Research Article

Comparison of Pharyngeal Airway Width among Individuals having Skeletal Class I Malocclusion with Different Growth Patterns

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ABSTRACT

Introduction: An interaction can be seen between respiratory function and the maxillary growth pattern. Therefore, this study was conducted to assess and compare the pharyngeal airway width of individuals with different growth patterns in skeletal class I malocclusion.

Materials and Method: Analytical cross-sectional study was done to assess total of 60 cephalometric radiographs of individuals with skeletal class I malocclusion pattern selected through convenience sampling method. McNamara analysis was done to measure the width of upper and lower pharyngeal space. Statistical analysis was done in SPSS version 20. One way ANOVA and Post Hoc test were done to determine the mean difference of upper and lower pharyngeal airway space width in between individuals of skeletal class I malocclusion with different growth pattern.

Result: There was no significant mean difference in upper pharyngeal airway space (p=0.201) seen in between three growth patterns of individuals with class I malocclusion. However, the study participants with vertical growth pattern showed significantly less lower pharyngeal space width (8.36±2.63mm) than in horizontal growth pattern (10.89±3.46 mm, p=0.028).

Conclusion: The findings of this study conclude that in skeletal class I malocclusion, there is no difference in upper pharyngeal space dimensions among individuals with different growth patterns but the vertical growth pattern shows smaller dimension of lower pharyngeal space than horizontal growth pattern.

KEYWORDS: McNamara, Pharyngeal airway, Skeletal class I.

INTRODUCTION

One of the area of interest in orthodontics is the pharyngeal airway and its relationships between different facial types.[1] The pharynx is a tube-shaped structure formed by muscles and membranes which can be anatomically separated into nasopharynx, oropharynx, and laryngopharynx.[2] It can have variations in its dimensions based on orthopedic therapy[3] or craniofacial growth.[4, 5]

There can be an interaction seen in between respiratory function and the maxillary and mandibular growth pattern.[6] The size of pharyngeal space is mainly determined by relative growth and size of soft tissues surrounding the dentofacial skeleton. The nasopharyngeal skeleton may change from adulthood to older age.[7]

There are factors leading to partial or total upper airway obstruction like morphological upper airway obstructive processes that results in functional imbalance. It may inturn lead to a significant mouth-breathing pattern, altering the craniofacial morphology and dental arch shape, eventually developing malocclusion.[8-12]

As the posterior wall becomes narrower, the depth of the nasopharynx increases. In patients having class I malocclusion with vertical growth pattern, a natural and anatomical predisposition of airway becomes thinner as it has been suggested that they have significantly narrower upper pharyngeal airways than those with normal growth patterns.This may allow the air flow resistance to rise, which may in turn increase the risk of snoring and in severe cases, lead to obstructive sleep apnea.[12,13]

In orthodontic literature, there is a paucity of studies involving the pharyngeal airway space relation with different growth patterns in skeletal class I malocclusion. Thus, this study was conducted to compare the different pharyngeal airway parameters with different growth patterns in skeletal class I malocclusion.

MATERIALS AND METHOD

This hospital based analytical cross-sectional study was conducted among 60 individuals visiting to the Department of Orthodontics and Dentofacial Orthopaedics, Kathmandu Medical College and Teaching Hospital from October 2021 to March 2022 after obtaining ethical clearance from Institutional Review Committee of the same institution (Ref. no: 0609202107). Sample size was calculated using data of similar study done by Shastri D et al.[14] Using formula for comparison of mean difference between groups,

Sample size (n) = $2sd^2 (Z_{1-\alpha/2}+Z_{1-\beta})^2/(m_1-m_2)^2$

Where,

m_1-m_2 = Difference in mean

$Z_{1-\alpha/2}$ = 1.96 at 95% confidence interval

$Z_{1-\beta}$ = 0.84 at 80% power

$(Z_{1-\alpha/2}+Z_{1-\beta})^2$= 7.84

sd= standard deviation

sd= $(sd_1+sd_2)/2 = \frac{[1.14+3.34]^2}{2}$

Calculated sample size (n) = $2*5.5*7.8/ (54.60-50.15)^2$

=19.38 (each group)

Adding 5% of non-response rate, the total sample size was calculated to be around 20 for each group (60 in total for three groups).

