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Association between maxillo-mandibular sagittal relationship and pharyngeal passage dimensions in class I skeletal pattern

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Abstract

Introduction: Pharyngeal dimensions differ among different facial forms and skeletal patterns and it has been hypothesized that there might be a correlation. This has created an interest in this domain. The present study aims to identify the association and relationship between pharyngeal size and class I facial skeletal patterns. Furthermore investigates whether pharyngeal structures of subjects could be affected by the positional relationships between the jaws.

Material and methods: This cross-sectional study spanned over six months included cephalometric analyses of 90 (45 males and 45 females) subjects between 13 to 15 years of age. Random cross sectional study sampling technique was used.

Results: The result shows that only apw4-ppw4, hy-apw4 and oropharynx area measurements were affected by the ANB angle. The majority of the measurements used to assess the pharyngeal structures are not affected by the ANB angle. The sexual dimorphism of all variables in pharyngeal size in class I skeletal patterns were statistically insignificant. The skeletal measurement differences amongst males and females in sagittal planes were also statistically insignificant.

Conclusions: The skeletal pattern does not affect the size of nasopharyngeal airway. However, with a reduced SNB angle, there is a reduction in size of the oropharyngeal airway. Moreover sexual dimorphism does not exist for the decreased value of the nasopharyngeal and oropharyngeal airways, respectively.

Keywords: Pharyngeal airway; skeletal pattern; airway dimensions

Introduction

Orthodontics is the art and science of dentistry concerned with the supervision, guidance and correction of the growing dentofacial structures by the adjustment of relationships between teeth and facial bones by the application of forces. It furthermore stimulates and redirects functional forces within the craniofacial complex.[1] An correlation might occur between the pharyngeal structures and the facial skeletal pattern, due to this close relationship and orthodontic interest is justified.[2-6]

Class II malocclusions are a consequence of backward position of the tongue, disturbing the cervical region. The respiratory function is impeded in the region of larynx and there is thus a faulty deglutition and mouth breathing. Class III malocclusions are due to a more forward position of the tongue and to cervical overdevelopment.[7]

The aim of the present study was to investigate whether the pharyngeal structures of subjects with normal nasal breathing could be affected by the positional relationships between the jaws and to determine the effects of the pharyngeal size on the developing malocclusions. This study will be helpful in

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planning orthodontic treatment especially for the patients suffering from pharyngeal airway problem. Conclusively, the objectives of this study were to; assess the relationship between the pharyngeal size and the class 1 facial skeletal patterns and also determine dimorphism between the two sexes.

Material and Methods:

It was a cross-sectional study conducted at the Department of Orthodontics, Bolan Medical College Quetta. Data was collected over six months. It included cephalometric radiographs of 90 (45 male and 45 female) subjects. A written informed consent was obtained from all subjects. All subjects were between 13 to 15 years of age. The sample size was assumed considering the probable average number of patient attending the department within the time limits of the study. The sample was collected randomly. All patients had standardized lateral cephalometric radiographs taken in natural head position. Patients with cranio-facial anomalies and syndromes, history of previous orthodontic treatment, history of trauma to the head or neck region and with deglutition disorders were excluded from this study.

The lateral cephalometric film was taken by standardized methods. Natural head position was obtained as the patient's head was positioned with the nasal rod rested against the bridge of the nose. Standardization of the Frankfort horizontal plane was accomplished on cephalometer with an orbital pointer. Frankfort horizontal plane was kept parallel with the floor (porion-orbitale). The patient was positioned in the x-ray beam with right side closer to the x-ray tube and both the external auditory meatuses in line of the central ray. A cephalostat or head holder was used to stabilize the patient in a fixed position. The x rays were taken with the patient's teeth in occlusion. The film size used was 8x10 inches for all patients. The x-ray tube and patient distance were standardized at 5 feets. The airway areas of nasopharynx and oropharynx were measured separately.

