

THE CORRELATION OF OVERBITE WITH SKELETAL, DENTAL AND SOFT TISSUES CHARACTERISTICS

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ABSTRACT

The objective was to determine correlation of the dental, skeletal and soft tissue characteristics with overbite and gender dimorphism. Lateral cephalographs were traced manually for 170 subjects who comprised of 80 males and 90 females. The subjects were divided into three groups based on the amount of overbite recorded on the subject's dental models. Various angles and measurements representing the dental, skeletal and soft tissue parameters were recorded. The data were analyzed using SPSS version 20.0 for windows. Multivariate analysis of covariance and Pearson's correlation were applied to determine the difference and correlation of various skeletal, dental and soft tissues among the three overbite groups and gender of the subjects. A p value of ≤ 0.05 was taken to be statistically significant. Statistically significant difference was seen for the parameters like MxIH ($p = .003$), MxMH ($p = .05$), MnIH ($p = .001$) and MnMH ($p = .001$), angle ANB ($p = .006$), angle SNMP ($p = .001$), angle FMA ($p = .001$) and AFHR ($p = .001$), lip length ($p = .003$) and incisor stomion ($p = .001$) across the overbite groups. A negative weak but significant correlation was seen for FMA, SNMP, AFHR, MxMH, MnMH and lip length with overbite. The incisor stomion and ANB showed positive weak but significant correlation with the overbite.

The study concluded that skeletal characteristics are significantly increased in open bite group as compared to deep bite and normal overbite. The maxillary and mandibular molars showed increased heights in the open bite group. The deep bite subjects indicated significantly decreased lip length as compared to normal overbite. The incisor stomion was significantly increased in deep bite group. All the values are significantly greater in males than females.

Key Words: Overbite, Lip length, Incisor stomion

This article may be cited as: Islam Z, Shaikh A, Fida M. The Correlation of Overbite with Skeletal, Dental and Soft Tissues Characteristics. Pak Oral Dent J 2020; 40(3):149-54.

INTRODUCTION

Overbite is often expressed as the percentage of the lower incisors crown height that is overlapped by the upper incisors.¹ The two variations of the overbite are the deep bite i.e. excessive overlap of mandibular incisor, and open bite which is the lack of contact between the incisors. The treatment objective for all such patients, whether deep bite or open bite, is to achieve a normal overbite of 1 to 3 millimeters.² To correct the deep bite

to normal, several strategies are employed including intrusion of anterior teeth, extrusion of posterior teeth and flaring of the incisors.³⁻⁵ Similarly, the correction of open bite malocclusion may necessitate the intrusion of posterior or extrusion of anterior teeth^{6,7}

Several studies have been carried out to find the relationship between the overbite and various skeletal and dental characteristics.⁸⁻⁹ The compensatory ability of the dentoalveolar segment to the developing skeletal morphology has created a wide array of opinions. A normal overbite is maintained despite the varying underlying skeletal morphology. According to some investigators the excessive facial skeletal development is compensated by excessive eruption of anterior teeth in an attempt to achieve normal overbite.⁹⁻¹¹ Some studies found increases in maxillary anterior dentoalveolar dimensions in hyperdivergent patients,¹⁰⁻¹¹ whereas others found no differences.¹² According to some reports, mandibular anterior dentoalveolar dimensions were reduced in open bite patients, but other studies found

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Received for Publication: Oct 11, 2019

Revision: Dec 10, 2019

Approved: Dec 12, 2019

no differences, and even enlarged dimensions.¹⁵ On the other hand, discrepancies between dentoalveolar morphology and the underlying vertical skeletal configuration might yield a deep bite or an open bite.^{8,16}

The modern era of orthodontics focuses more on the soft tissue esthetics rather than skeletal characteristics. Therefore, it is very important to keep focus on the soft tissue relations associated with orthodontic treatment. The intrusion and extrusion of the teeth in order to achieve normal overbite can cause deleterious effects on the esthetics of face and smile if the soft tissue relations are ignored during biomechanical plan. Studies¹⁷⁻¹⁸ have shown that maxillary intrusion arches or maxillary arch wires with accentuated curves could result in flattening of the smile arc and decrease in the lip to tooth relationship. For these reasons, it is very important to determine the relationship of the hard and soft tissues for the patients with variable overbite and include in the biomechanical plan to avoid the deleterious effects on facial and smile esthetics. Various studies conducted so far have ignored the soft tissue relationship to the skeletal and dental characteristics related to overbite. Therefore, this study has been conducted to evaluate the soft tissues relationship in addition to the dental and skeletal characteristics with overbite.

