

The Size and the Form of the Frontal Midsagittal Alveolar and Basal Bone of the Maxilla and the Mandible in Relation to the Over Bite.

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Abstract

In this study, the relationships between the over bite and the structure of the frontal alveolar and basal bone were investigated. The over bite, lower face height, and the anterior alveolar and basal midsagittal cross-sectional area from the maxilla and the mandible were assessed on lateral cephalograms from (88) un-treated subjects. The open bite group showed significantly larger maxillary and mandibular alveolar and basal cross sectional areas compared with the normal over bite group. It is concluded that open bite subject with long face have a larger mandibular and maxillary alveolar height, which is more associated with elongated and narrowed shape of the symphysis.

Introduction

In the cephalometric literature, the associations between the over bite and the vertical skeletal pattern have been described many times. Several descriptions of facial structure have been used, such as skeletal open bite,⁽¹⁻⁵⁾ skeletal deep bite,^(2,3) long-face syndrome,^(4,6) short-face syndrome,⁽⁷⁾ high angle type,⁽⁸⁾ low angle type,⁽⁹⁾ hyper divergent,⁽³⁾ hypo divergent,⁽¹⁰⁾ vertical maxillary excess,⁽⁸⁾ vertical maxillary deficiency,⁽⁷⁾ cephalometrically, these descriptions are made on the basis of total and lower face height,⁽⁸⁾ gonial angle,⁽⁴⁾ ramus length,⁽⁴⁾ mandibular plane angle,⁽⁸⁾ and facial prognathism or retrognathism.⁽⁸⁾ It has become very clear that the cephalometric characteristics of a long-face structure are predominantly located below the palatal plane.^(1,4,6)

Many articles have dealt with cephalometric comparisons between groups of patients with open bite and normal over bite. Generally, anterior open bite has been defined as " that

condition where upper incisor crowns fail to overlap the incisal third of the lower incisor crowns when the mandible is brought in to full occlusion"⁽¹¹⁾ whereas, a normal over bite was defined as a certain amount of overlap between the incisors.⁽¹²⁾

A dental open bite is limited to the anterior region in an individual with good facial proportions.⁽¹⁾ A skeletal open bite, on the other hand, typically involves increased anterior facial height, a steep mandibular plane, and excessive eruption of the posterior teeth.⁽¹³⁾

Some features described as being characteristic for the skeletal open bite, compared with patients with a normal vertical skeletal pattern are large lower facial height,^(1,8,11,14-18) smaller upper/lower anterior face height ratio,^(11,14-16,19) smaller posterior facial height,^(8,16,17) large angle between the cranial base and the mandibular plane,^(11,14,16-20) and a more obtuse gonial angle.^(11,14-16)

Some investigators recorded a large dento-alveolar height in the frontal part of both jaws in patients with open bite,

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compared with patients with normal or deep bite.⁽¹⁵⁾ Several authors^(1,11,17,18) reported significant differences between patient with normal and deep bite in the dento-alveolar region of the maxilla only. Others⁽¹⁹⁾ found no differences at all, and two authors^(16,20) recorded smaller dento-alveolar height of the incisor region in patients with open bite.

A relation ship may exist between the structure of the frontal part of the maxilla and mandible and the lower face height, in such a way that in cases with open bite or a deep bite, the vertical dento-alveolar development may be insufficient to compensate for the large or small distance between the jaws.⁽²¹⁾ This possible relation ship is illustrated in fig. (I).

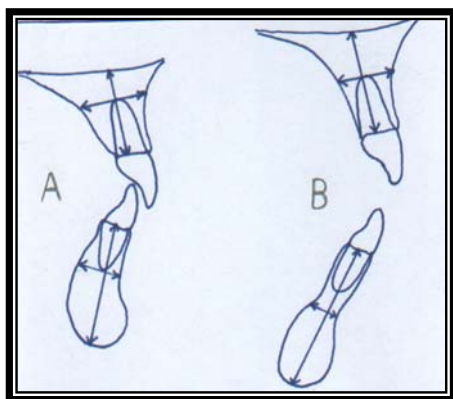


Fig.(I): Different projections of frontal alveolar and basal bone in average overbite (A), and Openbite (B).

