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Dentoalveolar Heights in Skeletal Malocclusion: A Dual Plane Study

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ABSTRACT

Introduction

Skeletal malocclusions are manifested in sagittal, vertical and transverse discrepancies. Aim of this study was to determine the relationship of dentoalveolar heights among skeletal malocclusion with different growth patterns.

Methods

In this cross-sectional study, traced cephalometric X-rays were grouped into skeletal Class I, Class II, Class III based on Steiner's ANB angle and growth patterns based on Steiner's SN-GoGn Angle and Tweeds FMA angle. A Total of 180 samples were proportionally divided in nine groups based on growth pattern and malocclusion classification. ANOVA was applied for data analysis using SPSS V21.

Results

Upper anterior dental height (UADH) showed significance differences in all three planes, (Class I: p=0.041, Class II: p=0.043, Class III: p=0.013), Lower anterior dental height (LADH) showed no statistically significant differences across any class of malocclusion (all $p > 0.1$). In UADH, Class I and III exhibited lower values in horizontal compared to normal, while Class I and II showed lower UADH in vertical compared to horizontal. For UPDH, Class III showed lower values in vertical compared to normal, whereas Class II and III showed lower UPDH in vertical compared to horizontal. In LPDH, a significant reduction was found in Class III individuals with vertical patterns compared to horizontal.

Conclusion

Significant differences were mainly observed between horizontal and vertical growth patterns in Class II and III. In class I, differences were notable between normal to horizontal and horizontal to vertical growth patterns.

Keywords

Dentoalveolar height; growth pattern; skeletal malocclusions

INTRODUCTION

The sagittal discrepancy is manifested as skeletal Class I, II, or III malocclusion whereas vertical discrepancy are classified as normodivergent, hypodivergent, or hyperdivergent profile. During the vertical facial growth, the teeth erupt into the space thus providing to them by the established skeletal patterns.[1,2] Dentoalveolar segment has the innate capability of adapting to the primary established or developing skeletal dysplasia,[3,4] known as dentoalveolar compensation. They are also related to varying degrees of dentoalveolar compensations.[4]

Components of dentoalveolar compensation are vertical development of basal and dentoalveolar height and the impact of incisor inclination.[4-7] Dentoalveolar height refers to the vertical height of the teeth along with its alveolar housing. For intrusion and extrusion, we need to identify the anterior and posterior dentoalveolar height being an important constituent in diagnosis and treatment planning of different malocclusions. Some study showed dentoalveolar compensation in vertical and horizontal growth pattern [7,8] while others show no association.[9] Studies on relationship between vertical and dentoalveolar characteristics provides valid results of cephalometric measurements in predicting patient growth and increased quality of treatment and prognosis.[10]

This is an important factor in planning orthodontic treatment because, in addition to affecting the maxillofacial system's growth, the face type also affect the selection of the anchorage setup in orthodontic treatment.[11] Various studies have shown conflicting results.[12-14] Aim of this study was to determine the relationship of dentoalveolar heights among skeletal malocclusion with different growth patterns.

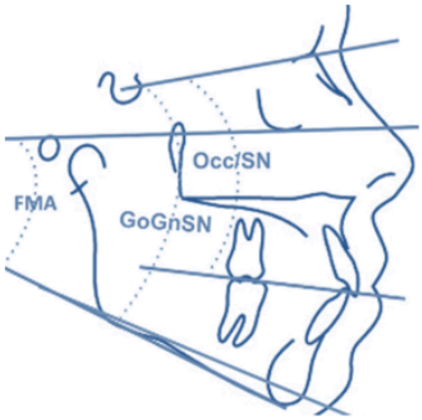

Figure 1. FMA and SN-GOGN angle

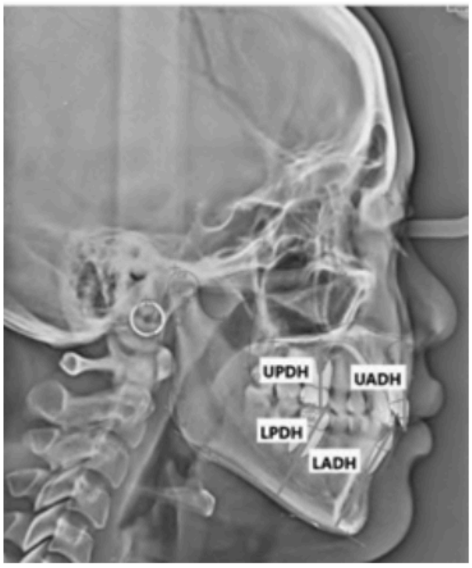

Figure 2. Dentoalveolar height measurements. LADH: Lower Anterior Dental Height; LPDH: Lower Posterior Dental Height; UADH: Upper Anterior Dental Height; UPDH: Upper Posterior Dental Height

METHODS

This is an observational, cross-sectional study. Ethical clearance (Reference No: 641(6-11) E2 080/081 was obtained from the Institutional Review Committee of Maharajgunj Medical Campus, Institute of Medicine, Kathmandu, Nepal.

