ORIGINAL ARTICLE

Comparison and Relationship of Upper Airway Width and Maxillary Intermolar Width in Hypodivergent and Hyperdivergent Skeletal Class II Subjects

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Abstract

Introduction: Dental arch width and facial form are vital aspects in deciding the outcome of orthodontic treatment. Facial morphology is the result of each person's genotype and phenotypic expression. The vertical skeletal relationship is regularly defined by the Frankfurt mandibular plane angle (FMA). A "high-angle" (hyperdivergent) pattern, where the angle is 30° or more, and "low-angle" (hypodivergent) where the angle is 20° or less. The growth and development of the craniofacial complex is affected by the growth of nasal cavities, nasopharyngeal space as well as oropharyngeal space.

Objective: Comparison and relationship of upper airway width and maxillary intermolar width (IMW) in hypodivergent and hyperdivergent skeletal Class II subjects.

Materials and methods: Study casts and lateral cephalograms of 50 skeletal class II patients divided into 2 groups hypodivergent and hyperdivergent, 25 subjects in each group based on FMA, having no past history of an orthodontic procedure or airway-related surgical procedure were involved. Measurement of upper airway space was recorded on the cephalograms as described by McNamara Jr. Measurement of maxillary IMW was taken on the study casts with the help of a digital vernier caliper.

Results: A significant difference was found between IMW and upper airway width in the hyperdivergent and hypodivergent groups. A negative correlation was found between FMA and IMW in both the hypodivergent and hyperdivergent groups. A positive correlation was detected between FMA and upper airway width in the hypodivergent group. There was a weak negative correlation found between upper airway width and IMW.

Conclusion: A relationship exists between the maxillary arch dimension and upper airway width with vertical facial morphology. Hyperdivergent growth had a constricted airway and IMW than hypodivergent growth.

Keywords: Frankfurt mandibular plane angle, Intermolar width, Upper airway width.

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Introduction

Dental arch width and facial form have a significant role in deciding the success and stability of orthodontic treatment. Facial morphology is under genetic control. It is also supposed that the functional capacity and the size of masticatory muscles and craniofacial form, all three are interrelated. As per Moss's functional matrix theory, for the growth and development of craniofacial and dentofacial complex, nasal breathing plays an important role. Mouth breathing occurs in chronic nasal obstruction, causing an abnormal position of the tongue, incompetent lips, a downward position of the mandible, and decreased muscle tonicity to balance the reduction in nasal airflow. It leads to disruption in the growth and progress of orofacial structures, including constriction of the upper jaw, a short length of the lower jaw, variations in the position of the head to the neck, proclination of the upper front teeth, and distal position of the lower jaw. Oral breathing led to "adenoid faces."

Skeletal Class II pattern with mandibular deficiency is a reason for upper airway syndromes and oropharyngeal airway deficiencies. Ling and Wong stated that timely orthodontic treatment of lower jaw retrusion in skeletal Class II patients is helpful to avoid potential respiratory problems.[1] So, the calculation of airway space is an essential part of orthodontics to achieve functional balance and stability. Hence, the aim of this study is to correlate the upper pharyngeal airway widths and intermolar width (IMW) in patients with hyperdivergent and hypodivergent skeletal Class II patterns.

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Materials and Methods

The study was conducted in the Department of Orthodontics and Dentofacial Orthopedics, National Dental College and Hospital, Derabassi, Punjab, India. Ethical approval was obtained from the Ethical Board Committee of National Dental College and

Fig. 1: Frankfurt mandibular plane angle

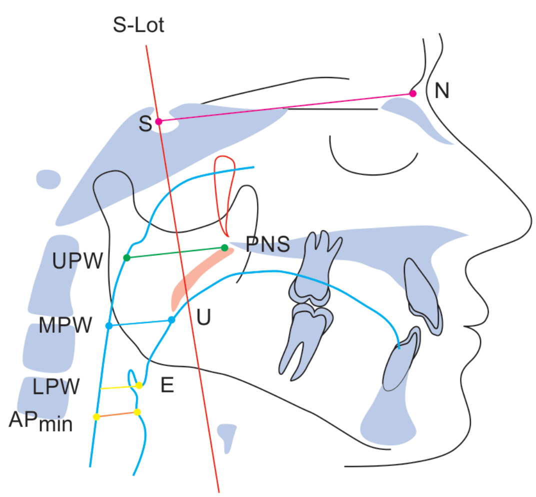

Fig. 2: Upper pharyngeal width (upper airway width)

Hospital, Derabassi, Punjab, India. The sample size was 50 skeletal Class II subjects with no past history of orthodontic treatment or respiratory problems were included. Informed written consent was taken from all subjects. Patients with a history of adenoidectomy or any other nasopharyngeal surgery were excluded. A total of 50 patients, 25 hypodivergent and 25 hyperdivergent groups based on Frankfurt mandibular plane angle (FMA) were selected. (Fig. 1).