MATERIAL AND METHODS

The data of the subjects were retrieved from the orthodontic records at Aga Khan University Hospital from September to November 2017. The study included 170 subjects that comprised of 80 males and 90 females. The subjects were further divided into 3 sub groups on the basis of the overbite. The three sub groups were normal overbite (1-3mm), deep bite (≥ 5 mm) and open bite (≤ -1 mm). The inclusion criteria were an age range from 14 to 20 years and fully erupted incisors and first molars. The subjects with prior orthodontic treatment, crown fractures, fillings and craniofacial anomalies/syndromes were excluded from the study.

The lateral cephalographs of the patients were traced manually and the various parameters were recorded as shown in Fig.1. The incisor stomion was recorded from the patient record files. Overjet and overbite were recorded from the models using overjet scale. The data were analyzed with SPSS version 20.0 for windows. Multivariate analysis of variance was applied to determine the difference in skeletal, dental and soft tissue variable among three overbite groups and gender of patients. Pearson's correlation was applied to assess the relationship of various skeletal, dental and soft tissue variables with the overbite. Cronbach's alpha test was applied to assess the inter examiner reliability. The *p* value of ≤ 0.05 was taken to be statistically significant.

RESULTS

The age of the subjects in various groups are shown in Fig 2 and were found to be most comparable. The skeletal variables are shown in Table 1, and statistically significant differences were found for angles ANB, SNMP and FMA and the anterior face height ratio among the three overbite groups. The results showed that the subjects in normal overbite group were skeletal Class I and had normal facial heights. The subjects in deep bite group had skeletal Class II and hypodivergent

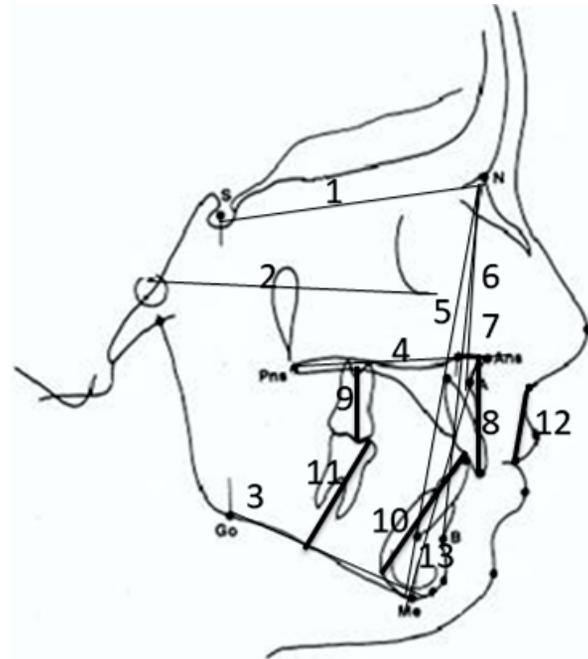


Fig 1: Cephalometric skeletal, dental and soft tissue measurements.

1 = SN plane, 2 = Frankfurt horizontal plane, 3 = Mandibular plane, 4 = Palatal plane, 5 = Total anterior face height, 6 = NA plane, 7 = NB plane, 8 = MxIH, 9 = MxMH, 10 = Mn IH, 11 = MnMH, 12 = Lip Length, 13 = Lower anterior facial height