Routine radiographs of 180 patients undergoing orthodontic treatment with skeletal Class I, skeletal Class II and skeletal Class III were collected as samples adopting convenient sampling method, for time period of 9-12 months, from Department of Orthodontics and Dentofacial Orthopaedics, Tribhuvan University Teaching Hospital, Maharajgunj Medical Campus, Institute of Medicine, Kathmandu, Nepal. All the selected cephalometric x-rays were hand traced and grouped into Class I, Class II, Class III based on Steiner's ANB Angles. normal, horizontal and vertical growth patterns were grouped based on Steiner's SN-GoGn Angle and Tweed's FMA angle. (Figure 1). SN Corrections will be applied as needed while selecting the cephalometric samples if the inference of FMA differs than SN-GoGn. A total sample size of 180 was derived based on sample size calculation formula $N=(Z\alpha+Z\beta)^2 X SD^2/(X_1-X_2)$.[2] Nine groups were formed consisting of normal, horizontal and vertical plane in each classification of malocclusions[16]. Total sample size of 180 was proportionately included in the study.

Dentoalveolar height measurements were done as LADH, lower anterior dental height, LPDH, lower posterior dental height, UADH, upper anterior dental height,UPDH, upper posterior dental height.(Figure 2). Subject with age above 18 years, presence of all permanent dentition, good quality cephalometric

Table 1. *Class I, II, and III categories based on Growth Pattern, Gender, and Age Group*

Category	Group	Class I	Class II	Class III	Total
Gender	Female	38 (46.30%)	27 (32.90%)	17 (20.70%)	82 (45.56%)
	Male	44 (44.90%)	40 (40.80%)	14 (14.30%)	98 (54.44%)
Age Group	18–20	47 (53.40%)	29 (33.00%)	12 (13.60%)	88 (48.89%)
	Above 20	35 (38.00%)	38 (41.30%)	19 (20.70%)	92 (51.11%)
Growth Pattern	Normal	33 (40.20%)	28 (41.80%)	17 (54.80%)	78 (43.33%)
	Horizontal	39 (47.60%)	20 (29.90%)	10 (32.30%)	69 (38.33%)
	Vertical	10 (12.20%)	19 (28.40%)	4 (12.90%)	33 (18.33%)

radiograph with easily identifiable landmarks and absence tooth agenesis or previous extractions were the inclusion criteria whereas, previous orthodontic treatment and jaw surgery and cleft lip and palate or any craniofacial anomalies were the exclusion criteria in this study.

To check inter-observer reliability, Intraclass Correlation Coefficient (ICC) test was used. Analyses was performed using SPSS 21(IBM Corp. Released 2012). One-factor analysis of variance (ANOVA) was used to compare means of measurements between different skeletal patterns. Post hoc multiple comparison was performed with Tukey test when ANOVA yielded significant difference. P values < 0.05 was considered to be significant. Descriptive statistics was used to calculate mean, minimum, and maximum values standard deviations.

RESULTS

The male were 44% in class I malocclusion, 40% in class malocclusion and 54% in class III malocclusion whereas the female samples were 46% in class I, 32 in class II malocclusion and 45% in class III malocclusion.

UADH showed significant differences in all three classes (Class I: p=0.041, Class II: p=0.043, Class III: p=0.013), LADH showed no statistically significant differences across groups in any class (all p > 0.1), UPDH showed significant differences in Class II and III (p=0.025 and p=0.001 respectively) and LPDH showed a significant difference (p=0.012) only in Class III (Table 2).

Post hoc comparisons across dentoalveolar height measurement for skeletal Classes I, II, and III

Table 2. *Dentoalveolar height in different saggital skeletal malocclusion with three different growth patterns*

Category	Group	Class I		Class II		Class III	
		Mean	SD	Mean	SD	Mean	SD
UADH	Normal	26.76	3.31	27.03	2.74	25.21	3.89
	Horizontal	25.12	3.35	25.92	4.79	21.4	2.51
	Vertical	27.4	1.64	28.71	2.34	26.25	1.66
	P-value	0.041*		0.043*		0.013*	
LADH	Normal	39.62	3.89	41.26	3.66	39.91	4.37
	Horizontal	40.62	4.42	40.6	4.66	37.1	4.25
	Vertical	40.4	5.94	43.15	3.95	42.13	5.85
	P-value	0.62		0.13		0.13	
UPDH	Normal	22.24	2.9	22.62	2.51	20.09	2.06
	Horizontal	22.51	3.7	21.37	3.39	19.85	1.27
	Vertical	23.05	2.3	23.81	2.16	24.25	2.06
	P-value	0.792		0.025*		0.001*	
LPDH	Normal	30.74	3.51	31.21	3.64	29.85	2.93
	Horizontal	31.55	3.89	31.2	4.09	26.45	3.32
	Vertical	30.3	4.47	33.52	3.62	32.38	5.66
	P-value	0.533		0.085		0.012*	

Table 3. Post-hoc Comparison showing multiple comparison of dentoalveolar height in different Sagittal skeletal malocclusion with three different growth patterns.