Significant negative correlation between the lower face height and the over bite were found by Adams and Kerr⁽²²⁾ and Dung.⁽²³⁾ However, not all long-faced subjects have an anterior open bite. There fore not only the vertical size of the jaws may be related to the over bite. This is suggested by Fleming,⁽²⁴⁾ who found significant positive correlations between the over bite and dento-alveolar height.

Observations on long-faced subjects with anterior open bite

demonstrate a narrow and elongated midsagittal projection of the maxilla and the mandible in the frontal region of the jaws.⁽¹²⁾

The objective of this study was to investigate the relations between the over bite, the lower face height and the structure of the frontal alveolar process and the basal bone in the maxilla and in the mandible in persons with an open bite compared with persons with a normal over bite.

We investigated that: (1) A longer lower face is associated with larger areas of the maxillary and mandibular frontal alveolar process and basal bone, and (2) A longer lower face is associated with a narrow and elongated shape of the maxillary and mandibular frontal alveolar process and basal bone.

Special measurements were developed to investigate the form and size of the alveolar and basal bone in the anterior region of both jaws including area measurements. The fallowing hypothesis was tested: the size and the form of the frontal alveolar and basal bone of the maxilla and the mandible are related to the over bite.

Material and methods

Pretreatment cephalograms of (88) subjects (14-16 years old) were selected. All cephalograms included in the study were taken of persons of Iraqi origin. No subject had sever craniofacial disorders, such as cleft palate, bridge or extensive prosthetic appliances. The cephalograms of all subjects were traced. Most landmarks were defined according to Riolo et al.⁽²⁵⁾

For the statically analysis, the subjects of this study were divided into 2 groups based on the over bite.

The tow groups were as follows:

- 1- Subjects with a normal over bite between 2-4 mm were

selected as a control group (No. = 40).

- 2- Subjects with a negative over bite being smaller than (-1) were selected as a study group (No. = 48).

The normal over bite group was defined after careful analysis of literature. ⁽²⁶⁾ The skeletal lower face height was evaluated and the group differences were compared. For all

statistical analysis, the confidence level $p < 0.5$ was considered significant.

Skeletal cephalometric landmarks, reference lines and measurements used in the study are described in fig. (II) and (III).

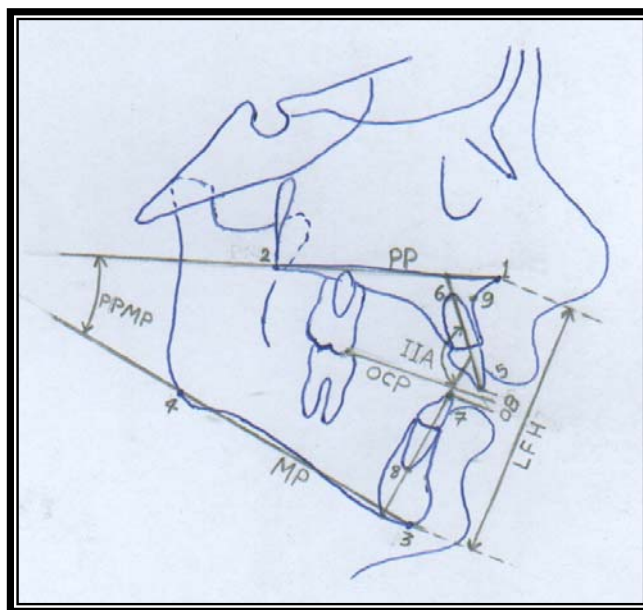
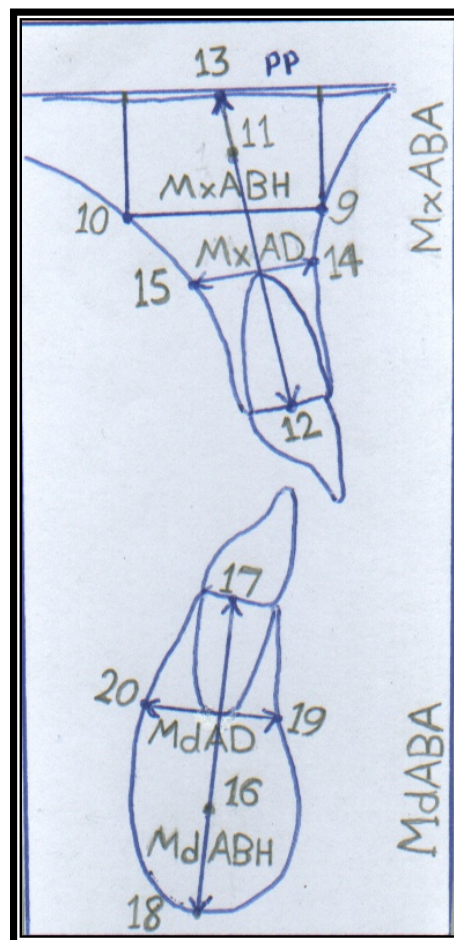


