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ORIGINAL ARTICLE

CORRELATION BETWEEN MOLARS ANGULATION, OVERBITE AND VERTICAL SKELETAL PATTERN

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ABSTRACT

OBJECTIVE: To determine the correlation between molars angulation, overbite and vertical skeletal pattern.

METHODS: This descriptive cross-sectional study was conducted from June to August 2019. Pretreatment records (lateral cephalograms and dental models) of 81 individuals were selected from the database of the Orthodontics Department. Overbite was measured from dental casts with a ruler and the values were recorded in both millimeter readings and percentages. Angulation of molars and the vertical skeletal pattern was evaluated from the lateral cephalograms. Correlation among molars angulation, overbite and vertical skeletal pattern was measured with the help of Pearson's correlation.

RESULTS: Out of 81 patients, 39 (48.1%) were males and 42 (51.9%) were females. Mean age of patients was 17±3 years. Mean angular measurements for upper 2nd molar angulation, upper 1st molar angulation, lower 2nd molar angulation and lower 1st molar angulation were 79.77±7.324, 82.38±5.967, 86.94±6.837, 82.38±6.638 degrees respectively. Mean linear measurements for posterior facial height (PFH), lower anterior facial height (LAFH), Jaraback's Ratio (PFH/AFH), lower anterior facial height percentage (LAFH/PFH) were 74.70±7.410, 62±6.4502, 66.63±5.769, 55.24±3.6272 and 3.414±2.1727 respectively. A positive, significant correlation was found between angulation of lower 2nd molars and overbite. Correlation between angulation of lower molars, PFH and Jaraback,s ratio was positive and significant. Similar relationship was also determined between upper molars and vertical skeletal pattern.

CONCLUSION: Angulation of upper and lower molars changed according to vertical skeletal pattern of an individual. Angulation of lower molars also changed with the overbite. Such a correlation was not found between upper molars and overbite.

KEYWORDS: Overbite (MeSH); Cephalometry (MeSH); Molar Angulation (Non-MeSH); Posterior Discrepancy (Non-MeSH)

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INTRODUCTION

Human occlusion is a dynamic entity. The various aspects of dental occlusion change with respect to time. Molar angulation is one of the associated features of this dynamic phenomenon. Andrews LF, included crown angulations in his six keys to normal occlusion and suggested that crown angulation is an important factor in obtaining a proper occlusal relationship. Angulation of upper and lower molars varies considerably among individuals and is considered to be a multifactorial phenomenon.[2-4] Bjork and Skieller demonstrated in their implant studies that the direction of eruption of teeth changes in order to compensate for changes in the position of jaws, because the amount and direction of growth show considerable variability.[5]

The angulation of upper and lower molars changes in order to compensate for variation in the growth of apical bases in both sagittal and vertical directions. Mandibular molars tend to be more stable with respect to developmental stages, while maxillary molars tend to tip more mesially with advancing age.[6] Orthodontic treatment is also associated with changes in molar angulations. Tipping of upper molars in a mesial direction is a common finding during orthodontic treatment.[7] Patients in whom maximum anchorage is required, tipping of 1st molars mesially indicates anchorage or space loss. Such an unfavorable change in molar angulation is associated with changes in the occlusal plane and less than optimal treatment results.[8]

The lack of space in the dental arch for complete eruption of 3rd molar results in increased molar heights accompanied by increased anterior pressure on the 2nd molar that may lead to anterior crowding. This concept is termed as posterior dentoalveolar discrepancy.[9-11] The upper and lower molars tend to incline mesially if there is insufficient space for the lower third molar.[11,12] The mesial angulation of posterior teeth may lead to development of occlusal interferences and a change in dental overbite. Mesial angulation of posterior teeth is most commonly seen in patients with anterior open bite, and correcting the angulation of posterior teeth has led to the correction of open bite malocclusion.[13]

Most of the studies in the literature have been carried out to study the influence of 3rd molars on angulation of posterior teeth, vertical skeletal pattern and overbite.[9-12] The results of these studies have a minimal clinical implication in cases where 3rd molars are absent. Finding a correlation between upper and lower molars angulation (in cases with absent 3rd molars), overbite and vertical skeletal pattern could help in achieving important results. These results could have a useful clinical implication in daily orthodontic practice.

The purpose of this study was to determine the correlation between upper and lower molars angulation, vertical skeletal pattern and overbite in orthodontic patients.

