Original Article

Nasopharyngeal Airway Dimensions in Different Dentofacial Skeletal Patterns

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ABSTRACT

Introduction: Dentofacial growth and development is noticeably affected by the various oropharyngeal and nasopharyngeal structures. It is also presumed that airway adequacy is related to the size and position of the mandible rather than maxillary variables. The purpose of this study was to compare the dimensions of nasopharynx in subjects with Class I and Class II malocclusions with normodivergent and hyperdivergent facial patterns.

Methodology: Pretreatment cephalometric radiographs of 80 subjects in age group of 14 to 25 years were taken and divided into four groups according to A point, nasion, B point (ANB) and Frankfort to mandibular plane angle (FMA) with 20 subjects in each group. The measurements of the dimensions of the nasopharynx, in all the subjects were taken.

Results: The anteroposterior dimensions of nasopharynx is narrower in subjects with Class I skeletal malocclusion with vertical growth pattern as compared to subjects with Class II skeletal malocclusion with vertical growth pattern as suggested by dimensions at posterior pharyngeal wall 1 and posterior pharyngeal wall 2 (PPW-1 and PPW-2). The anteroposterior dimensions of nasopharynx was narrower in subjects with Class II skeletal malocclusion with vertical growth pattern as compared to subjects with Class II skeletal malocclusion with average growth pattern as suggested by dimensions Ptm-ad1 and Nph1.

Conclusion: The nasopharyngeal airway dimensions are narrower in subjects with vertical growth patterns and compared to the subjects with average or horizontal growth patterns. The narrower anteroposterior dimension of the airway in hyperdivergent patients may be attributable to skeletal features common to such patients, that is, retrusion of the maxilla and the mandible and vertical maxillary excess and the relatively thin posterior pharyngeal wall observed in hyperdivergent patients might be a compensatory mechanism.

INTRODUCTION

From the late 1800s till now, the relationship between pharyngeal structures and dentofacial patterns have been intensively researched.[1] As was suggested by the functional matrix hypothesis, soft tissue units guided hard tissues to an extent. With regard to this dentofacial growth and development is noticeably affected by the various oropharyngeal and nasopharyngeal structures. Also it has been seen that the nasal obstruction and its inseperable counterpart "mouth breathing" also affect the dentofacial growth. Thus several studies tried to correlate patients with normal nasorespiratory functions with different malocclusions and airway dimensions.[2-8]

The size of the nasopharyngeal airway space is of importance in its relationship to the morphology of the face because with reduction of the nasopharyngeal airway space, nasal breathing becomes difficult or impossible, and mouth breathing becomes necessary. It is with chronic mouth breathing that the normal balance of oral and paraoral structures is upset and changes of both structures can be expected.

It has been noted that Class II patients have a tendency for a narrower anteroposterior pharyngeal dimension, specifically in the nasopharynx at the level of the hard palate and in the oropharynx at the level of the tip of the soft palate and the mandible.[9] The midsagittal

nasopharyngeal area and the nasopharyngeal depth are significantly larger in subjects with normal occlusion than in those with Class II malocclusion.[10] Skeletal features such as retrusion of maxilla and mandible and vertical maxillary excess in hyperdivergent patients can lead to narrower anteroposterior dimensions of airway.

It is also presumed that airway adequacy was related to the size and position of the mandible rather than maxillary variables.[11] Because of the close relationship between the pharynx and the dentofacial structures, a mutual interaction is expected to occur between the pharyngeal structures and the dentofacial pattern, and therefore justifies orthodontic interest. The purpose of this study was to compare nasopharyngeal dimensions in subjects with Class I and Class II malocclusions with normodivergent and hyperdivergent facial patterns.

METHODS

The study protocol was approved by the ethics committee of Baba Farid University of Health Sciences, Faridkot. An informed consent was taken by the parents and the patients before the subjects entered the study The study comprised of pretreatment cephalometric radiographs of 80 subjects. Subjects included in the study were healthy with normal body mass index, no previous orthodontic treatment and in the age range of 14 to 25 years. Children with known upper airways anomalies, abnormal development, chronic infections, asthma or perennial allergies were excluded. The subjects were divided into four groups according to A point, nasion, B point (ANB) and Frankfort to mandibular plane angle (FMA) with 20 subjects in each group.

