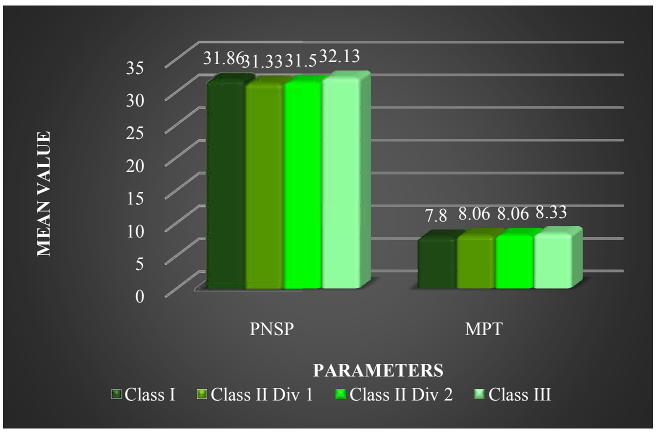


Graph 1

Table 2 Graph 2: Mean, S.D. And S.E. For Soft Palte Length and Thickness In Skeletal Class I, Class II Div 1, CLASS II div 2 And Class III

Variables	Group	N	Mean	Standerd Deviation	Std. Error
PNSP	Class I	30	31.86	3.36	0.613
	Class II Div 1	30	31.33	2.32	0.424
	Class II Div 2	30	31.50	2.59	0.474
	Class III	30	32.13	2.47	0.451
MPT	Class I	30	7.80	1.49	0.272
	Class II Div 1	30	8.06	1.33	0.244
	Class II Div 2	30	8.06	1.31	0.239
	Class III	30	8.33	0.92	0.168

All the parameter's values are in millimetres (mm).

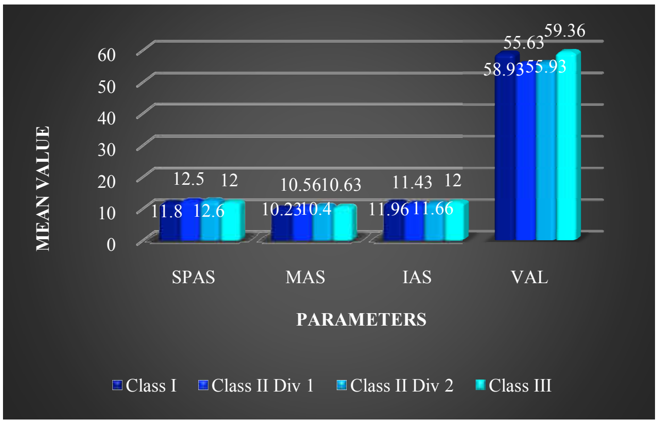


Graph 2

Table 3 Graph 3: Mean, S.D. And S.E. For Upper Airway Parameters IN Skeletal Class I, Class II Div 1, Class II Div 2 and Class III

Variables	Group	N	Mean	Standerd deviation	Std. Error
SPAS	Class I	30	11.80	2.46	0.450
	Class II Div 1	30	12.50	2.12	0.388
	Class II Div 2	30	12.60	2.37	0.433
	Class III	30	12.00	1.76	0.321
MAS	Class I	30	10.23	1.90	0.348
	Class II Div 1	30	10.56	2.06	0.376
	Class II Div 2	30	10.40	2.30	0.421
	Class III	30	10.63	1.75	0.319
IAS	Class I	30	11.96	2.99	0.547
	Class II Div 1	30	11.43	2.71	0.495
	Class II Div 2	30	11.66	2.49	0.455
	Class III	30	12.00	2.10	0.383
VAL	Class I	30	58.93	4.60	0.841
	Class II Div 1	30	55.63	4.29	0.784
	Class II Div 2	30	55.93	3.52	0.643
	Class III	30	59.36	4.31	0.788

All the parameter's values are in millimetres (mm).



Graph 3

Table 4 One way anova analysis for Tongue length (TGL)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	49.367	3	16.456	0.489	0.551
Within group	3905.000	116	33.664		
Total	3954.367	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 5 One way anova analysis for Tongue height (TGH)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	94.092	3	31.364	2.406	0.070
Within group	1511.900	116	13.034		
Total	1605.992	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 6 One Way Anova Analysis for Soft Palate Length (PNSP)

	Sum of Squares	Df	Mean Square	F	Sig.
Between group	11.692	3	3.897	0.527	0.664
Within group	857.100	116	7.389		
Total	868.792	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 7 one Way Anova Analysis for Soft palate thickness (MPT)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	4.267	3	1.422	0.863	0.462
Within group	191.200	116	1.648		
Total	195.467	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 8 One Way Anova Analysis for Superior posterior airway space (SPAS)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	13.425	3	4.475	0.924	0.462
Within group	561.500	116	4.841		
Total	574.925	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 9 One Way Anova Analysis for Middle airway Space (MAS)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	6.767	3	2.256	0.554	0.646
Within group	472.400	116	4.072		
Total	479.167	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 10 One Way Anova Analysis for Inferior Airway Space (IAS)

	Sum of Squares	df	Mean Square	F	Sig.
Between group	6.467	3	2.156	0.319	0.108
Within group	783.000	116	6.750		
Total	789.467	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 11(A) One Way Anova Analysis for Vertical airway length (VAL)

