Evaluation of Pharyngeal Space in Different Combinations of Class II Skeletal Malocclusion

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ABSTRACT

Objectives: The study was aimed to evaluate the pharyngeal airway linear measurements of untreated skeletal class II subjects with normal facial vertical pattern in prognathic maxilla with orthognathic mandible and orthognathic maxilla with retrognathic mandible. **Materials and method:** the sample comprised of lateral Cephalograms of two groups (30 each) of class II malocclusion variants. Group 1 comprised of class II malocclusion with prognathic maxilla and orthognathic mandible, whereas group 2 comprised of class II malocclusion with orthognathic maxilla and retrognathic mandible. Each group was traced for the linear measurements of the pharyngeal airway like the oropharynx, nasopharynx and soft palate. The obtained data was subjected to independent t test and the Mann Whitney test to check the difference between the two groups and within the groups respectively. **Results:** there was significant difference between all the linear measurements at the soft palate region and the distance between the tip of soft palate to its counter point on the pharyngeal wall in oropharynx region (p-ppm). **Conclusion:** the pharyngeal airway for class II malocclusion with various combination in an average growth pattern adult showed significant difference. The present results suggested, that the pharyngeal airway space might be the etiological factor for different sagittal growth pattern of the jaws and probable usage of different growth modification appliance can influence the pharyngeal airway.

Key words: Class II malocclusion, Pharyngeal space, orthognathic maxilla, retrognathic mandible, prognathic maxilla, orthognathic mandible.

1. INTRODUCTION

The potent pharyngeal air way is needed for the normal growth and development of craniofacial region. The pharyngeal airway is composed of three parts: the nasopharynx, oropharynx, and hypopharynx. The nasopharyngeal airway is a muscular cone shaped tube which includes adenoids and the complex network of lymphatic tissues in the posterior region (1).

The upper airway which include the nasopharynx and the oropharynx controls the vital functional process like swallowing and phonation and it dynamically contributes to the development of overall facial morphology and the ideal occlusion (2-5). It is a well-known fact that the pathological alteration of the airway patency can lead to altered craniofacial development.

The airway had been evaluated using several diagnostic methods, i.e., nasal resistance and airflow tests (5), nasoendoscopy, lateral cephalometric (2- 6), Magnetic Resonance Imaging (MRI) and 3-dimensional (3D) imaging techniques like CT and CBCT (7). However, the latest technological investigation methods had their own disadvantages; MRI requires longer operating time resulting in poor image quality (7) and in CBCT imaging the expenses and radiation dose encountered were higher than conventional lateral cephalometry (8) hence, it is suggested that the CBCT should be limited for specific purposes in orthodontic patients (9)

So far, the lateral cephalometric method for the evaluation has been the simple and the reproducible method for the evaluation of the airway space (10) and the studies have shown positive correlation between the between the nasopharyngeal airway space displayed in a head image and its actual volumetric size in a CBCT scan (11).

The relationship between the airway anatomy and the severity of malocclusion is a proven fact (2-4, 10) and the airway obstruction is particularly associated with the class II malocclusions (11). The variety of published controversial data exists for the airway obstruction in different age groups which suggests that the width of the nasopharynx correlate closely with age in growing children (12), Whereas, some maintain that the size of the nasopharynx increases with skeletal growth and age, others state that its size were established during the first 2 years of life and remain constant thereafter (6, 13).

Patients with skeletal Class II malocclusions are characterized by a maxillary protrusion or mandibular retrusion or a combination of both of them. The extensive literature survey for the association of pharyngeal space for the different combination of class II malocclusion yielded rather very negligible result. Thus, it was decided to analyze the impact of position of maxilla and mandible on pharyngeal airway linear measurements in untreated skeletal class II subjects with normal facial pattern.

2. MATERIALS AND METHODS

The study was carried out in the department of orthodontics and dentofacial orthopedics, KM Sha Dental College and Hospital, Piparia, Vadodara. For this particular retrospective study the pretreatment lateral Cephalograms were collected from the old records (1999-2014) of the department based on the inclusion criteria's;

- Age: greater than 18 years
- Skeletal Class II malocclusions confirmed after cephalometric tracing
- ANB angle more than 4°.
- Normal vertical facial pattern.