TABLE I:DEFINITIONS OF CEPHALOMETRIC POINTS AND ANGLES

Cephalometric Points and Angles		Definition
Angular measurements	Maxillary molars angulation	The angle between the maxillary first molar axis (intercuspid groove, bifurcation) and the palatal plane (ANS-PNS).[16]
	Mandibular molars angulation	The angle formed by the mandibular 1st and 2nd molar axis (intercuspid groove, bifurcation) and the mandibular plane (Go-Gn).[16]
Linear measurements	Lower anterior facial height (LAFH)	The linear distance between anterior nasal spine (ANS) and menton (Me) in mm.[18]
	Posterior facial height (PFH)	The linear distance between nasion (N) and menton (Me).[9]
	Total anterior facial height	The linear distance between nasion (N) and menton (Me).[9]
	Overbite	The distance between incisal edges of maxillary and mandibular incisor, perpendicular to occlusal plane.[15]
	Jaraback,s ratio	The ratio of posterior facial height (PFH) to anterior facial height (AFH)[16]

TABLE II: DESCRIPTIVE STATISTICS OF STUDY SUBJECTS

Variables		Range	Minimum	Maximum	Mean	Standard deviation
Angular measurements	MX7.PP	38	63	101	79.77	7.324
	MX6.PP	27	72	99	82.38	5.967
	MD7.MP	33	71	104	86.94	6.837
	MD6.MP	35	65	100	82.38	6.638
Linear measurements	PFH	46	49	95	74.70	7.410
	LAFH	34	50	84	62	6.4502
	Jaraback,s ratio	33.6	50	83.6	66.63	5.769
	LAFH%	18.3	46.7	65.0	55.24	3.6272
	Overbite	13	0	13	3.414	2.1727

MX7.PP= upper 2nd molar angulation, MX6PP= upper 1st molar angulation, MD7.MP= lower 2nd molar angulation, MD6.MP= lower 1st molar angulation, PFH posterior facial height, LAFH = lower anterior facial height, Jaraback,s Ratio= pfh/afh, LAFH%= lower anterior facial height percentage (LAFH/PFH)

TABLE III: CORRELATION BETWEEN MOLARS ANGULATION AND OVERBITE

Variables		Overbite	
		r	*p*-value
Upper molars angulation	MX7.PP	0.013	0.907
	MX6.PP	0.044	0.694
Lower molars angulation	MD7.MP	0.313	0.004**
	MD6.MP	0.133	0.234

MX7.PP= upper 2nd molar angulation, MX6PP= upper 1st molar angulation, MD7.MP= lower 2nd molar angulation, MD6.MP= lower 1st molar angulation,

METHODS

This descriptive cross-sectional study was conducted from June to August 2019, at Department of Orthodontics, Sardar Begam Dental College, Gandhara University, Peshawar, Pakistan. The ethical approval was obtained from Ethical Review Committee of the institute. Pretreatment records of 81 individuals were selected by using consecutive sampling. The records were obtained from the database of the department and included lateral cephalograms and dental casts. The inclusion criteria were presence of all permanent teeth, no anomalies of crown morphology, complete set of records (lateral cephalogram and dental casts) and no history of previous orthodontic treatment.

Data was collected from pretreatment records of the patients seeking orthodontic treatment. The lateral cephalograms were taken with teeth in maximum intercuspation and lips at rest. Imaging was performed with digital cephalometric panoramic equipment (CRANEX™3D, SOREDEX, Finland). The lateral cephalograms were traced on acetate sheets and measured by a single investigator. The definitions of cephalometric points, linear and angular measurements are shown in Table I The mandibular plane and palatal planes were drawn according to the definitions given by Downs.[14] Overbite was measured as a vertical distance in millimeters between incisal edges of upper and lower incisors.[15] The values were recorded in both percentages and millimeter readings from the dental casts. Vertical skeletal pattern was evaluated on lateral cehphalogram. Three linear readings; anterior facial height (AFH), posterior facial height (PFH) and lower anterior facial height (LAFH) were calculated. The angulation of upper and lower molars was measured by the angle formed by the molars long axis (intercuspid groove- bifurcation) and the palatal plane and mandibular plane respectively.[16]

All the statistical analysis was done using SPSS version 21. Descriptive Statistics i-e means, standard deviation and ranges were calculated for all the quantitative variables used in the study. Correlation among molars angulation and other variables (overbite and vertical skeletal pattern) were measured with the help of Pearson's product moment correlation(r). Statistical significance was pre-determined at $p < 0.05$.

RESULTS

Descriptive statistics of all the measurements used in the study are given in Table II. Out of 81 patients 39 (48.1%) were males and 42 (51.9%). Mean age of the patients was 17.72±3.80 years.

A positive and highly significant correlation was found between angulation of lower 2nd molars and overbite. Lower 2nd molars tend to incline mesially in deep bite patients. Correlation between lower 1st molars angulation and overbite was non-significant (Table III).

There was no effect of upper molars angulation on the overbite. Correlation between upper molars angulation and overbite was very weak and non-significant (Table III). Angulation of upper 1st and 2nd molars also changed with the vertical skeletal pattern of growth. A positive and significant correlation was found between angulation of upper molars and posterior facial height. The upper molars were more mesially inclined in hypodivergant individuals (Table IV).