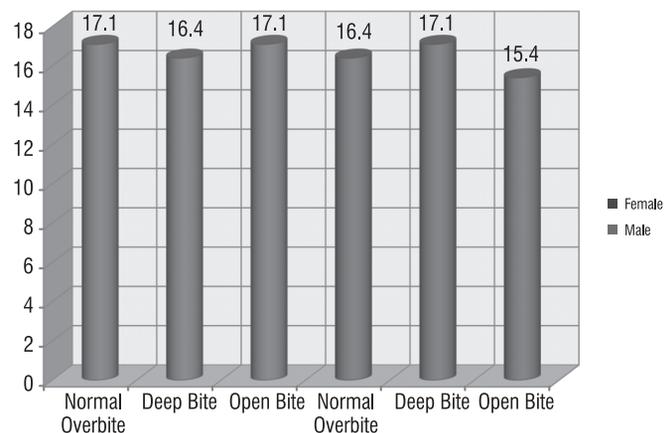


Fig 2. Age of the subjects in various overbite groups
N = 170

TABLE 1: COMPARISON OF THE SKELETAL VARIABLES AMONG THE THREE OVERBITE GROUPS AND BETWEEN THE GENDERS OF SUBJECTS.

Variables	Gender	Normal Over-bite Mean \pm SD	Deep Bite Mean \pm SD	Open Bite Mean \pm SD	P value
ANB	M	3.86 \pm 2.6	5.25 \pm 2.6	0.55 \pm 5.5	.006* (across group)
	F	3.95 \pm 2.5	4.82 \pm 3.4	5.23 \pm 3.7	.007* (across gender)
SNMP	M	30.93 \pm 6.2	28.70 \pm 5.2	34.50 \pm 7.3	.001* (across group)
	F	32.87 \pm 5.1	26.48 \pm 5.3	36.63 \pm 6.7	.508 (across gender)
FMA	M	26 \pm 5.7	22.93 \pm 4.9	29.50 \pm 7.3	.001* (across group)
	F	27.93 \pm 4.6	21.37 \pm 4.7	31 \pm 7.1	.493 (across gender)
AFHR	M	57.74 \pm 2.7	56.40 \pm 3.2	58.37 \pm 3.5	.001* (across group)
	F	56.83 \pm 2.5	55.67 \pm 2.6	58.65 \pm 2.1	.296 (across gender)

N = 170

Two Way ANOVA

Level of significance = $\leq 0.05^*$

TABLE 2: COMPARISON OF THE DENTAL VARIABLES AMONG THE THREE OVERBITE GROUPS AND BETWEEN THE GENDER OF SUBJECTS.

Variables	Gender	Normal Over-bite Mean \pm SD	Deep Bite Mean \pm SD	Open Bite Mean \pm SD	P value
MxIH	M	29.7 \pm 2.9	29.4 \pm 2.9	29.5 \pm 2.9	.531 (across group)
	F	28.7 \pm 2.5	27.9 \pm 3.9	27.7 \pm 3.9	.003* (across gender)
MxMH	M	23.2 \pm 3.5	22.2 \pm 2.7	24.8 \pm 3.9	.006* (across group)
	F	22.9 \pm 2.6	21.6 \pm 2.8	22.9 \pm 3.2	.058* (across gender)
MnIH	M	43.1 \pm 3.2	42.6 \pm 2.9	45.5 \pm 3.9	.140 (across group)
	F	41.1 \pm 2.3	42.2 \pm 2.7	41.1 \pm 3.4	.000*(across gender)
MnMH	M	34.1 \pm 3.7	32.4 \pm 2.5	35.3 \pm 4.2	.008* (across group)
	F	31.3 \pm 2.7	31.4 \pm 2.6	32.3 \pm 3.2	.000* (across gender)
UI – SN	M	109.1 \pm 7.9	105.5 \pm 1.9	112.8 \pm 6.2	.435 (across group)
	F	108.3 \pm 6.3	110.3 \pm 2.2	107.6 \pm 7.5	.791 (across gender)
IMPA	M	99.9 \pm 8.1	98.5 \pm 7.1	93.2 \pm 6.2	.019* (across group)
	F	96.3 \pm 8.1	98.1 \pm 9.1	95.5 \pm 8.4	.652 (across gender)
Overjet	M	4.6 \pm 2.8	6.6 \pm 3.5	2.3 \pm 5.3	.000* (across group)
	F	3.6 \pm 2.3	7.2 \pm 4.4	5.1 \pm 4.8	.192 (across gender)

N = 170

Two Way ANOVA

Level of significance = $\leq 0.05^*$

tendency. In the open bite group, the male subjects were skeletal Class I while females had Class II tendency however, both showed hyperdivergent facial profiles in vertical dimension.

