Original Article

Skeletal and Dentoalveolar Features in Patients with Deep Overbite Malocclusion

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Abstract

Objective: An increased overbite may be due to a skeletal or dental etiology that may influence treatment. The purpose of this study was to evaluate the skeletal and dentoalveolar features in patients with deep bite malocclusion in an Iranian population and to determine the most and least effective and contributory variables causing deep bite.

Materials and Methods: Lateral cephalograms and study casts of normal (n=85) and deep bite (n=85) subjects were used to evaluate skeletal and dentoalveolar variables. Data were analyzed statistically by independent t-test. The percentages of each variable within normal limits, less and more than one standard deviation were calculated for deep bite subjects.

Results: The most significant skeletal contributing factors were gonial and basal angles, as well as the posterior facial height, ramus length, lower anterior facial height and upper anterior facial height. An increased curve of spee and decreased mandibular first molar height were predominant dental variables in the deep bite group. The variables with the greatest variances from the normal limit were the ratio of the lower anterior facial height to the total anterior facial height, the lower anterior facial height to the upper anterior facial height and the ramus length.

Conclusion: The counterclockwise rotation of the mandible and the increased curve of spee were the dominant feature of deep bite malocclusion.

Key Words: overbite; Cephalometry; Malocclusion

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Received: 28 March 2014
Accepted: 9 August 2014

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2014; Vol. 11, No. 6)

INTRODUCTION

Deep bite or deep overbite is defined as excessive vertical overlapping of the mandibular incisors by the maxillary incisors in centric occlusion. Normally, the incisal edges of the lower teeth should contact slightly at or above the cingulum of the upper teeth, which is approximately 1-3 mm overbite. Due to differences in the crown lengths of the incisors, normal overbite is about 30% or one third of the clinical crown height of the mandibular incisors [1].

Deep bite is the most common malocclusion involving children and adults [2]. According to a study conducted by Proffit and Fields (2007), "overbite more than 5 mm is found in nearly 20% of the children and 13% of the adults" [2]. Subjects with mild deep bite typically require no correction, unless the patient appeals correction for esthetics. However, severe overbite, considered as a clinical problem, should be corrected through orthodontic or orthosurgical intervention. Severe overbite may affect the temporomandibular joint, cause periodontal problems and tooth wearing, as well as traumatizing the incisive papilla or interfering with mastication function [3]. In orthodontics, various methods have been provided for deep bite correction. However, any treatment must be carefully specified for each patient based on the etiology of malocclusion and analysis of the effective factors. Maintenance of a corrected deep bite is one of the most important challenges for orthodontists. When no accurate identification of the etiologic factors is performed, treatment relapse is common.

The skeletal and dental patterns of deep bite malocclusion have been investigated in several studies. Trouten et al. [4] studied the morphologic factors in deep bite and open bite patients. It was revealed that deep bite malocclusion was associated with decreased gonial angle, deep curve of spee, decreased posterior maxillary dimension, downward rotation of the palatal plane, and more forward position of the ramus. Beckmann et al. assessed alveolar and skeletal dimensions associated with over bite and lower facial height [5, 6]. They suggested that a deeper bite coincided with smaller lower facial height [5], larger anterior alveolar and basal areas, and retroinclination of the maxillary incisors [6]. Bydass et al. [7] studied the effect of the depth of curve of spee on overbite and overjet. Increased overbite was observed in the deep curve of spee caused by extruded lower anterior teeth. Overbite could affect the maxillary and mandibular morphology and was associated with a decreased gonial angle [8]. Al-Zubaidi and Obaidi [9] measured the lower facial height (LFH) in subjects with deep bite and normal overbite. They found no differences in the LFH, maxillary and mandibular anterior alveolar and basal height between the two groups. El-Dawlatly et al. [10] evaluated skeletal and dental variables in patients with deep bite malocclusion and showed that deep bite has multi-factorial etiology in which an exaggerated curve of spee and a decreased gonial angle were the greatest contributing factors. In a longitudinal study, Naumann et al. [11] examined vertical components of the overbite change. Their research showed that skeletal components were more effective than dental components on overbite change; in addition the mandible was more efficient than the maxilla in changing the amount of overbite.

Previous studies reported the difference between deep bite and normal bite confined in the maxillary dentoalveolar area [4, 12-14] or in the mandibular dentoalveolar area [15]. Betzenberger et al. [16], and Haskell [17] believed that overbite changes were due to dentoalveolar morphology of the upper and lower jaws. The purpose of this study to investigate the influence of skeletal and dentoalveolar features on deep bite malocclusion in an Iranian population and to determine the most frequent dental and skeletal contributing factors associated with deep bite malocclusion. Undoubtedly, a thorough knowledge of the most effective dental and skeletal contributing factors in deep bite malocclusion helps clinicians to perform the most effective treatment in this population.

MATERIALS AND METHODS

This cross sectional study was conducted on the casts, photographs and the lateral cephalometric radiographs of subjects selected among more than 2000 patients seeking orthodontic treatment in Imam Reza Clinic, Shiraz, Iran.