- Horizontal growth pattern (hypodivergent) – FMA angle is 20° or less.
- Vertical growth pattern (hyperdivergent) – FMA angle is 30° or more.

Standard lateral cephalograms were taken for the subjects. The distance between the posterior pharyngeal wall and the anterior half of the soft palate was taken as the upper airway (UA) (Fig. 2).

Impressions of the subjects were taken with the help of alginate. Study models were prepared with orthodontic plaster. Trimming of casts was done.

The IMW was taken from the mesiobuccal cusp tip of the first permanent molar on the right side to the first molar on the left side. A digital caliper was used for this (Fig. 3).

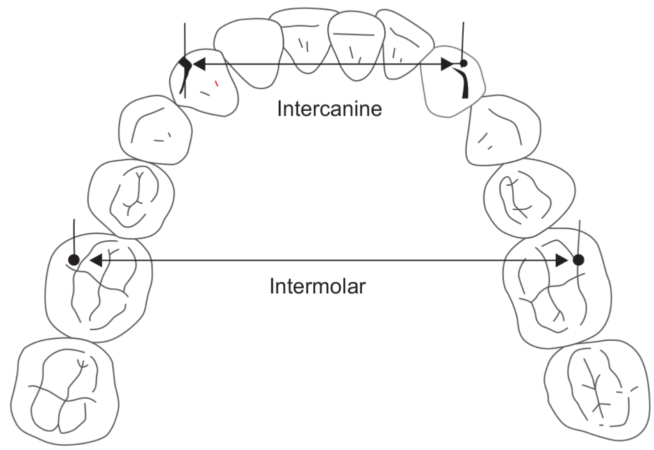

Fig. 3: Intermolar width

For interexaminer reliability, measurements for 10 randomly selected patients were repeated by another examiner, 3 weeks from the first reading.

Statistical Analysis

SPSS version 16 was used for data analysis. Means and standard deviations recorded for both the parameters (the IMW and upper airway space) in hypodivergent and hyperdivergent skeletal Class II subjects were recorded. To evaluate inter- and intraexaminer reliability independent *t*-test was used. Pearson's correlation was used to check the correlation between FMA, upper airway space, and maxillary IMW. The outcomes of the test were considered to be significant at $p \leq 0.05$.

Results

Results show a noticeable difference was found with respect to IMW in hyperdivergent and hypodivergent groups as the *p*-value came to 0.045 which was less than 0.05. A noticeable difference was recorded in upper airway width among hyperdivergent and hypodivergent groups as the *p*-value came to 0.02 which was less than 0.05 as shown in Table 1. Intermolar width and upper airway width were more in the hypodivergent group as compared to hyperdivergent group. Bar chart (Fig. 4) showing the comparison of FMA, IMW and upper airway width in both hyperdivergent and hypodivergent groups.

The correlation was found between FMA and IMW in both hypodivergent and hyperdivergent groups as the calculated *p*-value was less than 0.05 as shown in Table 2. The value of Pearson correlation came out to be –0.423 in the hyperdivergent group and –0.603 in the hypodivergent group. It shows that in both the groups IMW decreases with an increase in FMA (Figs 5 and 6). A positive correlation was found between FMA and upper airway width in the hypodivergent group as the *p*-value came to 0.016 and had a Pearson correlation value of 0.478 (Fig. 7). An insignificant correlation was found between upper airway width in the hyperdivergent group. A weak correlation was found between IMW and upper airway width (Table 2).