Table 2 shows the difference in the dental variables among the three overbite groups. A statistically significant difference was found for the variables like MxMH, MnMH, IMPA and overjet. All the dentoalveolar heights were significantly greater in male as compared

to female subjects. Post Hoc Bonferroni test showed that the MxMH ($p = .012$) and MnMH ($p = .024$) were significantly greater in open bite group as compared to deep bite group. The overjet was significantly greater in deep bite group as compared to normal overbite ($p = <.001$) and open bite ($p = <.001$) groups. The lower incisor inclination was also found to be significantly increased in deep bite group as compared to open bite group ($p = .046$).

TABLE 3: COMPARISON OF THE SOFT TISSUE VARIABLES AMONG THE THREE OVERBITE GROUPS AND BETWEEN THE GENDER OF SUBJECTS.

Variables	Gender	Normal Over-bite Mean \pm SD	Deep Bite Mean \pm SD	Open Bite Mean \pm SD	P value
Lip Length	M	21.6 \pm 3.1	20.4 \pm 2.3	21.4 \pm 2.3	.003* (across group)
	F	21.1 \pm 2.1	19.1 \pm 2.6	20.1 \pm 2.8	.008* (across gender)
Incisor Stomion	M	4.4 \pm 2.1	5.6 \pm 1.8	2.7 \pm 2.7	.000* (across group)
	F	3.8 \pm 1.7	5.4 \pm 3.1	4.1 \pm 2.1	.643(across gender)

N = 170

Two Way ANOVA

Level of significance = $\leq 0.05^*$

TABLE 4: CORRELATION OF THE DENTAL SKELETAL AND SOFT TISSUE VARIABLES WITH THE OVERBITE.

Variables	Overbite	
	r value	p value
Age	.121	.117
Overjet	.332	.000**
UI – SN	-.043	.181
IMPA	.132	.087
MxIH	.054	.486
MxMH	-.187	.015*
MnIH	.033	.670
MnMH	-.166	.031*
ANB	.184	.016
SNMP	-.478	.000**
FMA	-.485	.000**
AFHR	-.312	.000**
Lip Length	-.146	.057
Incisor Stomion	.346	.000**

N = 170

Pearson's correlation

Correlation is significant at 0.05*

Correlation is significant at 0.01**

TABLE 5: INTER EXAMINER RELIABILITY FOR MEASUREMENTS.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.893	.890	8

N = 20

Cronbach's alpha test

Table 3 represents the comparison of the upper lip length and incisor stomion among the overbite groups as well as gender dimorphism. A statistically significant difference was seen for the incisor stomion and lip length among the three overbite groups. The lip length was significantly greater in male as compared to the female subjects. Post Hoc Bonferroni test showed the lip length to be significantly decreased in deep bite group as compared to normal overbite group ($p = .004$). However, the incisor stomion was found to be significantly greater in deep bite group as compared to normal overbite ($p = .003$) and open bite groups ($p = <.001$).

The correlation of the various skeletal, dental and soft tissue variables with overbite is shown in Table 4. The MxMH and MnMH showed significant but inverse linear correlation with the overbite. The vertical skeletal variables <SNMP, FMA and AFHR showed negative weak to moderate but highly significant correlation with overbite. However, a positive weak but significant correlation was found for the overbite with sagittal skeletal variable (<ANB). The lip length showed negative weak but significant correlation with the overbite. The correlation for incisor stomion with overbite was positive weak but highly significant.

The inter examiner reliability was assessed by Cronbach's alpha test (Table 5). There was a strong reliability between the values which excludes the measurement errors in the study

DISCUSSION

Most of the studies^{2,4,7-11} have focused on the skeletal and dental characteristics associated with the overbite. They have not considered the relationship of the incisors to the upper lip which is affected during the orthodontic correction of the overbite.^{17,18} The present study in addition to dental and skeletal characteristics, also investigate the lip to tooth relation and upper lip length with the various overbite groups. This will help to understand and devise a biomechanical plan that

will be most compatible with the esthetic needs of the patients.