TABLE IV: CORRELATION BETWEEN UPPER MOLARS ANGULATION AND VERTICAL SKELETAL PATTERN

Upper 2nd molar angulation	Vertical skeletal pattern	r	p-value	Upper 1st molars angulation	Vertical skeletal pattern	r	p-value
MX7.PP	LAFH	0.038	0.737	MX6.PP	LAFH	-0.125	0.263
	PFH	0.392	0.000**		PFH	0.245	0.026*
	Jaraback,s ratio	-0.050	0.002		Jaraback,s ratio	0.215	0.054
	LAFH%	-0.050	0.654		LAFH%	-0.232	0.036*

MX7.PP= upper 2nd molar angulation, MX6PP= upper 1st molar angulation, MD7.MP= lower 2nd molar angulation, MD6.MP= lower 1st molar angulation, PFH posterior facial height, LAFH = lower anterior facial height, Jaraback,s Ratio= pfh/afh, LAFH%= lower anterior facial height percentage (LAFH/PFH)

TABLE V: CORRELATION BETWEEN LOWER MOLARS ANGULATION AND VERTICAL SKELETAL PATTERN

Lower 2nd molar angulation	Vertical skeletal pattern	r	p-value	Lower 1st molars angulation	Vertical skeletal pattern	r	p-value
MD7.MP	LAFH	-0.026	0.063	MD6.MP	LAFH	-0.342	0.002**
	PFH	0.198	0.026*		PFH	0.199	*0.027
	Jaraback,s ratio	-0.372	0.001**		Jaraback,s ratio	0.375	0.001**
	LAFH%	-0.199	0.073		LAFH%	-0.350	0.001**

MD7.MP= lower 2nd molar angulation, MD6.MP= lower 1st molar angulation, PFH posterior facial height, LAFH = lower anterior facial height, Jaraback,s Ratio= pfh/afh, LAFH%= lower anterior facial height percentage (LAFH/PFH)

Angulation of lower molars also changed with the vertical skeletal pattern. The lower 1st and 2nd molars were mesially inclined in low angle cases. A positive and significant correlation was found between lower molars angulation, PFH and Jaraback,s ratio (Table V).

DISCUSSION

Crown angulation is one of the major factors in achieving proper occlusal relationship among upper and lower teeth.[1] Angulation of upper and lower molars should be observed carefully before the start of the treatment to achieve good interdigitation in the finishing stage of orthodontic treatment.

This study was conducted to find a correlation between molars angulation, overbite and vertical skeletal pattern. Findings of the current study showed that there was a positive correlation between angulation of lower molars and overbite. Increased overbite was found in individuals with mesial angulation of lower 2nd molars. Similar results were found in a study conducted by Aron Aliaga et al.[16] They reported that in individuals with a deep bite malocclusion the lower 1st and 2nd molars were mesially inclined as compared to individuals with open bite. Rijpstra et al[10] showed in a review study that the molars were supra erupted and mesially inclined in patients with open bite malocclusion. The mesial angulation of molars and their supra eruption is mainly caused by inadequate space available for 3rd molars (posterior space deficiency). These findings are in contradiction to our study, because the relationship between posterior space discrepancy, overbite and posterior teeth angulation is variable. Some studies have suggested that the effect of posterior space discrepancy on overbite was non significant,[9] also we haven't included 3rd molars in our study, which could lead to disagreement between the two studies. In our study there was a trend towards more mesial angulation of upper and lower molars in hypodivergant patients. The results of current are in agreement with the study carried out by Bjork and Skieller.[5] They observed the tendency for molars to incline distally in hyperdivergant patients. Hong Su et al[6] demonstrated that molars compensate for skeletal growth patterns in sagittal and vertical directions. According to their study the upper and lower molars were most distally tipped in hyperdivergant patients. An opposite trend for compensation of angulation was observed in low angle cases, which is in accordance with the present study. Such finding may help in explaining loss of anchorage in high angle cases.

Kim[4] suggested that in open bite patients especially with steep mandibular plane, palatal plane and short posterior vertical facial dimension the terminal molars are significantly inclined mesially. These observations are different from the current study. The difference in the pattern of molar angulation in both these studies may be attributed to genetic factors because; tooth formation and eruption pathway is genetically determined.[17]

Our results have shown that the angulation of upper molars varies according to the vertical growth pattern of an individual. Based on results of our study we would recommend that in high angle cases uprightining of the distally inclined molars with straight wires should be done carefully. The mesial tipping of upper molars in such cases may lead to loss of anchorage and occlusal instability.[6] Correcting the angulation of compensatory tipped molars into ideal angulation with a straight wire appliance can also lead to exaggeration of class II molar relationship and exaggerated curve of occlusion.[8]

CONCLUSION

1. Angulation of upper and lower molars changed according to vertical skeletal pattern of an individual.
2. Upper and lower molars were more mesially inclined in hypodivergant patients. An opposite trend for molars angulation was found in hyperdivergant patients.
3. Increased overbite was found in individuals with more mesial angulation of lower 2nd molars. No such relationship was found in the upper arch.

LIMITATIONS OF THE STUDY

1. The study had a smaller sample size. For more predictable results, a larger study sample will be needed.
2. The correlations between all the variables were weak to moderate; therefore, a clearer outcome cannot be stated.
3. The clinical implications of the current study are limited.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:

YIS: Concept and study design, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published.

NA & IT: Concept and study design, drafting the manuscript, critical review, approval of the final version to be published.

ZH: Acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published.

HRK: Acquisition of data, drafting the manuscript, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Authors declared no conflict of interest

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request