Convenience sampling method was used to select the individuals of age more than 18 years having skeletal Class-I malocclusion with different growth pattern. Individuals having skeletal Class I relationship, (SNA angle between 2° and 4°) with no history of prior orthodontic treatment were included in the study. However, individuals with craniofacial anomalies, syndromes, cleft or symptoms or signs of obstructive sleep apnoea were excluded from the study. Data collection was done after obtaining informed consent from the study participants. Lateral cephalograms of the study participants were taken. A 0.3 mm lead pencil was used to trace the lateral cephalograms on 0.003-inch acetate paper and various landmarks were noted. The study participants were divided into hypodivergent, normodivergent, and hyperdivergent facial patterns when SN-GoGn angle were <28°, 28°–36°, and >36°, respectively.

McNamara's airway analysis was used to measure the upper and lower pharyngeal airway. The upper pharyngeal width was measured from the point on the posterior outline of the soft palate to the closest point on the distal wall of pharynx. The lower pharyngeal width was measured from the point of intersection of the distal portion of the tongue and the lower border of the mandible to the nearest point on the distal wall of pharynx.

Data were entered in MicroSoft Excel Sheet and analysed in Statistical Package of Social Sciences version 20. Mean, standard deviation, frequency and percentage were calculated according to the nature of data. One way ANOVA test was done for assessing difference in means between three groups. Independent t test was done to compare the mean space width in between males and females.

RESULT

Out of 60 study participants with skeletal Class I malocclusion, 20 individuals belonged to each group depending upon their growth pattern. The demographic profile of the study participants is presented in Table 1.

Table 2 shows the mean difference in between upper and lower pharyngeal airway space dimensions in between three groups. There was no significant mean difference in upper pharyngeal airway space width (p=0.201) seen in between horizontal, normal and vertical growth patterns of individuals with class I malocclusion. However, the study participants with horizontal growth pattern showed significantly lower lower pharyngeal space width (8.36 ± 2.63mm) than in vertical growth pattern (10.89 ± 3.46 mm, p=0.028, Table 3).

Table 1. Demographic profile of study participants according to their growth pattern

Characteristics	Growth pattern (n=60)			Total
	Horizontal (n=20)	Normal (n=20)	Vertical (n=20)	
Age in years (mean±SD)	25.6±4.79	24.8±5.62	23.65±4.60	24.68±5.01
Sex	Male= 9, female=11	Male=8, female=12	Male= 13, female=7	Male = 30 (50%) Female = 30 (50%)

Table 2. Comparison of pharyngeal airway space according to growth pattern

Characteristics	Growth pattern	No. of participants (n)	Mean±SD (mm)	Standard error of mean	P value*
Upper pharyngeal airway width (UPWC)	Vertical	20	8.94±3.26	0.73	0.201
	Normal	20	10.65±3.03	0.67	
	Horizontal	20	9.29±3.13	0.70	
Lower pharyngeal airway width (LPWC)	Vertical	20	8.36±2.63	0.58	0.028
	Normal	20	10.03±2.66	0.59	
	Horizontal	20	10.89±3.46	0.77	

*One way ANOVA test

Table 3. Post hoc test for multiple comparisons of lower pharyngeal airway space dimensions according to growth pattern

Characteristics	Growth pattern	Comparative group	Mean difference	P value*
Lower pharyngeal airway width (LPWC)	Vertical	Normal	-1.67	0.182
		Horizontal	-2.53	0.023
	Normal	Vertical	1.67	0.182
		Horizontal	-0.86	0.626
	Horizontal	Vertical	2.53	0.023
		Normal	0.86	0.626

*Tukey Post Hoc test

Table 4: Comparison of pharyngeal airway space dimensions in skeletal class I individuals according to sex

Characteristics	Sex	No. of participants (n)	Mean±SD (mm)	Standard error of mean	P value*
Upper pharyngeal airway width (UPWC)	Male	30	9.69±2.32	0.42	0.881
	Female	30	9.56±3.89	0.71	
Lower pharyngeal airway width (LPWC)	Male	30	10.53±3.44	0.63	0.053
	Female	30	9.0±2.51	0.46	