The syndromes' patients, facial asymmetric and the orthodontically treated cases were excluded from the study. It was ensured that all the radiographs were taken by the same radiographer (1990-2014) under the standard settings with the teeth in centric occlusion.

All the Cephalograms were retraced for the confirmation of the initial data for the class II skeletal malocclusion and the growth pattern. The parameters used for the sagittal and the vertical skeletal assessment is depicted in the table 1. After the confirmation of the initial data the Cephalograms were segregated into two groups; Group 1 comprised of 30 cephalograms indicating prognathic maxilla with orthognathic mandible with the mean age of 19.45 ± 2.37 years and Group 2 comprised of 30 cephalograms indicating retrognathic mandible with orthognathic maxilla with the mean age of 20.95 ± 2.99 years. Overall sample included 60 % males and 40% females. The cephalograms were traced again for the evaluation of the pharyngeal air way using the method suggested by Ulas Oz et al (14) for the nasopharynx, oropharynx and the soft palate. The parameters used for the same are depicted table 1 and figure 1. The cephalograms were traced by the single investigator using 0.5 mm pencil on matte acetate tracing paper (0.003 inches thick) and the intra examiner variability accounted 0.95 k after the kappa statistical test, which was done on the randomly selected ten lateral cephalograms for the retracing by the same investigator with in the period of one week.

2.1. Statistical analysis

The obtained data was segregated, tabulated and was subjected statistical analysis using the SPSS software 15. Independent t-test was used to check the statistically significant difference between the means in two unrelated groups. It is used in between the groups of ANB angle, Sn to Go-Gn, SNA, SNB, ad1- PNS (mm), ad2- PNS (mm), ANS-PNS to PPW (mm), AA-PNS (mm), P-PP (mm), PH-PPH (mm),