Category	Group 1	Group 2	Class I		Class II		Class III	
			Mean Diff	P-value	Mean Diff	P-value	Mean Diff	P-value
UADH	Normal	Horizontal	1.63	0.034*	1.11	0.80	3.80	0.023*
	Normal	Vertical	-0.63	0.581	-1.67	0.30	-1.04	1.000
	Horizontal	Vertical	-2.27	0.048*	-2.78*	0.03	-4.85	0.059
LADH	Normal	Horizontal	-1.00	1.000	0.66	1.00	2.81	0.389
	Normal	Vertical	-0.77	1.000	-1.89	0.36	-2.21	1.000
	Horizontal	Vertical	0.22	1.000	-2.55	0.16	-5.02	0.211
UPDH	Normal	Horizontal	-0.26	1.000	1.25	0.36	0.23	1.000
	Normal	Vertical	-0.80	1.000	-1.19	0.43	-4.16	0.001*
	Horizontal	Vertical	-0.53	1.000	-2.44*	0.02	-4.40	0.001*
LPDH	Normal	Horizontal	-0.80	1.000	0.01	1.00	3.40	0.059
	Normal	Vertical	0.44	1.000	-2.31	0.13	-2.52	0.596
	Horizontal	Vertical	1.25	1.000	-2.32	0.17	-5.92	0.021*

revealed several significant findings (Table 3). In UADH, Class I and III exhibited lower values in horizontal compared to normal (p = 0.034, p = 0.023), while Class I and II showed lower UADH in vertical compared to horizontal (p = 0.048, p = 0.039). No significant differences were observed in LADH. For UPDH, Class III showed lower values in vertical compared to normal (p = 0.001), and both Class II and III showed lower UPDH in vertical compared to horizontal (p = 0.002, p = 0.001). In LPDH, a significant reduction was found in Class III individuals with vertical patterns compared to horizontal (p = 0.021).

DISCUSSION

Our study found significant variation in UADH and UPDH across different growth patterns in Class II and III, while LADH remained unaffected. These findings align with those of Islam et al.[11], who demonstrated greater dentoalveolar heights in hyperdivergent subjects, particularly in the posterior segments.

It has been proposed that this increase is an adaptive mechanism allowing the teeth to erupt further to compensate for the downward growth of the jaws in vertical growers[12,13]. Yousif[13] and Hasan[14] also observed a positive correlation between lower anterior facial height (LAFH) and molar dentoalveolar height, indicating that vertical growth direction influences posterior dentoalveolar dimensions. Ardani et al.[15] further supported this by showing that skeletal Class I subjects with vertical growth patterns exhibited increased molar eruption, contributing to posterior height compensation. In our study, Class III vertical growers demonstrated reduced LPDH, contrary to expectations. This could be due to clockwise mandibular rotation in vertical growers, which limits the vertical eruption of posterior mandibular teeth[18,19] Mandibular clockwise rotation is mainly associated with backward displacement and lower position of the mandible, decreasing the gained space for vertical eruption of posterior teeth resulting in occlusal instability.[19]

Ligthelm-Bakker et al.[20] demonstrated that vertical growth of the anterior face is tightly linked to dentoalveolar vertical development, particularly in the incisal region. This supports our finding that UADH varies with growth pattern and suggests that anterior dental heights adapt to maintain overbite relationships despite skeletal divergence. The lack of significant differences in LADH across all groups suggests that anterior mandibular teeth might be influenced lightly by skeletal vertical pattern and more tightly regulated in their eruption path. This may be due to constraints from stronger muscular of lower lip and tongue, limiting excessive vertical eruption compared to posterior teeth. [11,14,16,17]

Overall, this study supports a concept that dentoalveolar heights are not static entity but are highly influenced by vertical skeletal dynamics. These findings suggest the need for individualized treatment planning, with respect to anchorage management, vertical dimension control, and prolonged stability of occlusion in patients with different skeletal growth pattern.

CONCLUSION

Significant differences were mainly observed between horizontal and vertical growth patterns in Class II and Class III. In class I, notable differences were notable between normal to horizontal, and horizontal to vertical growth patterns. Understanding the knowledge on relationship between dentoalveolar height and growth patterns helps orthodontist to appropriately plan the treatment of malocclusions. By doing so excessive complications can be prevented.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

AUTHOR CONTRIBUTIONS

RY, NY, AY: Research concept, proposal writing, data collection, manuscript preparation and finalization, article submission

DRJ: Data analysis, correction

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