Group A: Class I malocclusion (ANB 0°- 4°) with average growth patterns (FMA20^0- 30^0)

Group B: Class I malocclusion (ANB 0° - 4°) with vertical growth patterns (FMA > 3 0°)

Group C: Class II malocclusion (ANB > 4°) with average growth patterns (FMA20^0- 30°)

Group D: Class II malocclusion (ANB > 4°) with vertical growth patterns (FMA > 3 0°)

All lateral cephalograms were selected from the pre treatment records of orthodontic patients at the Department of Orthodontics and Dentofacial Orthopaedics, Guru Nanak Dev Dental College and Research Institute, Sunam. The measurements of the dimensions of the pharynx in all the subjects were obtained (Figure 1 and 2). None of subject had a history of previous orthodontic or orthopaedic treatment or any palatal/lip cleft syndrome.

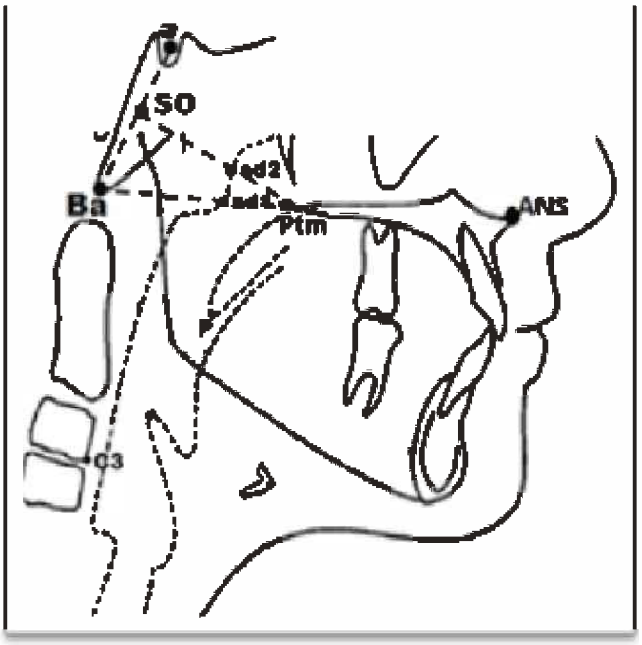

Figure 1: Soft Tissue and Hard Tissue Landmarks.

ANS (Anterior nasal spine), **Ptm** (Pterygomaxillary fissure), **Point P** (Tip of the soft palate), **Adl** (intersection of the line Ptm-Ba and the posterior nasopharyngeal wall), **Ad2** (intersection of the posterior nasopharyngeal wall and line Ptm-So)

Statistical analysis including the mean and the standard deviation for each group were computed using SPSS (SPSS Inc., Chicago, III). The differences between growth patterns 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. Pearson's correlation coefficient test was used to detect any relationship between ANB angle and other variables.

RESULTS

Significant differences were observed in the nasopharynx airway dimensions when parameters PPW1, Nph-2 and PPW2 ($p \leq 0.01$) were taken into consideration according to ANOVA. The parameters in which statistically significant difference was observed were Ptm-ad1, Ptm-ad2 and Nph-1 ($p \leq 0.05$). Significant differences were not found in other nasopharynx dimension parameters i.e P-Nph1, PNS-P, SPW, (ANS-PNS)- P angle (Table 1).

When nasopharynx dimensions comparison was done between Class I Average growth pattern and Class I Vertical growth pattern groups, then the results were non significant as suggested by the measurements (Table 2).