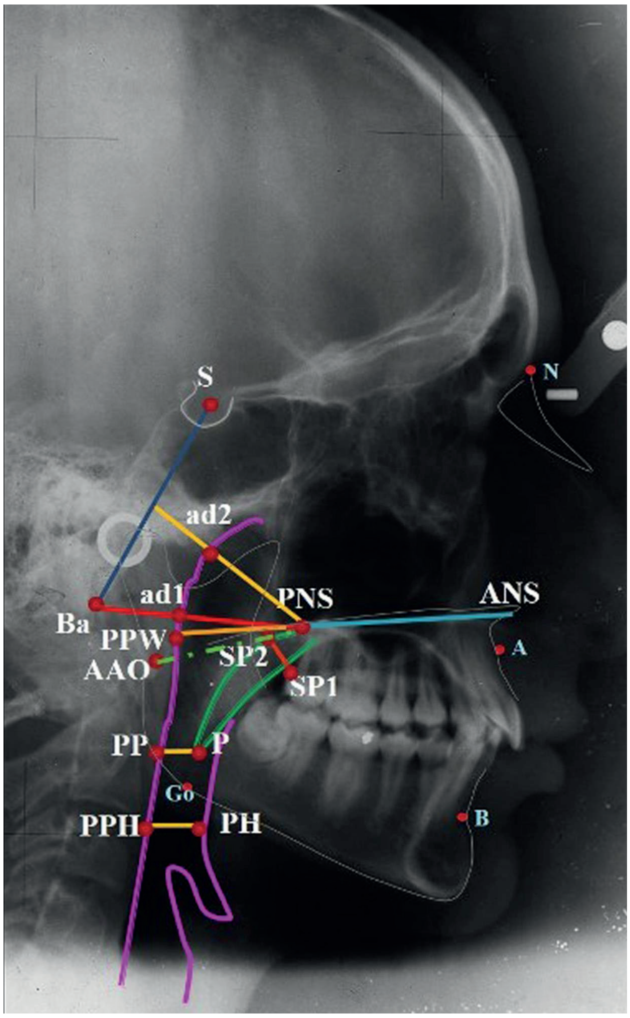

Figure 1. Cephalometric Landmarks. S (Sella): Point representing the midpoint of the pituitary fossa (sella turcica); N (Nasion): The most anterior point of the front nasal suture in the median plane; Point A: The point at the deepest midline concavity on the maxilla between the anterior nasal spine and prosthion; Point B: The point at the deepest midline concavity on the mandibular symphysis between infradentale and pogonion; Gn (Gnathion): Most anteroinferior point on the symphysis of the chin; Go (Gonion): Constructed point of intersection of the ramus plane and the mandibular plane; ANS: Anterior Nasal Spine; PNS: Posterior Nasal Spine; Ba (Basion): The median point of the anterior margin of the foramen magnum; ad1: The intersection point of the posterior pharyngeal wall and the line from PNS to Ba; ad2: The intersection point of the posterior pharyngeal wall and the line from the midpoint of the line from sella (S) to Ba to PNS; AAO : Anterior point of atlas vertebra; PPW: Posterior pharyngeal wall along the palatal plane line; P Tip of soft palate; PP: Horizontal counterpoint of tip of soft palate on the posterior pharyngeal wall; PPH: Horizontal counterpoints of the anterior pharyngeal wall on the posterior pharyngeal wall at its narrowest section ; PH: Horizontal counterpoints of posterior pharyngeal wall on the anterior pharyngeal wall at its narrowest section; SP1: Superior most point on the upper surface of the soft palate; SP2: Inferior most point on the lower surface of the soft palate

Parameters for sagittal and vertical relationship	SNA	Angle formed by Sella – Nasion (S-N) plane to point A
	SNB	Angle formed by S-N plane to point B
	ANB	Angle formed by Subtracting SNA and SNB
	Sn to Go-Gn	formed by lines drawn between Gonion (Go) and Gnathion (Gn) to the S-N plane
Parameters for naso-pharynx	ad1-PNS(mm)	The distance of ad1 to the posterior nasal spine (PNS)
	ad2-PNS(mm)	The distance of ad2 to PNS
	ANS-PNS to PPW(mm)	nasopharyngeal space, PNS to posterior pharyngeal wall along the palatal plane line.
Parameters for Oro-pharynx	AAO-PNS(mm)	The distance of the most anterior point of atlas vertebra (AA) to PNS.
	P-PP(mm)	The distance between the tip of soft palate (p) and horizontal counterpoint on the posterior pharyngeal wall.
	PH-PPH(mm)	The distance of horizontal counterpoints on anterior and posterior pharyngeal wall in the oropharynx at its narrowest area
Parameters for Soft palate	ANS-PNS to P°(angle)	The angle, anterior nasal spine (ANS) to PNS to tip of soft palate (p).
	PNS-P(mm)	The distance of PNS to point p.
	SP1-SP2(mm)	The thickest cross-section of the soft palate.

Table 1. Cephalometric parameters

Parameters	Group	Mean	Std. Deviation	Std. Error Mean	p-value
ANB Angle	GROUP – 1	6.4000	1.35336	.30262	1.000
	GROUP – 2	6.4000	1.18766	.26557	
Sn to Go-Gn	GROUP – 1	30.7000	1.17429	.26258	.235
	GROUP – 2	31.1500	1.18210	.26433	
SNA°	GROUP – 1	86.5000	1.50438	.33639	<.001
	GROUP – 2	81.2000	1.15166	.25752	
SNB°	GROUP – 1	80.1000	1.29371	.28928	<.001
	GROUP – 2	74.8000	1.43637	.32118	

Table 2. Comparison of various sagittal parameters for segregating the groups.

ANS-PNS to P (mm), PNS-P (mm), SP1-SP2 (mm).

Mann Whitney Test was used within the groups of ANB angle, Sn to Go-Gn, SNA, SNB, ad1- PNS (mm), ad2- PNS (mm), ANS-PNS to PPW (mm), AA-PNS (mm), P-PP (mm), PH-PPH (mm), ANS-PNS to P (mm), PNS-P (mm), SP1-SP2 (mm). And to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed.