The Pm vertical was used as the anterior border of the nasopharyngeal airway and the ANS-PNS plane as the lower border. The ANS-PNS plane and the hy-cv3ia line were accepted as upper and lower borders of the oropharyngeal air passage. Each area was measured three times successively and mean value of measurements were computed. To determine the errors associated with radiographic measurements, 25 radiographs were selected randomly from the observation group. The tracings and measurements of these films were repeated 2 weeks after the first measurement. The effects of ANB angle and gender on the pharynx size was also investigated. The data was analyzed using SPSS (version 10.0). Mean and standard deviations and ranges were computed for each measurement in the groups. Correlation analysis and scatter diagram was used. A paired 't' test was applied to the first and second measurements and error associated with the radiographic tracings and measurements were found. The arithmetic means, standard deviation and range were analyzed for skeletal angular, pharyngeal soft tissue linear parameters (SNA, SNB, ANB, Ba-ad1, Ba-ad2, Ba-PNS, Ptm-ad1, Ptm-ad2, PNS-ppw1, apw2 -ppw2, apw4 -ppw4, t –ppw, Hy-apw2, Hy-apw4, Ho ⊥ ANS-PNS), nasopharynx and oropharynx areas.

To determine the errors associated with radiographic measurements, 25 radiographs were selected at random from the observation group, and re-traced manually on acetate paper with 4H lead pencil for all the parameters. The mean values of both the tracings were compared for all measurements. The tracings and the measurements of these films were repeated two weeks after the first measurement. The re-traced values were compared with first readings of the same radiographs, using paired t-test at n-10 degree of freedom. Whereas, the number of cephalograms that were retraced were 25; statistical significance was calculated through t-distribution table. Males and females were compared for skeletal angular, pharyngeal soft tissue linear parameters using t-test.

Following hard tissue cephalometric points were traced as shown as below:

1.	Nasion (N)	The most anterior point on the Fronto-nasal suture on the mid sagittal plane
2.	Sella (S)	Center of the contour of sella by inspection.
3.	Anterior nasal spine (ANS)	The most anterior point on the contour of bony palate
4.	Posterior nasal spine (PNS)	The most posterior point on the contour of bony palate
5.	Point A	The deepest point on mid sagittal plane between ANS and prosthion
6.	Point B	Deepest point on the anterior surface of the mandible in the mid-sagittal plane
7.	Basion(ba)	Lower most point on anterior margin of foramen magnum
8.	Hormion Ho	Most inferior point of Sphenooccipital Synchondrosis
9.	Pterygo maxillary Ptm	Fissure: most inferior point on average of right and left outlines of pterygomaxillary fissure
10.	cv2ia	Most inferoanterior point on body of second cervical vertebra
11.	cv3ia	Most inferoanterior point on body of third cervical vertebra
12.	cv4ia	Most inferoanterior point on body of fourth cervical vertebra
13.	Hy	Most superior and anterior point on body of hyoid bone

Pharyngeal Landmarks

Following landmarks were traced as shown below:

1. ad1	Point of intersection of posterior pharyngeal wall and line ptm to ba.
2. ad2	Point of intersection of posterior pharyngeal wall and line from ptm as normal perpendicular to S-ba.
3. t	Dorsal tongue surface intersecting occlusal plane.
4. ppw	Posterior pharyngeal wall intersecting occlusal plane.
5. ppw1	Posterior pharyngeal wall intersection with ANS-PNS line.
6. ppw2	Posterior pharyngeal wall along line intersecting cv2ia and hy.
7. apw2	Anterior pharyngeal wall along line intersecting cv2ia and hy.
8. apw4	Anterior pharyngeal wall along line intersecting cv4ia and hy.

Skeletal Planes

Following skeletal planes were taken:

1.	Sella-Nasion plane:	Plane formed by joining midpoint of Sella turcica(S) to Nasion (N).
2.	Palatal Plane:	Plane formed by joining Anterior nasal spine (ANS) to Posterior nasal spine (PNS).

Hard Tissue Angular Measurements

Following hard tissue angular measurements were taken as below:

1. SNA;	Angle formed by points Sella, Nasion and point A
2. SNB;	Angle formed by points Sella, Nasion and point B
3. ANB;	Angle formed by point A, Nasion and point B

Results

A total of 35 radiographs of patients with skeletal pattern classes I, were included in this study. Lateral cephalometric radiographs were taken for all the subjects with the teeth in centric occlusion and relaxed lips under similar conditions. The radiographs were manually traced for skeletal pattern and pharyngeal size relationships. The mean ± SD age of the sample was 14.8 ± 0.84 years, with a range of 13-15 years. The age range for male class I patients was 13.98 ± 0.58 years, with a range of 13-15 years. Similarly, the age range for the female patients was 14.3 ± 0.85 years in class I. The mean, standard deviation, minimum and maximum of skeletal pattern and pharyngeal size relationships for all 90 patients were computed (Table 2).