Discussion

Oral respiration interrupts the pressure applied by orofacial muscles such as the tongue, cheeks, and lips on the maxillary arch. Features

Table 1: Comparison of FMA, IMW, and upper airway width among hyperdivergent and hypodivergent group

Group	*N*	*Mean*	*Standard deviation*	*t*	*p-value*	*Significance*
FMA						
Hyperdivergent	25	32.12	1.73	20.115	0.000	S
Hypodivergent	25	17.60	3.16			
IMW						
Hyperdivergent	25	49.32	2.54	−2.059	0.045	S
Hypodivergent	25	51.00	3.18			
Upper airway width						
Hyperdivergent	25	14.28	1.33	−3.373	0.002	S
Hypodivergent	25	16.48	2.97			

*p-value ≤ 0.05 (significant); **p-value = 0.001 (highly significant)

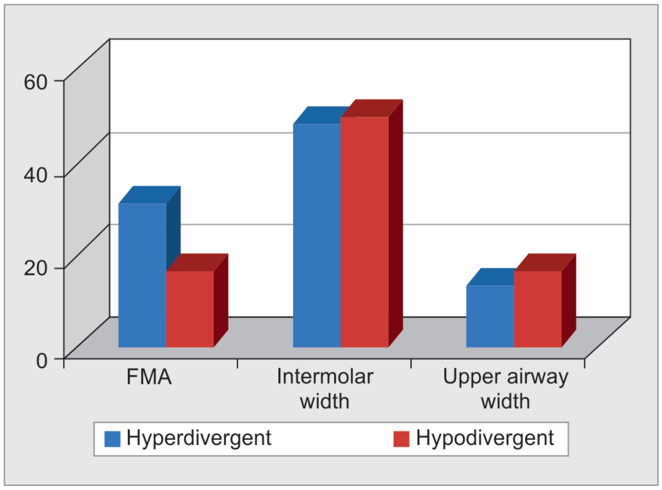

Fig. 4: Comparison of FMA, intermolar width and upper airway width

Table 2: Correlation between FMA, IMW, and upper airway width in hypodivergent and hyperdivergent groups

	Hyperdivergent group		*Hypodivergent group*	
Correlation variables	*Pearson correlation*	*p-value*	*Pearson correlation*	*p-value*
FMA vs IMW	−0.423	0.035*	−0.603	0.001**
FMA vs Upper airway width	0.343	0.094	0.478	0.016*
IMW vs Upper airway width	−0.400	0.051	−0.313	0.045*

*p-value ≤ 0.05 (significant); **p-value = 0.001 (highly significant)

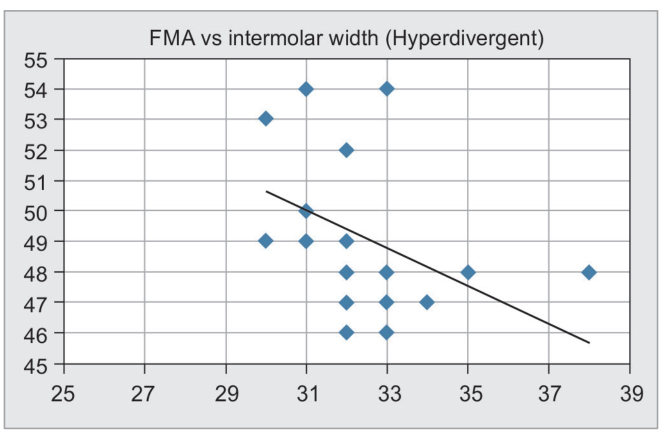

Fig. 5: Scatter plot between FMA and intermolar width in hyperdivergent group depicts negative correlation between two variables

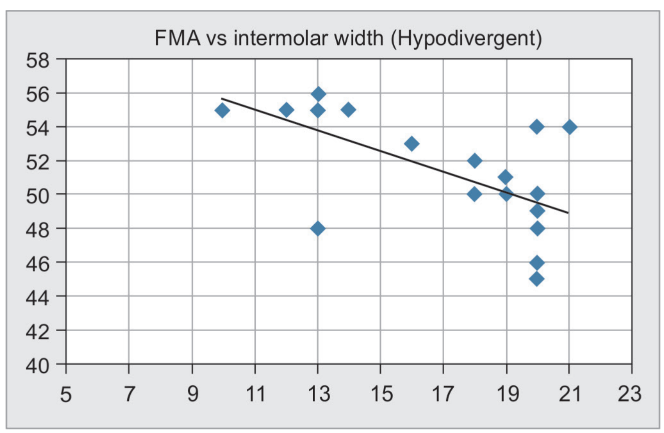

Fig. 6: Scatter plot between FMA and intermolar width in hypodivergent group depicts negative correlation between two variables