Fig. (II) Skeletal cephalometric landmarks, reference lines and measurements used in the study. Landmarks: **(Refer to Riolo)**⁽²⁵⁾ .1: Anterior nasal spine, tip of median sharp long process of maxilla at lower margin of anterior nasal opening; 2: Posterior nasal spine, most posterior point at sagittal plane on bony hard palate; 3: Menton, most inferior point on symphysial outline of chin; 4: Gonion, midpoint of angle of mandible found by bisecting angle at mandibular plane and plane through articular, posterior and along portion of mandibular ramus inferior to it; 5: Incisal tip of central maxillary incisor; 6: Apex of central maxillary incisor; 7: Incisal tip of central mandibular incisor; 8: Apex of central mandibular incisor; 9: A- Point: deepest point of curvature of frontal midsagittal section of maxilla. **Reference lines:** MP: Mandibular plane, line connecting menton and gonion, define according to Fields ⁽⁴⁾, Schendel ⁽⁸⁾, Janson ⁽²⁷⁾. PP: palatal plane, line connecting posterior and anterior nasal spine. OCP: Occlusal plane, connecting mid points between incisal ridges of central incisors and mid point between mesio-buccal cusps of first molars. **Measurements:** LFH: lower face height, direct distance between Anterior Nasal Spine and Menton. OB: over bite, distance between incisal tips of maxillary and mandibular central incisor perpendicular to occlusal plane. Positive values for overbite indicated normal. Where as open bite was indicated by negative value. PPMP: palato-mandibular angle, angle between palatal and mandibular plane. IIA: inter incisal angle, angle between axes of maxillary and mandibular incisors.