3. RESULTS

Table 1 shows the comparison of the cephalometric parameters for the segregation of the group 1 and group 2. The results showed significant difference for SNA and SNB between the two groups.

The pharyngeal airway comparison between the two groups is depicted in the table 2. The results showed significant difference for the parameters like P-PP (mm), ANS-PNS to P° (angle), PNS-P (mm) and SP1-SP2 (mm).

The Mann Whitney test results for the statistical difference

Parameters for naso-pharynx	Group	Mean	Std. Deviation	Std. Error Mean	p-value
ad1-PNS(mm)	GROUP – 1	29.9000	3.24281	.72511	.063
	GROUP – 2	28.2750	1.98332	.44348	
ad2-PNS(mm)	GROUP – 1	25.4750	3.64719	.81554	.846
	GROUP – 2	25.6750	2.76384	.61801	
ANS-PNS to PPW(mm)	GROUP – 1	31.8000	3.31821	.74197	.611
	GROUP – 2	32.3750	3.76226	.84127	
Parameters for oro-pharynx					
AA-PNS(mm)	GROUP – 1	39.3000	1.89459	.42364	.585
	GROUP – 2	38.9750	1.83873	.41115	
P-PP(mm)	GROUP – 1	14.2000	1.64157	.36707	<.001
	GROUP – 2	9.6500	1.54834	.34622	
PH-PPH(mm)	GROUP – 1	11.9250	2.37462	.53098	.004
	GROUP – 2	10.1250	1.03714	.23191	
Parameters for Soft palate					
ANS-PNS to P°(angle)	GROUP – 1	134.25E2	2.33678	.52252	<.001
	GROUP – 2	141.30E2	2.65766	.59427	
PNS-P(mm)	GROUP – 1	32.5250	1.59337	.35629	<.001
	GROUP – 2	37.4500	1.63755	.36617	
SP1-SP2(mm)	GROUP – 1	11.1750	1.51549	.33887	<.001
	GROUP – 2	8.1000	1.08337	.24225	

Table 3. Comparison of the different pharyngeal parameters for Group1 and Group2. P <.001- Significant

for the different parameters within the group showed no significant difference and the same is shown in the table 3.

4. DISCUSSION

It's well known fact that the appropriate treatment of class II malocclusion with the air way obstruction has led to the improvement in the respiration (14). According Balter's the etiology for the class II malocclusion is the backward positioning of the tongue, leading to the disturbance in the cervical region (15). Which in turn results in faulty deglutition and mouth breathing. The previous literature emphasizes that the narrowing of the pharyngeal airway space leads to altered breathing pattern (16, 17). So, we can conclude that the variation in the skeletal pattern could predispose the upper airway obstruction (15-17).

The studies pertaining to the pharyngeal dimension in class II malocclusion patients are very limited and none of the studies have demonstrated difference or correlation between airway size in skeletal class-II subjects having prognathic maxilla & retrognathic mandible. Hence an attempt was made to discern the relation of pharyngeal airway among subjects having prognathic maxilla & retrognathic mandible.

The evaluation of the nasopharynx area of the pharyngeal air way showed that no significant difference for all the cephalometric parameters [ad1-PNS (mm), ad2-PNS (mm), ANS-PNS to PPW (mm)] between the two groups. Similar

	ANB Angle	Sn to Go-Gn	SNA°	SNB°	ad1-PNS (mm)	ad2-PNS (mm)	ANS-PNS to PPW (mm)	AA-PNS (mm)	P-PP (mm)	PH-PPH (mm)	ANS-PNS to P° (angle)	PNS-P (mm)	SP1-SP2 (mm)
0Mann-Whitney U	193.500	166.000	.000	.000	125.000	192.000	197.000	179.500	.000	92.500	3.500	.000	18.500
Wilcoxon W	403.500	376.000	210.000	210.000	335.000	402.000	407.000	389.500	210.000	302.500	213.500	210.000	228.500
Z	-.183	-.992	-5.463	-5.458	-2.053	-.217	-.082	-.566	-5.452	-2.970	-5.343	-5.440	-4.940
p-value	.855	.321	.000	.000	.040	.828	.935	.572	.000	.003	.000	.000	.000

Table 4. Comparison of the different parameters within the group. P <.001- Significant

results were reported in the previous literature, where they found that upper pharyngeal width in the subjects with Class II malocclusions with vertical growth patterns was statistically significantly narrower than in the normal growth-pattern group (18).