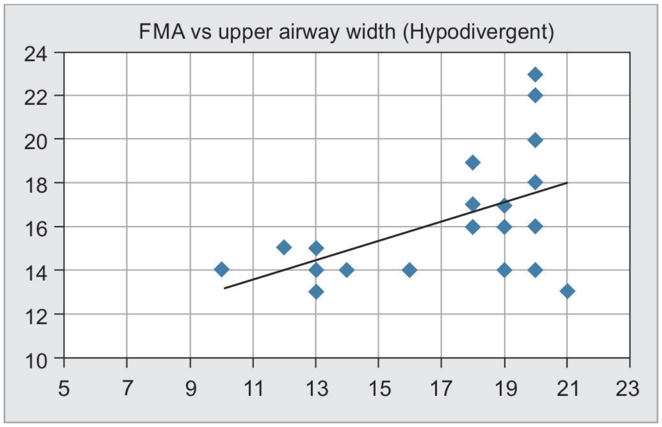

Fig. 7: Scatter plot between FMA and upper airway width in hypodivergent group depicts positive correlation between two variables

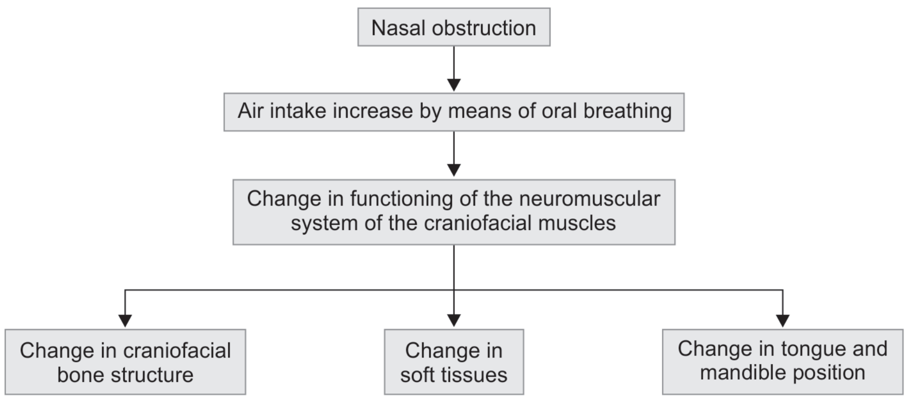

Fig. 8: The relationship between naso-respiratory obstruction and craniofacial growth

of the airway obstruction disease are the existence of enlarged tonsils or adenoids, mouth breathing, open-bite, cross-bite, long face, incompetent lips, increased display of upper incisors, constricted external nares, "V" shaped maxillary arch.

Kristina and Algis have done a study on children having trouble with nasal breathing.[2] A strong correlation among nasal airway resistance and overjet, open-bite, maxillary crowding, and posterior cross-bite was found. The results of this study match with our results.

As per Moss's functional matrix concept, nasal breathing leads to proper growth and development of the craniofacial complex. So, uninterrupted airflow from the nasal breathing brings continuous stimulus for the lateral growth of the maxilla and for the lowering of the palatal vault. In contrast, midface hypoplasia can occur in upper respiratory tract obstruction (Fig. 8).

Due to airway obstruction, the balance between force and pressure of orofacial muscles gets disturbed which leads to changes in dentoalveolar and craniofacial structures. McNamara defined a biological mechanism that causes these changes in the neuromuscular system as a result of upper respiratory airway obstruction.[3] The neuromuscular change leads to alteration in the bony and soft tissues of the dental and craniofacial structures.

Gupta S and Ravi MS, noted a correlation between airway width and facial skeletal pattern.[4] Individuals with vertical skeletal patterns have narrower upper airways as compared to horizontal skeletal patterns. Marcos Roberto de Freitas et al.[5] also proved the same. Grauer et al.[6] discovered that subjects in hypodivergent group had the largest bizygomatic width and because of this, patients in the hypodivergent group had larger pharyngeal airway volumes than patients in the hyperdivergent and normodivergent groups.

For the IMW, a significant inverse relationship was found between the mandibular plane angle and IMW in hypodivergent and hyperdivergent groups. The correlation was strong. Many authors have noticed that individuals with increased vertical dimensions have a tendency of more buccally inclined posterior teeth and with decreased vertical dimensions have a tendency of more lingual inclination of posterior teeth (Isaacson et al.;[7] Schudy;[8] Guilherme et al.).[9]

Sharma et al.[10] conducted a study to evaluate the relationship between vertical facial patterns and dental arch forms in skeletal class II malocclusion. It was found that Inverse correlation between dental arch form and vertical facial pattern.