Fig. (III) Illustrations of dento-alveolar cephalometric landmarks, reference lines, and measurements used in study. **Landmarks:** 10: Palatal counter part of A-point on palatal cortical bone at same distance from palatal plane as A-point. 11: Center of rectangle limited by line (9-10) and palatal plane. Rectangle represents midsagittal section of basal bone of maxilla. This point was defined as center point of maxillary alveolus. 12: Mid point of alveolar meatus of maxillary central incisor. 13: Intersection between palatal plane and maxillary alveolar axis (maxillary alveolar axis runs from midpoint of alveolar meatus of maxillary central incisor through central point of maxillary alveolus). 14: Frontal point of shortest line above apex of maxillary central incisors between maxillary midsagittal labial and palatal alveolar cortical bone. 15: Dorsal point of shortest line above apex of maxillary central incisors between maxillary midsagittal labial and palatal alveolar cortical bone. 16: Center point of basal midsagittal bone of mandible. 17: Midpoint of alveolar meatus of mandibular central incisor. 18: Inter section between symphyseal surface and mandibular alveolar axis (mandibular alveolar axis runs from midpoint of alveolar meatus of mandibular central incisor through center point of symphyseal). 19: Frontal point of shortest line above apex of mandibular central incisors between mandibular midsagittal labial and lingual alveolar cortical bone. 20: Dorsal point of shortest line below apex of mandibular central incisors between mandibular midsagittal labial and lingual alveolar cortical bone. **Measurements:** MxABH: maxillary alveolar and basal height, distance between midpoint of alveolar meatus of maxillary central incisor and intersection between palatal plane and maxillary alveolar axis. MdABH: mandibular alveolar and basal height, distance between midpoint of alveolar meatus of mandibular central incisor and intersection between symphyseal surface and mandibular alveolar axis. MxAD: maxillary anterior depth, defined as distance between point 14 and 15. MdAD: mandibular alveolar depth, defined as distance between points 19 and 20. MxABA: Area of alveolar and basal midsagittal cross-section of maxillary jaw. Line was drawn perpendicular to palatal plane, intersecting point A and forming anterior border of maxillary alveolar and basal area. From point A (9), line was drawn parallel to nasal plane intersecting dorsal contour of maxillary alveolar bone. Dorsal border of maxillary basal area was formed by line, perpendicular to nasal plane, intersecting point (10). Area was then measured between these lines and outer contour of maxillary alveolar and basal bone below line 9-10. MdABA: area of alveolar and basal midsagittal cross-section of mandible, area between outer contours of symphysis.



Results

Statistical Analysis

Student t-Test were performed between the first and the second group of recording to detect any systematic deference between the first and second tracing of the error study. No significant difference was detected between the initial and repeated recording (at $P>0.05$) indicating a good reliability of the method.

Student t-Test was used to determine the significant differences of all variables between normal and open bite groups. For all statistical analysis, the confidence level $P<0.05$ was considered significant.

The statistical comparison for the dimensions of the frontal alveolar and basal midsagittal cross-sectional bone from the maxilla and the mandible was evaluated and all measurements showed an over all-significant differences between the two different over bite groups as shown in table (I).

Open bite group showed a larger adjusted means for the maxillary and mandibular alveolar and basal heights and a smaller adjusted means values for the maxillary and mandibular alveolar and basal depth and a larger adjusted means for the mandibular alveolar and basal area than normal over bite group. In addition, the maxillary mandibular plane angle and the interincisal angle show a high significant differences for open bite group than the normal over bite group except for the difference in the maxillary alveolar and basal area was larger in the open bite group but not reach the significant level.

The vertical linear measurements of overbite and the lower face height

and the angular measurements showed an over all high significant differences between the open bite group over the normal over bite group.

Correlations

Pearson correlation coefficients were calculated to assess the relation between over bite, lower face height, and the structure of the frontal – alveolar process and the basal bone in the maxilla and mandible in subject with open bite as shown in table (II).

The strongest positive correlation was found between the lower face height and the maxilla and the mandibular alveolar and basal height, the palato-mandibular plane angle, as well as the mandibular alveolar and basal area. The significant negative correlation was found between lower face height and the maxilla and mandibular alveolar depth.

Negative correlations coefficient were found between maxillary alveolar and basal height with the maxillary alveolar depth and the interincisal angle.

Positive correlations were found between the maxillary alveolar depth with the maxillary alveolar and basal area and inter incisal angle.

Mandibular alveolar and basal height show significant positive correlation with the mandibular alveolar and basal area and palato-mandibular angle and significantly negative correlated with the mandibular alveolar depth and inter-incisal angle.

Positive correlation was found between mandibular alveolar depth and mandibular alveolar and basal area.

Table (1): Student t-test.