The result shows that only apw4-ppw4, hy-apw4 and oropharynx area measurements were affected by the ANB angle. It has been observed that the majority of measurements used to assess the pharyngeal structures were not affected by the ANB angle. According to the results, hy-apw4 measurement was found to be statistically significant (<p.005).

The sexual dimorphism of all variables concerned with the pharyngeal size in skeletal class I was also ascertained. All measurements of both sexes were statistically insignificant (Tables 1). While comparing the skeletal measurements in males and females in sagittal planes SNA, SNB, and ANB in class I, it was seen that the mean values of SNA in males (80.87±4.79°) were not statistically different from that of females (81.73±6.45°). There was no statistically significant difference between SNB angle values of males (76.53±4.44°) and females (78.13±6.96°). The mean value of ANB in males (3.67±1.23°) was not statistically different from that of females (3.67±1.05°). In class I, it was insignificant both in males and females (Table 2).

To evaluate any intra-observer tracing error, 25 radiographs were randomly selected and retraced by same technique for the skeletal pattern and pharyngeal size relationships. There was no significant difference between first and second tracing on applying paired t-test (Table 3). Each area was measured three times successively and the mean value of the three measurements was computed. Paired t-test was applied to calculate t-value and p-value (Table 4).

Table I: Comparison of all variables in males and females in skeletal class I

Parameters	Males Mean ± SD	Females Mean ± SD	P value
Ba-ad1	26.60±3.29	25.40±4.48	0.714
Ba-ad2	33.47±4.02	35.20±4.23	0.177
Ba-PNS	40.47±1.88	42.27±2.71	0.536
Ptm-ad1	12.47±3.50	13.33±3.90	0.387
Ptm-ad2	8.80±2.70	9.20±2.54	0.713
PNS-ppw1	20.40±4.00	21.53±4.39	0.795
apw2-ppw2	12.47±2.90	12.73±5.05	0.783
apw4-ppw4	15.67±1.54	14.67±2.77	0.128
t-ppw	11.40±2.82	14.67±2.77	0.552
hy-apw2	19.47±4.42	21.80±6.26	0.514
hy-apw4	20.33±2.74	19.40±1.88	0.835
ho⊥ANSPNS	18.93±2.22	19.07±1.98	0.726
Nasopharynx	367.67±116.96	395.47±97.55	0.313
Oropharynx	670.73±74.54	736.13±195.22	0.422

P>0.05

Table II: Comparison of males and females skeletal measurements in class I

	Males (n = 15) Mean ± SD	Females (n = 15) Mean ± SD	t-value	P-value
SNA	80.87±4.79	81.73±6.45	.418	.679
SNB	76.53±4.44	78.13±6.96	.749	.460
ANB	3.67±1.23	3.67±1.05	1.000	1.000

Keys

SNA Angle formed by points S, N and A
SNB Angle formed by points S, N and B
ANB Angle formed by points A, N and B

Table III: Comparison of all variables in pharyngeal measurements for method error

Parameters	Tracing I Mean ± Std. Deviation	Tracing II Mean ± Std. Deviation	t value	P value
Ba-ad1	26.28±4.80	25.96±2.13	.299	.767
Ba-ad2	34.48±4.74	32.40±4.47	1.708	.101
Ba-PNS	42.08±3.53	40.52±4.81	1.226	.232
Ptm-ad1	14.60±4.04	14.56±2.55	.042	.967
Ptm-ad2	10.28±2.60	9.56±1.75	1.269	.216
PNS-ppw1	23.52±4.63	22.16±6.64	.747	.462
apw2-ppw2	13.80±4.17	11.12±3.76	2.385	.025
apw4-ppw4	15.28±2.31	16.16±2.86	-1.287	.210
t-ppw	12.48±3.25	11.64±1.97	1.151	.261
hy-apw2	21.20±5.73	20.84±3.72	.223	.826
hy-apw4	20.28±2.85	18.00±2.82	2.500	.020*
ho⊥ANSPNS	19.72±2.07	20.44±4.73	-.693	.495