*Independent t test

DISCUSSION

The size of the pharyngeal space is mainly determined by the relative growth and size of soft tissues surrounding the dentofacial skeleton.[15] Pharynx and dentofacial structures have close relationship with each other in between which an orthodontist can expect occurrence of mutual interaction.[16] Upper airway space dimensions play important role during breathing and is associated with growth of craniofacial complex.[17] In this study, lateral cephalogram was used to compare the upper and lower pharyngeal airway space dimensions in individuals with skeletal class I malocclusion having vertical, normal and horizontal growth pattern. Individuals without any craniofacial deformity were chosen as study participants in order to determine the pharyngeal airway space dimensions in natural anatomical conditions excluding the influence of any existing pathology. Also, the participants selected for the study belonged to post-pubertal age in order to remove any influence of growth and aging in the measuring dimensions.

There is increase in susceptibility for mouth breathing and obstructive sleep anpea due to narrow airway space dimensions.[18] In the present study, the mean upper airway space dimensions were not significantly different (p=0.201) in individuals with class I malocclusion having different vertical facial height (low angle, normal or high angle). However, Alfawazan,[19] in his study concluded that the individuals with a high angle vertical facial pattern had statistically significant narrow upper airway widths compared to those with low or normal angle (p=0.013, p=0.021, respectively). Also, Shastri et al. revealed that pharyngeal length was larger in low angle subjects than in high angle subjects.[14] A study by Memon et al.[20] found that participants of class I malocclusion with hyperdivergent facial pattern had a significantly narrower upper pharyngeal airway width compared to those of normodivergent and hypodivergent pattern.

On comparison of lower airway space dimensions among individuals having class I malocclusion with three different vertical facial heights in the current study, those with vertical growth pattern had significantly smaller dimensions than those with horizontal growth pattern (p=0.023). However, there was no significant difference in between dimensions of vertical and normal growth pattern (p=0.182) or horizontal and normal growth pattern (p=0.626). Similar to the findings of this study, Sharma,[21] found decreased width of lower pharyngeal airway in Angle's Class-I malocclsuion with vertical growth pattern than the horizontal growth pattern. These results reflect that there is some role of growth pattern in determining the width of lower pharyngeal airway.[21] On contrary to these findings, Ucar and Usyal[22] noted no statistically significant difference in the lower pharyngeal airways among individuals with different vertical growth pattern.

In this study, there was no significant difference noticed between dimensions of upper and lower pharyngeal airway among males and females similar to a study done by Sharma in India.[21] This finding revealed that the airway patency is not changed according to gender. However, a study by Acharya et al.[23] showed significantly smaller lower pharyngeal airway space dimensions in females than in males. The difference in findings may be because of difference in selection of study participants as the study included individuals with skeletal class I, II and III malocclusion.

This study has some limitations. The study was conducted in a single dental institution only due to which the study findings cannot be generalised to whole population. A larger sample with broad coverage should be done further for confirmation of the study findings.

CONCLUSION

This study concluded that there was no difference in upper pharyngeal space widths among individuals with different growth patterns in individuals with Class I malocclusion, but the vertical growth pattern showed smaller lower pharyngeal airway space dimension than in horizontal growth pattern. If possible, needful orthodontic interventions should be performed in individuals with narrow dimensions for preventing complications due to airway constriction.

CONFLICTS OF INTEREST

The authors declare no potential conflict of interest.