Individuals with strong elevator muscles are likely to have wider transverse head dimensions (Ringqvist;[11] van Spronsen et al.;[12] Hannam AG and Wood WW).[13] A brachyfacial pattern (short face) has strong masticatory muscles. This will lead to an increased mechanical load on the jaws and may cause an initiation of sutural growth and bone deposition, finally resulting in increased transverse growth of the jaws and bone bases for the dental arches.

Conclusion

- A significant difference was found in IMW and upper airway width in hyperdivergent and hypodivergent groups.
- Intermolar width and upper airway width were more in the hypodivergent group as compared to hyperdivergent group.
- A negative correlation was found between FMA and IMW in both hyperdivergent and hypodivergent groups.
- Positive correlation was found between FMA and upper airway width in the hypodivergent group.
- A weak correlation was found between upper airway width and IMW which needs to be checked by further research.

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References

1. Ling JYK, Wong RWK. Dental arch widths of Southern Chinese. Angle Orthod 2009;79(1):54–63. DOI: 10.2319/092007-452.1.
2. Lopatiene K, Babarskas A. Malocclusion and upper airway obstruction. Medicina (Kaunas) 2002;38(3):277–283. PMID: 12474699.
3. McNamara JA Jr. Naso-respiratory function and craniofacial growth Monograph 9, Craniofacial Growth Series. Ann Arbor: University of Michigan, Center for Human Growth and Development; 1979; pp. 1–26.
4. Gupta S, Subrahmanya RM. Assessment of oropharyngeal widths in individuals with different facial skeletal patterns. J Health Allied Sci NU 2014;04(2):34–38. DOI: 10.1055/s-0040-1703761.
5. de Freitas MR, Alcazar NM, Janson G, et al. Upper and lower pharyngeal airways in subjects with class I and class II malocclusions and different growth patterns. Am J Orthod Dentofacial Orthop 2006;130(6):742–745. DOI: 10.1016/j.ajodo.2005.01.033.
6. Grauer D, Cevidanes LSH, Styner MA, et al. Pharyngeal airway volume and shape from cone–beam computed tomography: Relationship to facial morphology. Am J Orthod Dentofacial Orthop 2009;136(6): 805–814. DOI: 10.1016/j.ajodo.2008.01.020.
7. Isaacson JR, Isaacson RJ, Speidel TM, et al. Extreme variation in vertical facial growth and associated variation in skeletal and dental relations. Angle Orthod 1971;41(3):219–229. DOI: 10.1043/0003-3219(1971)041<0219:EVIVFG>2.0.CO;2.
8. Schudy FF. Vertical growth versus anteroposterior growth as related to function and treatment. Angle Orthod 1964;34(02):75–93. DOI: 10.1043/0003-3219(1964)034<0075:VGVAGA>2.0.CO;2.
9. Janson G, Bombonatti R, Cruz KS, et al. Buccolingual inclinations of posterior teeth in subjects with different facial patterns. Am J Orthod Dentofacial Orthop 2004;125(3):316–322. DOI: 10.1016/j.ajodo.2003.03.010.
10. Sharma A, Sharma A, Vaidya A, et al. Relationship between vertical facial pattern and dental arch forms in skeletal class II malocclusion. Saudi J Oral Dent Res 2019;4(9):657–665. DOI: 10.36348/SJODR.2019.v04i09.016.
11. Ringqvist M. Isometric bite force and its relation to dimensions of the facial skeleton. Acta Odontol Scand 1973;31(1):35–42. DOI: 10.3109/00016357309004611.
12. van Spronsen PH, Weijis A, Valk J, et al. Relationships between jaw muscle cross-sections and craniofacial morphology in normal adults, studied with magnetic resonance imaging. Eur J Orthod 1991;13(5):351–361. DOI: 10.1093/ejo/13.5.351.
13. Hannam AG, Wood WW. Relationships between the size and spatial morphology of masseter and medial pterygoid muscles, the craniofacial skeleton, and jaw biomechanics. Am J Phys Anthropol 1989;80(4):429–445. DOI: 10.1002/ajpa.1330800404.