*P<0.05 (Not significant)

Table IV: Comparison of skeletal measurements for method error

Skeletal	Tracing I Mean ± Std. Deviation	Tracing II Mean ± Std. Deviation	t value	P value
SNA	82.92±4.31	82.84±4.25	.811	.425
SNB	80.56±5.06	80.12±5.59	1.018	.319
ANB	2.36±4.74	2.32±4.71	.253	.802

SNA	Angle formed by points S, N and A
SNB	Angle formed by points S, N and B
ANB	Angle formed by points A, N and B

Discussion

The visual impact of soft tissues of face, determine the esthetic value of the face. In contemporary Orthodontics, detailed skeletal pattern analysis is an important component of comprehensive diagnosis and treatment planning. The results obtained in the present study showed the reliability of landmark locations and measurements were within the acceptable range (Table 1-3). The ANB angle, which is most commonly used in the determination of anteroposterior dentofacial discrepancy,[8-9] was used to classify the subjects according to their skeletal configurations. In this classification, Gazilerli's[10] Turkish norm regarding ANB angle (ANB = 3°±2°) was used. Both area measurements, which could better demonstrate the respiration capacity[11] and several linear measurements were used in the assessment of pharyngeal structures. In similar studies, linear, area, and rhinomanometric measurements have also been used to assess the pharyngeal structures and the airway capacity.[9,12]

The use of lateral cephalometric radiographs to evaluate the upper airway is somewhat limited as they provide 2-dimensional images of the nasopharynx, which consists of complex 3-dimensional anatomical structures.[13] Not withstanding this observation, Linder-Aronson[14] found a high level of correlation between the results of posterior rhinoscopy and radiographic cephalometrics in the assessment of adenoid size. This observation was made also by previous authors[15-17] who found that lateral skull radiographs provide a good picture of the size of the nasopharyngeal airway in children of all ages. The functional adequacy of the upper airway should always be evaluated fully, making use of all of the appropriate diagnostic means. Growth studies of the soft tissues of the pharynx have also been performed by means of cephalometric radiographs.[18,19]

Erdem and Arat[20] measured the naso-oro-pharyngeal area on the cephalometric head films of pre-pubertal and post-pubertal children and could not find any relationship with the ANB angle. In the present study, the areas of nasopharynx and oropharynx were measured separately, as opposed to the observations made by Erdem and Arat[20] and it was observed that the nasopharyngeal area was not affected by the ANB angle, but the oropharyngeal airway became smaller with the increase of the ANB angle. However, the sagittal measurements of oropharynx were not affected by the ANB angle.

Our findings are similar to those of Sosa et al[21] in which statistically significant relationships were not found between the pharyngeal structures and the ANB angles of the subjects with Class I and Class II Division 1 malocclusions. Similarly, Solow et al[9] Wenzel et al,[22] Mergen and Jacobs[23] were unable to find a relationship between the pharyngeal size and the measurements regarding the anteroposterior jaw relationship. The fact that measurements of 14 parameters showed insignificant difference between the genders indicates that pharyngeal structures have not been affected by sex at this age group. This finding agrees with the results of Solow et al[6] Handelman and Osborne[24] and Linder-Aronson and Leighton.[14]

Therefore, it can be said that a number of postural changes can occur and these can involve the structures of head and neck regions in response to the changes in sagittal jaw relationships. The size of the pharyngeal airway does not change appreciably.

Conclusions

It is concluded that;

1. The anteroposterior relationship of the jaws (skeletal pattern) does not affect the size of nasopharyngeal airway. However, with a reduced SNB angle, there is a reduction in size of the oropharyngeal airway.
2. There is no statistically significant sexual dimorphism for this corresponding static and decreased value for the nasopharyngeal and oropharyngeal airways, respectively. The change in sagittal jaw relationship can occur in response of postural changes.
3. A number of postural changes can occur and these can involve the structures of head and neck regions in response to the changes in sagittal jaw relationships. The size of the pharyngeal airway does not change appreciably.

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