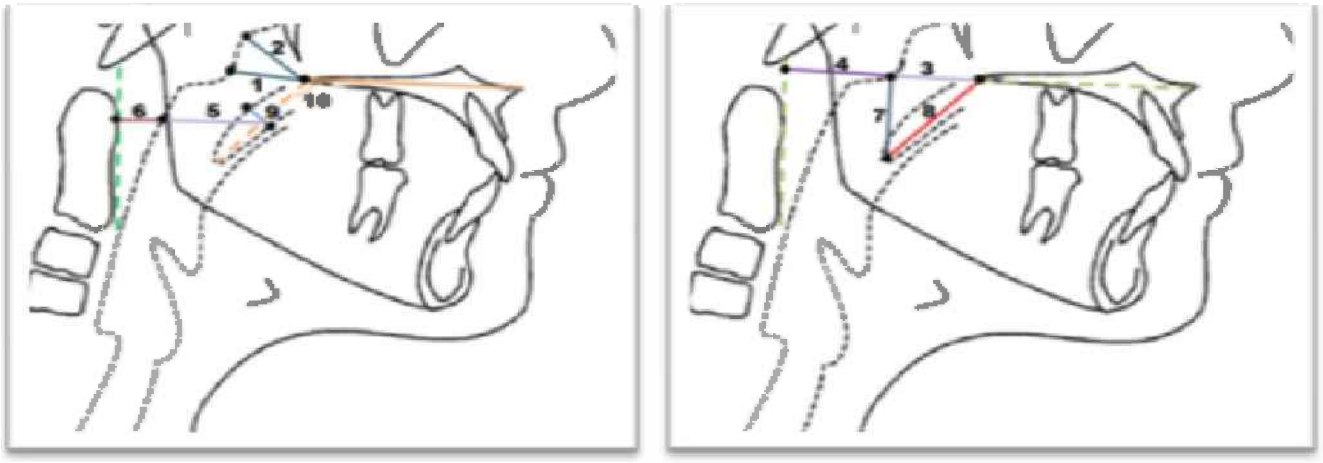

Figure 2: Nasopharynx dimension parameters.

1. Ptm-ad1 (distance between the posterior nasal spine and ad1), **2. Ptm-ad2** (distance between the posterior nasal spine and ad2), **3. Nph1** (nasopharyngeal space 1), **4. PPW1** (posterior pharyngeal wall 1), **5. Nph2** (nasopharyngeal space 2), **6. PPW2** (posterior pharyngeal wall 2), **7. P-Nph1** (perpendicular distance between the soft palate tip and Nph1), **8. PNS-P** (distance between posterior nasal spine and soft palate tip) **9. SPW** (soft palate width), **10. ANS-PNS-P** (palatal angle)

Table 1: Nasopharynx parameters

Parameters	Group A (n=20) Mean±SD	Group B (n=20) Mean±SD	Group C (n=20) Mean±SD	Group D (n=20) Mean±SD	Significance
Ptm-ad1 (mm)	23.65±2.62	22.95±2.62	24.45±2.80	21.30±4.88	*
Ptm-ad2 (mm)	19.35±3.52	17.55±4.13	18.70±3.31	15.95±3.69	*
Nph-1 (mm)	24.55±2.60	23.35±3.77	26.05±2.83	22.65±4.67	*
PPW-1 (mm)	14.65±3.71	12.33±3.02	15.88±2.29	15.15±2.77	**
Nph-2 (mm)	19.18±2.26	17.35±2.56	19.85±1.53	18.13±2.71	**
PPW-2 (mm)	9.00±2.28	7.73±1.78	10.43±2.19	9.95±2.17	**
P-Nph1 (mm)	23.00±3.34	23.70±3.23	22.85±2.83	22.45±3.13	NS
PNS-P (mm)	29.40±3.29	30.75±3.86	30.45±3.76	30.20±4.03	NS
SPW (mm)	8.525±1.56	8.000±1.64	7.925±1.80	8.275±1.36	NS
(ANS-PNS)-P (degree)	130.3±5.01	130.8±5.55	131.6±4.34	131.5±3.31	NS

* $p \leq 0.05$; ** $p \leq 0.01$; NS = Non Significant
Group A- Class I skeletal malocclusion with average growth pattern; Group B- Class I skeletal malocclusion with vertical growth pattern
Group C- Class II skeletal malocclusion with average growth pattern; Group D- Class II skeletal malocclusion with vertical growth pattern

Table 2: Comparison of nasopharynx dimensions in Class I skeletal malocclusion

Parameters	Mean Value (Group A)	Mean Value (Group B)	Standard Error	p-value
Ptm-ad1	23.65 mm	22.95 mm	1.06	NS
Ptm-ad2	19.35 mm	17.55 mm	1.16	NS
Nph1	24.55 mm	23.35 mm	1.12	NS
PPW1	14.65 mm	12.33 mm	0.94	NS
Nph2	19.18 mm	17.35 mm	0.73	NS
PPW2	9.00 mm	7.73 mm	0.67	NS
P-Nph1	23.00 mm	23.70 mm	0.99	NS
PNS-P	29.40 mm	30.75 mm	1.18	NS
SPW	8.52 mm	8.00 mm	0.50	NS

NS = Non Significant,
Group A- Class I skeletal malocclusion with average growth pattern; Group B- Class I skeletal malocclusion with vertical growth pattern

When comparison was done between Class I and Class II Average growers then also the results were not significant as suggested by the measurements (Table 3).