The results of the study show that the upper lip length is significantly decreased in the deep bite group as compared to the normal overbite group. The male subjects have larger lip length than the females. The gender difference has been also found by Peck et al²⁵ in their study with similar variance. In the present study, the incisor stomion was found to be significantly increased in the deep bite group as compared to both the normal overbite and open bite groups. Taken together, the short upper lip and increased incisor stomion favors the intrusion of the upper incisors in the subjects with deep bite. The decrease in the lip length may be either a genotypic expression or the compression of the lip due to short skeletal morphology. To further elucidate the authentic results of these findings, direct measurements of the upper lip on live subjects are needed to be obtained for comparison in the overbite groups.

Beckmann et al⁸ in their study showed smaller lower facial heights for the deep bite group and larger values for the open bite group. According to them, the lower facial height is negatively related to the overbite. Similarly, the results of this study show a negative relation between anterior facial height ratio and overbite so that the open bite group show greater facial heights and the deep bite group showed smaller facial heights. Moreover, the mandibular plane angle was also shown to be significantly greater in open bite group as compared to the deep bite and normal overbite groups. This shows that the longer and hyperdivergent facial profile is consistent with the open bite and shorter hypodivergent facial profile characterizes the deep bite group.

Although, the dentoalveolar heights have been found in several studies¹⁹⁻²⁰ to be positively related to the vertical facial morphology, few studies^{21,22} have also shown a negative relation. This shows a wide variation in the adaptive nature of the dentoalveolar segment to the underlying skeletal morphology. When compared in various overbite groups, Ismail et al²³ found significant differences between the maxillary and mandibular anterior and maxillary posterior dentoalveolar heights. The maxillary incisors and molars heights showed a significant moderate positive correlation with overbite. In our study, we found significantly greater maxillary and mandibular molars heights in open bite group as compared to deep bite group. Furthermore, the maxillary and mandibular molars heights showed a negative weak but significant correlation with the overbite. Another study²² has also shown similar results with significant difference in maxillary and mandibular molars heights between the open bite and deep bite groups. In contrast, Kuitert et al²⁴ in their study found that the

overbite is independent of the vertical molar heights in open bite and deep bite subjects. Mandibular incisors heights were shown to be the principle determinant of overbite in short face subjects while the overbite was mainly determined by the lower facial height.

The mandibular incisors, in our study, were significantly proclined in the normal overbite group as compared to the open bite and deep bite groups. The overjet was significantly greater in the deep bite group than the other two groups. The deep bite group showed greater values for the angle ANB which reveal a Class II skeletal base relation. Therefore, the subjects with deep bite were skeletal Class II with increased overjet which may have caused the incisors to erupt more to create increased vertical overlap. Beckmann et al⁸ in their study found the maxillary incisors to be more protruded in open bite group and steeply inclined in the deep bite group. The mandibular central incisors were more protruded in the deep bite group, compared with the open bite group.

The correction of open bite and deep bite requires careful consideration of all the skeletal, dental and soft tissue factors. The results of the present study show that the open bite group is characterized by increased facial height, increased facial divergence, decrease incisor stomion and greater maxillary and mandibular molar heights. Therefore, the biomechanical plan that will be most favorable in such cases should focus on the intrusion of the molars and extrusion of the incisors. This will improve tooth to lip relation and the facial height along with achievement of normal overbite. On contrary, the deep bite is characterized by decreased of facial height and divergence, shorter upper lip, reduced maxillary and mandibular molar heights and increased incisor stomion. Hence, these characteristics favor the biomechanical plan that will produce intrusion of the maxillary incisors and extrusion of the molars.

CONCLUSIONS

- The subjects with open bite exhibit long facial skeletal characteristics whereas, the deep bite show short facial skeletal characteristics.
- The maxillary and mandibular molars are the principle determinants of the overbite.
- The upper lip length is significantly decreased in deep bite group as compared to the normal overbite group.
- The deep bite group show significantly greater incisor stomion as compared to the open bite and normal overbite groups.
- The male subjects show greater dimensions of the dental skeletal and soft tissues than the female subjects.

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