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REFERENCES

1. El H, Palomo JM.Measuring the airway in 3 dimensions: a reliability and accuracy study.American J Orthod Dentofac Orthoped. 2010 Apr 1;137(4):S50-e1.Sch wab RJ.Upper airway imaging.Clin Chest Med 1998;19:33-54.
2. Lee JW, Park KH, Kim SH, Park YG, Kim SJ.Correlation between skeletal changes by maxillary protraction and upper airway dimensions. Angle Orthod. 2011 May;81(3):426-32.
3. Sheng Ch, Lin L, Su Y, Tsai H.Developmental changes in pharyngeal airway depth and hyoid bone position from childhood to young adulthood. Angle Orthod. 2009 May;79(3):484-90.
4. Oh KM, Hong JS, Kim YJ, Cevidanes LS, Park YH.Three-dimensional analysis of pharyngeal airway form in children with anteroposterior facial patterns. Angle Orthod. 2011 Nov;81(6):1075-82.
5. Jena AK, Singh SP, Utreja AK.Sagittal mandibular development effects on the dimensions of the awake pharyngeal airway passage. Angle Orthod 2010;80:106: 1-7.
6. Johnston CD, Richardson A.Cephalometric changes in adult pharyngeal morphology. Eur J Orthod. 1999;21: 357-62.
7. Major MP, Flores-Mir C, Major PW.Assessment of lateral cephalometric diagnosis of adenoid hypertrophy and posterior upper airway obstruction: a systematic review.Am J Orthod Dentofacial Orthop. 2006 Dec; 130(6):7008.
8. Takemoto Y, Saitoh I, Iwasaki T, Inada E, Yamada C, Iwase Y, et al.Pharyngeal airway in children with prognathism and normal occlusion. Angle Orthod.2011 Jan; 81(1):75-80.
9. Martin O, Muelas L, Viñas MJ.Nasopharyngeal cephalometric studyof ideal occlusions. Am J Orthod Dentofacial Orthop. 2006 Oct; 130(4):436.e1-9.
10. Bollhalder J, Hänggi MP, Schätzle M, Markic G, Roos M, Peltomäki TA.Dentofacial and upper airway characteristics of mild and severe Class II division 1 subjects.Eur J Orthod. 2013 Aug; 35(4):447-53.
11. Park SB, Kim YI, Son WS, Hwang DS, Cho BH.Cone-beam computed tomography evaluation of short- and long-term airway change and stability after orthognathic surgery in patients with Class III skeletal deformities: bimaxillary surgery and mandibular setback surgery. Int J Oral Maxillofac Surg. 2012 Jan; 41(1):87-93.
12. Godt A, Koos B, Hagen H, Göz G.Changes in upper airway width associated with Class II treatments (headgear vs activator) and different growth patterns. Angle Orthod. 2011 May; 81(3):440-6.
13. Zhao Y, Nguyen M, Gohl E, Mah JK, Sameshima G, Enciso R.Oropharyngeal airway changes after rapid palatal expansion evaluated with cone-beam computed tomography. Am J Orthod Dentofacial Orthop. 2010 Apr; 137(4 Suppl):S71-8.
14. Shastri D, Tandon P, Nagar A, Singh A.Pharyngeal airway parameters in subjects with Class I malocclusion with different growth patterns. J Orthod Res. 2015 Jan 1;3(1):11.
15. Johnston CD, Richardson A. Cephalometric changes in adult pharyngeal morphology. Eur J Orthod 1999;21:357-62.
16. Ceylan, Oktay. Pharyneal size in different skeletal patterns. Am J Orthod Dentofac Orthop 1995;108(1):69-75.
17. Claudino LV, Mattos CT, Ruellas AC, Sant' Anna EF. Pharyngeal airway characterization in adolescents related to facial skeletal pattern: a preliminary study. Am J Orthod Dentofacial Orthop. 2013 June;143(6):799-809.
18. Batool I, Shaheed M, Rizvi SA, Abbas A. Comparison of upper and lower pharyngeal airway space in class II high and low angle cases. Pak Oral Dent J 2010;30:81-4.
19. Alfawzan AA. Assessment of airway dimensions in skeletal Class I malocclusion patients with various vertical facial patterns: A cephalometric study in a sample of the Saudi population. J Orthod Sci. 2020;9.
20. Memon S, Fida M, Shaikh A. Comparison of different craniofacial patterns with pharyngeal widths. J Coll Physicians Surg Pak. 2012;22:302-6.
21. Sharma R.Evaluation of upper and lower pharyngeal airway widths in class I and class II malocclusion with different growth pattern. 2017 Mar; 9(3):47516-9.
22. Ucar FI, Uysal T. Orofacial airway dimensions in subjects with Class I malocclusion and different growth patterns. Angle Orthod 2011;81:460-8.
23. Acharya G, Shrestha R, Gupta A, Acharya S. Pharyngeal airway space in different skeletal malocclusion and facial forms. J Chitwan Medl Coll. 2022 Mar 15;12(1):86-90.