Post Hoc Tukey's HSD (Honest Significant Difference) test showed significant differences in nasopharynx dimensions at posterior pharyngeal wall 1 (PPW1) and posterior pharyngeal wall 2 (PPW2), between group B and D (Class I malocclusion with vertical growth pattern group and Class II malocclusion with vertical growth pattern group) ($p < 0.05$) (Table 4). When the nasopharynx dimension parameters were compared between groups C and D, it was found that Ptm-adl and Nphl were significantly smaller in Class II malocclusion and vertical growth pattern group i.e group D when compared with Class II malocclusion and normal growth pattern group i.e group C ($p < 0.05$) (Table 4).

Table 3: Comparison of nasopharynx dimensions in Class I skeletal malocclusion and in Class II skeletal malocclusion

Parameters	Mean Value (Group A)	Mean Value (Group B)	Standard Error	p-value
Ptm-ad1	23.65 mm	24.45 mm	1.06	NS
Ptm-ad2	19.35 mm	18.70 mm	1.16	NS
Nph1	24.55 mm	26.05 mm	1.12	NS
PPW1	14.65 mm	15.88 mm	0.94	NS
Nph2	19.18 mm	19.85 mm	0.73	NS
PPW2	9.00 mm	10.43 mm	0.67	NS
P-Nph1	23.00 mm	22.85 mm	0.99	NS
PNS-P	29.40 mm	30.45 mm	1.18	NS
SPW	8.52 mm	7.92 mm	0.50	NS

NS = Non Significant

Group A- Class I skeletal malocclusion with average growth pattern

Group C- Class II skeletal malocclusion with average growth pattern

Table 4 : Comparison of nasopharynx dimension in Class I skeletal malocclusion and in Class II skeletal malocclusion

Parameters	Mean Value (Group A)	Mean Value (Group C)	Standard Error	p-value
Ptm-ad1	22.95 mm	21.30 mm	1.06	NS
Ptm-ad2	17.55 mm	15.95 mm	1.16	NS
Nph1	23.35 mm	22.65 mm	1.12	NS
PPW1	12.33 mm	15.15 mm	0.94	*
Nph2	17.35 mm	18.13 mm	0.73	NS
PPW2	7.73 mm	9.95 mm	0.67	**
P-Nph1	23.70 mm	22.45 mm	0.99	NS
PNS-P	30.75 mm	30.20 mm	1.18	NS
SPW	8.00 mm	8.27 mm	0.50	NS

*$p \leq 0.05$; **$p \leq 0.01$; NS - Non Significant,

Group B- Class I skeletal malocclusion with vertical growth pattern

Group D- Class II skeletal malocclusion with vertical growth pattern

When the nasopharynx dimension parameters were compared between groups C and D, it was found that Ptm-adl and Nphl were significantly smaller in Class II malocclusion and vertical growth pattern group i.e group D when compared with Class II malocclusion and normal growth pattern group i.e group C ($p < 0.05$) (Table 5).

DISCUSSION

A close relationship is present between the pharynx and the dentofacial structures, thus mutual interaction is expected to occur between the pharyngeal structures and the dentofacial pattern. Narrowing of the pharyngeal space might be a factor in obstructive sleep apnea. The nasopharyngeal airway dimensions are narrower in Class I skeletal malocclusion with vertical growth pattern as compared to Class II skeletal malocclusion with vertical growth pattern. Pharynx is approximately 12 to 14 cm, and it is divided into three parts: nasopharynx, oropharynx, and hypopharynx.[11,12] The nasopharyngeal dimensions continue to grow rapidly until 13 years of age and then slow until adulthood.[13,14] In this study, the age range was 14-25 years to ensure that the oropharyngeal structures had reached adult size.