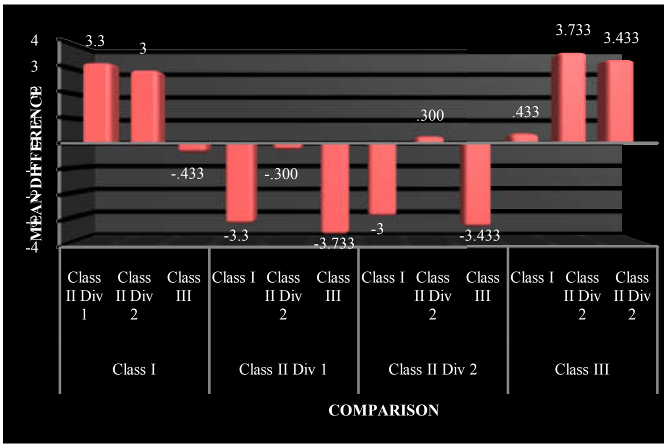
	Sum of Squares	df	Mean Square	F	Sig.
Between group	344.200	3	114.733	6.487	0.000**
Within group	2051.667	116	17.687		
Total	2395.867	119			

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**

Table 11 B Post HOC LSD Test

I	J	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Class I	Class II Div 1	3.300	1.086	0.003**	1.15	5.45
	Class II Div 2	3.000	1.086	0.007**	0.85	5.15
	Class III	-0.433	1.086	0.691	-2.58	1.72
Class II Div 1	Class II Div 2	-0.300	1.086	0.783	-2.45	1.85
	Class III	-3.733	1.086	0.001**	-5.88	-1.58
Class II Div 2	Class III	-3.433	1.086	0.002**	-5.58	-1.28

P > 0.05 = statistically non-significant P < 0.05 = statistically significant* P < 0.01 = statistically highly significant**



Graph 4 Intergroup Comparison

Table 12 Comparison of Various Parameters For Uvulo-Glosso-Pharyngeal Dimensions Between Males And Females

Variables	Group	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	P value
TGL	Male	60	74.78	4.02	0.52	0.95	0.303
	Female	60	73.83	5.87	0.76		
TGH	Male	60	31.10	5.10	0.66	1.43	0.053
	Female	60	29.67	3.29	0.42		
PNSP	Male	60	31.65	2.93	0.38	0.63	0.228
	Female	60	31.02	2.81	0.36		
MPT	Male	60	7.93	1.34	0.17	0.33	0.157
	Female	60	7.60	1.22	0.16		
SPAS	Male	60	12.28	2.29	0.30	-0.13	0.754
	Female	60	12.42	2.37	0.31		
MAS	Male	60	11.15	2.31	0.30	0.63	0.118
	Female	60	10.52	2.10	0.27		
IAS	Male	60	11.27	2.77	0.36	-0.50	0.306
	Female	60	11.77	2.56	0.33		
VAL	Male	60	58.70	4.49	0.58	1.22	0.108
	Female	60	57.48	3.72	0.48		

DISCUSSION

An accurate anteroposterior measurement of jaw relationships is critically important in orthodontic diagnosis and treatment planning.ANB angle is considered the most commonly used cephalometric measurement for evaluation of anteroposterior jaw relationship.The validity of this measurement has been investigated by several researchers. Jacobson showed that ANB angle does not provide adequate assessment of jaw relationship because rotational growth of the jaws and the anteroposterior position of nasion influence the ANB angle. Another angle given by Baik and Ververidou, Beta angle is also most reliable parameter to evaluate the sagittal jaw relationship more consistently.

Significant difference is not observed in uvulo-glosso-pharyngeal dimensions in subjects with different anteroposterior skeletal patterns, except in vertical airway length (VAL). vertical airway length is reduced in skeletal class II subjects as compared to skeletal class I and class III subjects. There is reduced inferior airway space in skeletal Class II subjects, though that difference is statistically nonsignificant. This shows that position of the position of the hyoid bone may be a predisposing factor for reduction of inferior airway space and vertical airway length, thereby can be a causative factor for obstructive sleep apnoea(OSA). So that assessment of airway parameters during diagnosis and treatment planning is most vital procedure. Skeletal class II malocclusion is associated with reduced airway space. If early diagnosis can be carried out during treatment planning, improvement of airway dimensions could be predicted and possibility of development of obstructive sleep apnoea at later age can be prevented.

Sex difference were not detected in tongue, soft palate and pharyngeal dimensions. So sexual dimorphism does not exist for uvulo-gloss-pharyngeal dimensions.

CONCLUSION

1. Tongue length and tongue height does not show significant difference between the groups.
2. Soft palate length and soft palate thickness also does not show significant difference between the groups.
3. Vertical airway length (VAL) is significantly reduced in skeletal Class II subjects as compared to skeletal Class I and Class III subjects.
4. Sexual dimorphism does not exist for airway parameters.

Since mutual interaction exists between the pharyngeal structures and dentofacial pattern, assessment of pharyngeal structures should be included with the orthodontic diagnosis and treatment planning as a functional, positional and structural assessment of the dentofacial pattern.

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How to cite this article:

Hardik Suvagiya *et al.*2018, Evaluation of Uvulo-Glosso-Pharyngeal Dimensions In Different Skeletal Patterns- A Cephalometric Study. *Int J Recent Sci Res.* 9(7), pp. 27836-27841. DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2342

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