Variables	Open bite (48)		Normal (40)		t-Test P-level
	Mean	S.D.	Mean	S.D.	
OB	-2.98	1.03	2.59	1.09	H.S.
LFH	75.25	5.04	63.31	1.95	H.S.
MXABH	24.47	3.36	21.0	2.39	H.S.
MXAD	8.91	1.31	12.93	1.9	H.S.
MDABH	35.72	3.9	31.93	2.14	H.S.
MDAD	6.10	0.92	9.37	1.14	H.S.
MXABA	110.43	20.32	96.70	30.32	N.S.
MDABA	205.75	25.65	193.41	28.15	H.S.
PPMP	32.39	3.70	23.18	3.37	H.S.
II	121.60	8.94	124.31	10.01	S.

Table (II): Pearson's correlation coefficient between all variables for openbite group.

VARIABLE	OB	LFH	MXABH	MXAD	MDABH	MDAD	MXABA	MDABA	PPMP	II
OB		- *							- *	
LFH			**	- *	**	- *		*	**	
MXABH				- *	**		*			- *
MXAD							*			*
MDABH						- *		**	**	- *
MDAD								**		
MXABA										
MDABA										
PPMP										
II										

* = Significant correlation at $P < 0.05$

** = Highly significant correlation at $P < 0.01$

Discussion

The diagnosis and treatment of anterior open bite malocclusion continues to be one of the most difficult problems facing the practicing orthodontist. When dealing with an orthodontic patient, the clinician should begin the diagnosis process by looking for any skeletal problems.⁽²⁸⁾

Usually, the study of open bite is carried out by analyzing the differences between selected groups of patients with open bite with a control group.^(14-18,29) The Interactions between

lower facial height and other measurements that may influence the overbite are often not taken into consideration.

In most articles concerning the long face syndrome,^(1,4,8,17,30,31) the long-face groups also include anterior open bite cases.^(1,4,32) A study of Haskell⁽³⁰⁾ demonstrated that the bony chin in subjects with open bite was smaller, compared with a normal over bite group. This suggests a relationship between the overbite and the structure of the alveolar and basal bone in the frontal part of the jaws. Therefore, in

this study, only subjects with a normal overbite (between 2 and 4 mm) were selected for the group comparisons. To achieve the true distance between the jaw bases, the direct distance between the Anterior Nasal Spine and Menton was measured.

In many articles ^(8,32), the dento-alveolar height was measured but the structure, shape and size of the alveolar and basal bone in the frontal part of the jaws, which was the subjects of this study, were not investigated. A discrepancy between the vertical dimensions of the alveolar and basal bone on the one hand, the vertical dimensions of the lower anterior face on the other hand may reflect an abnormal vertical position of the incisors, and there by influence the over bite.

In this study, no differences were found to be significant among sex groups with open bite subjects.

The results of this study indicate that the over bite and the lower face height have a certain impact on the dimensions of the maxilla and the mandibular symphysis.

The correlation analyses showed that the lower facial height and the overbite were negatively related; subjects with an open bite generally had a larger lower facial height. This was also confirmed by previously reported findings. ^(1,11,16,17,33-35) Additionally, Gardiner(1998) ⁽³⁶⁾ state "Although the teeth and alveolar processes are adaptable within limits and manage to compensate for moderate variations in vertical height of the lower part of the face ,the open bite will result", and accordingly an anterior open bite associated with an increase infra-nasal height. However, not all long-faced subjects have an anterior open bite. ^(4,8,23)

The results of this study indicate that a long-faced person with anterior open bite generally have a larger area

of the maxillary alveolar and basal bone with no significant deviation of its shape. Although the cephalometric approach is only two-dimensional, this may indicate that the volume of the maxillary alveolar and basal bone coincides with a longer maxillary alveolus.