In our findings no significant difference was observed between Class I malocclusion having normal and vertical growth patterns. Our findings are in agreement with studies of Kerr et al[14] who stated that there was a low correlation between the nasopharyngeal and dentofacial dimensions. Similar results have been reported earlier [15,16] who also could not find any clear-cut relationship between the nasopharyngeal area in Class I and Class II malocclusions. A highly significant increase in the nasopharynx airway dimension was observed when comparison was done in subjects having different saggital relationship and hyperdivergent growth pattern, as suggested by increased measurements at middle portion of nasopharynx at posterior pharyngeal wall 2 (PPW2) and also a significant increase in measurements at posterior pharyngeal wall 1 (PPW1). In other studies, Kerr et al[14] investigated the relationship between the nasopharyngeal and dentofacial dimensions on the subjects with normal and Class II malocclusions, and found that the subjects with Class II malocclusion had a larger nasopharyngeal airway area than the subjects with normal occlusions. The results of the present study are not in agreement with Freitas et al[8] who reported that subjects with Class I and Class II malocclusions and vertical growth patterns had significantly narrower upper pharyngeal airways than Class I and Class II subjects with normal growth patterns. The present study revealed that significantly smaller nasopharyngeal airway space in high angle subjects were found when compared with average growing subjects as suggested by the reduced Ptm-adl and Nph-1 dimensions. The narrow dimensions of the superior part of the upper airway in the vertical facial pattern groups may be result of deficient development of the craniomaxillary complex. Our conclusions were similar to the previous studies which suggested that the pharyngeal cephalometric anatomy of patients with a hyperdivergent facial pattern is markedly different from that in normodivergent individuals. Joseph et al[17] reported

Table 5 : Comparison of nasopharynx dimension in Class II skeletal malocclusion

Parameters	Mean Value (Group C)	Mean Value (Group D)	Standard Error	p-value
Ptm-ad1	24.45 mm	21.30 mm	1.06	*
Ptm-ad2	18.70 mm	15.95 mm	1.16	NS
Nph1	26.05 mm	22.65 mm	1.12	*
PPW1	15.88 mm	15.15 mm	0.94	NS
Nph2	19.85 mm	18.13 mm	0.73	NS
PPW2	10.43 mm	9.95 mm	0.67	NS
P-Nph1	22.85 mm	22.45 mm	0.99	NS
PNS-P	30.45 mm	30.20 mm	1.18	NS
SPW	7.925 mm	8.275 mm	0.50	NS

* $p \leq 0.05$; NS - Non Significant,

Group C- Class II skeletal malocclusion with average growth pattern

Group D- Class II skeletal malocclusion with vertical growth pattern

that the nasopharyngeal airway in hyperdivergent individuals was significantly narrower than in normodivergent individuals. They suggested that this difference occurred because of the relative bimaxillary retrusion exhibited by the hyperdivergent group. A normal sized, yet retropositioned, maxilla can lead to a narrowing of the nasopharynx.

The possibility that hyperdivergent growth, with its associated airway narrowing, may predispose patients to obstructive episodes also needs to be studied. Therefore, orthodontists must be aware that specific dimensional characteristics such as a greater constriction might be associated with the skeletal pattern. The anteroposterior dimensions of nasopharynx is narrower in subjects with Class I skeletal malocclusion with vertical growth pattern as compared to subjects with Class II skeletal malocclusion with vertical growth pattern as suggested by dimensions at posterior pharyngeal wall 1 and posterior pharyngeal wall 2 (PPW-1 and PPW-2). The anteroposterior dimensions of nasopharynx is narrower in subjects with Class II skeletal malocclusion with vertical growth pattern as compared to subjects with Class II skeletal malocclusion with average growth pattern as suggested by dimensions Ptm-adl and Nphl.

CONCLUSION

The nasopharyngeal airway dimensions are narrower in subjects with vertical growth patterns and compared to the subjects with average or horizontal growth patterns. The narrower anteroposterior dimension of the airway in hyperdivergent patients may be attributable to skeletal features common to such patients, that is, retrusion of the maxilla and the mandible and vertical maxillary excess and the relatively thin posterior pharyngeal wall observed in hyperdivergent patients might be a compensatory mechanism.

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