However, the examination of the oropharynx region showed significant difference for the parameter P-PP (mm) between the two groups. P-PP (mm) is the distance of the tip of soft palate (p) to horizontal counterpoint on posterior pharyngeal wall (pp), it was greater in the group 1 i.e in class II with prognathic maxilla, indicating the narrow oropharynx airway in class II malocclusion with mandibular retrognathism. Similar results were also noted in the previous literature for the class II malocclusion with high angle cases (14). Kyung-Min Oh et al in the CBCT study of the pharyngeal airway found that children with Class II malocclusion had more backward orientation and smaller volume of the pharyngeal airway than do children with Class I and III malocclusion and the results are in accordance to the present study (19). Similarly, Mirja Kirjavainen and Turkka Kirjavainen noted narrower oro- and hypopharyngeal spaces in class II malocclusion individuals (11).

In the previous study by Zhe Zhong et al (20) and Lam et al (21) it was observed that there was a significant difference for the parameters measuring the oropharynx and they attributed this to the decreased size and the posterior positioning of the mandible, which lead palatopharyngeal and hypopharyngeal obstruction. Our observation were in accordance to above findings.

Kerr (22) highlighted that there was a low correlation between the nasopharyngeal part of the airway and dentofacial structures when the nasal functions were normal. And the results of present study correlate with their findings.

In the region of soft palate, all the parameters [ANS-PNS to P° (angle), PNS-P (mm), SP1-SP2 (mm)] showed the significant difference between the two groups. The angle between ANS –PNS to tip of soft palate (ANS-PNS to P angle), and the distance between the PNS to tip of the soft palate (PNS-P) was greater in class II Malocclusion group with retrognathic mandible (Group 2). This indicated a lengthier soft palate region in class II malocclusion with mandibular retrognathic cases than the maxillary prognathic cases. However, the thickest cross section of the soft palate (SP1-SP2) were greater in the group 1, i.e in class II malocclusion due to prognathic maxilla. This inverse relation of soft palate and the mandibular position was reported in the previous studies, where they ascertain backward positioning of the tongue in retrognathic mandible as the cause for this finding (16, 23). However, Wenzel et al reported that there existed no correlation between the air way size and the mandibular morphology (24). In one of the previous studies it was demonstrated that the pharyngeal structures were not affected by changes in the ANB angle (15). Nevertheless, the present study did show a significant difference in the upper and lower pharyngeal airway measurements with different patterns of class II malocclusion. Similar results were reported in the study on the Indian population with different sagittal patterns of malocclusion, where, they found that the dimensions of pharyngeal airway decreased from class III to class I to class II (25). Retrospectively, Kochel et al., demonstrated that the posterior pharyngeal airway in class II adults increases with bilateral mandibular sagittal advancement (26).

However, a further study has to be conducted on correlation of mandibular size to the pharyngeal airway. The use of 2-dimensional (2D) cephalograms is another potential study limitation, since assessing a 3D structure into 2D image leads to a loss of significant structural information (2).

5. CONCLUSION

The results of the present study indicate that there was a major difference in the structure of the oro-pharyngeal and soft palate part of the pharyngeal air way in different patterns of class II malocclusion with more amount of constriction in these parts for class II malocclusion with mandibular retrognathism. Probably by recommending growth modification appliance to increase the mandibular growth may influence the above mentioned structures to bring about the positive changes in the stomatognathic system.

CONFLICTS OF INTEREST: NONE DECLARED.

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