In the mandible, an even stronger relation between the symphysis and the lower face height is found. The vertical height of the symphysis is determined by its shape ,The increase in height of the symphysis seems to coincide more with a narrowing of its shape .Thus ,in open bite subjects, the sagittal dimensions of the mandibular apical area in the incisor region is reduced, but this reduction was associated with more increase in the dento alveolar height. In contrast to normal over bite subjects .This is in agreement with the results of Backmann et al (1998).⁽¹²⁾ Another study ⁽²¹⁾ found that the open bite group showed significantly smaller maxillary and mandibular alveolar and basal cross-sectional areas compared with the end-to-end group ,the normal overbite group, or the deep bite group.

Only a slight relation was found between the dimensions of the corresponding maxillary frontal alveolar and basal bone and the over bite. The feasibility of over bite correction by orthodontic treatment may thus be assessed by using the measurements (the alveolar and basal areas, as well as the lower face height, depth, and areas.

In this study, the depth of the symphysis was measured only at the level of the apices of the central mandibular incisors, so it cannot be ruled out that the depth of the symphysis measured at another level (for example at the bony chin) ⁽³⁰⁾ may have a different relation ship with the over bite.

Another study ⁽¹²⁾ showed that subjects with a short-face structure generally had a smaller area and amore widened and shortened shape of the symphysis.

However, this study revealed that in the open bite group with long face height, the area of the symphysis generally was larger and the shape of the symphysis generally was more narrowed and elongated.

Thus, in open bite with long faced patients, the sagittal dimensions of the mandibular apical area in the incisor region is reduced in contrast to normal overbite subjects who have normal sagittal dimensions of the mandibular apical area. Consequently, the possibilities of labiolingual movement of the mandibular incisors in long-faced patients with anterior open bite are limited. This suggests a compensatory mechanism simultaneously enlarging the vertical dimensions while reducing the labiolingual dimensions of the basal and alveolar bone in the frontal part of both jaws. Thus the structure of the alveolar and basal bone may be useful for predicting the treatment success of the over bite problems.

As the shape of the maxillary alveolar and basal bone is related to the vertical facial dimensions, the scope of anterior-posterior movements of the maxillary incisors is large.

In this study, the depth of the symphysis was measured only at the level of the apices of the central mandibular incisors, so it cannot be ruled out that the depth of the symphysis measured at another level (for example at the bony chin) ⁽³⁰⁾ may have a different relation ship with the over bite.

The fact that the palato mandibular angle was larger in the open bite group compared with the normal over bite group. This is in agreement with the

results of Fields, ⁽⁴⁾ Schendel, ⁽⁸⁾ and Ulgen. ⁽³²⁾

The inclination of the maxillary and mandibular central incisor seems to have an effect on the over bite. This study showed that in subjects with open bite, the interincisal angle was smaller in the open bite group, the maxillary and mandibular central incisor generally are protruded, where as in subjects with normal over bite, (more steeply inclined). Here a slight increase or decrease in the inclination of the central incisor will produce a large effect on its vertical height. This is in agreement with the results of Beckmann et al 1998. ⁽²¹⁾ Ulgen, ⁽³²⁾ found no significant differences between the long face with open bite group and the control group for the inter incisal angle.

Several investigators ^(37,38) concluded that the lower anterior face height is largely determined by heredity. Because the lower anterior face height and the mandibular alveolar and basal shape seem to be related, it is possible that the shape of the frontal alveolar and basal bones is also at least partially influenced by the same genetic factors, which also determine the lower face height. As the maxillary alveolar and basal area also is correlated with the lower face height, the volume of the maxillary and basal might be influenced by the same genetic factor that controls the lower face height. This same factor also may influence the shape of the symphysis. Therefore, disharmonies between the effect of the size controlling genetic factor and the effect of the shape/lower face height controlling genetic factor may account for considerable variation in over bite.

Conclusion

The size and form of the mandibular symphysis are more

strongly related to the overbite and lower face height. With increasing lower face height, the symphysis is elongated and narrowed, where as its area is increased. The midsagittal alveolar and basal area and shape of the maxilla showed a slight relation with the overbite. Thus, an estimation of the feasibility treatment may be performed by using the area and the shape of the symphysis along with the lower face height.

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