Inclusion criteria in the subjects were no history of orthodontic treatment, presence of permanent dentition, no systemic disease or craniofacial disorder, absence of supernumerary or missing teeth, intact and acceptable quality of the study cast, and 1 to 3 mm overbite for the normal group and greater than 3 mm for the deep bite group based on the study conducted by Proffit and Fields (2007).

The sample size was based on previous studies and calculated by power SSC software (first type of error: α =0.05, power test: 1- β= 0.8).

The casts, photographs and the lateral cephalometric radiographs were selected and evaluated in 170 individuals aged 12-35 years with a slight female predominance.

They were assigned into two groups (n=85) of normal overbite and deep bite with a mean age of 19.6 ±5.9 and 20.6 ±5.7 years, respectively.

Two last year dental students performed analysis of the casts and lateral cephalometric radiographs. The lateral cephalometric radiographs were traced manually on the standard tracing paper over a standard illuminated view box with a transparent metric ruler. The depth of curve of spee, overbite and the clinical crown length of the central incisors and the first molars were measured on dental casts using a digital caliper (Model No CD6"GS, Mitoyoto Digimatic caliper NO.500 Tokyo, Japan) with an accuracy of 0.01 mm. To determine the method error in this study, one third of the samples were randomly selected and remeasured by the first and second examiner after 2 weeks of the initial measurement for evaluation of the intra- and inter-observer reliabilities. The skeletal and dentoalveolar measurements used for analysis are given in Tables 1 and 2.

Statistical Methods

Data were statistically analyzed using SPSS version 15.0 for Windows version (SPSS Inc., Chicago, Illinois, USA).

Descriptive statistics (maximum, minimum, mean and standard deviation) for each variable were determined. The independent t-test was performed to assess differences between normal and deep bite groups. The levels of significance used were P< 0.05(*), P<0.01(**) and P<0.01(***). The percentages of the subjects within normal limits, less and more than one standard deviation were calculated to assess the increase and decrease of the variables that had the highest prevalence in deep bite patients. The Pearson correlation was used for intra-observer and inter-observer reliabilities and was significant for both measurements (P<001).

RESULTS

The mean and standard deviation of the skeletal and dental variables for the deep bite and normal groups are shown in Tables 3 and 4. The percentages of subjects within the normal limits and less and more than one standard deviation are shown in Tables 5 and 6.

Skeletal Variables:

Statistically significant differences were found in 11 of the 17 cephalometric measurements between the two groups. The FH-GoMe, basal and gonial angles, LAFH, LAFH/TAFH, LAFH/UAFH and Bjork were significantly lower in the deep bite group compared with the normal group. The UAFH, ramus length, PFH and Jaraback index were statistically greater in the deep bite group. No statistical differences were found in the saddle, articular, inclination, sn-pp, ramus-FH angles and TAFH between the two groups (Table 3).

The skeletal variables with the greatest variances from the normal limit were decreased LAFH/TAFH (48.23%) and LAFH/UAFH (45.88%), followed by the increased ramus length (41.3%), decreased gonial angle (40%), increased PFH (39.5%) and decreased basal angle (38.8%) (Table 5).

Dentoalveolar Variables:

Statistically significant differences were found in 5 of the 11 measurements.

Table 1. Definition of Skeletal Measurements

Mandibular plane angle (FH-Gome)	Angle between the Frankfort plane and the mandibular plane
Basal angle (Ans Pns- Gome)	Angle between the palatal plane and the mandibular plane
Saddle angle (Sn-SAr)	Angle between the anterior cranial base and the posterior cranial base
Articular angle (SAr- ArGo)	Angle between the posterior cranial base and the ramal plane
Gonial angle (Ar-Go-Me)	Angle between the posterior border of the ramus and the corpus line
Sum of Bjork	Sum of Gonial, articular and saddle angles
Inclination Angle (Pnline-AnsPns)	Angle between the perpendicular plane and the palatal plane
Palatal Plane angle (Sn-Ans Pns)	Angle between the palatal plane and the sella-nasion plane
Ramus-FH	Angle between the posterior border of the mandible and the Frankfort horizontal plane
Jarabax index	The ratio of the posterior facial height to the anterior facial height
Total anterior facial height =TAFH (N-Me)	A linear measurement from the junction of the nasal and frontal bone to the menton
Upper anterior facial height=UAFH (N-A)	A linear measurement from the junction of the nasal and frontal bone to the most concave portion of the premaxilla
Lower Facial height =LAFH (A-Me)	A linear measurement from the most concave portion of the premaxilla to the menton
Lower Facial height/Total Facial height×100 (LAFH/TAFH)	The ratio of the lower facial height to the total anterior facial height
Lower Facial height/ upper Facial height ×100 (LAFH/UAFH)	The ratio of the lower facial height to the upper facial height
Ramus length (Ar-Go)	A linear measurement from the intersection of the posterior of the ramus and the outer margin of the cranial base to the most inferior posterior portion of the angle of the mandible
Posterior facial height=PFH(S-Go)	A linear measurement from the midpoint of the sella and the most inferior posterior portion of the angle of the mandible

Table 2. Definition of Dentoalveolar Measurements

Maxillary anterior alveolar and basal height (MXAABH)	Distance between the midpoint of the alveolar meatus of the upper first incisor and the intersection point between the palatal plane and the long axis of the upper first incisor
Maxillary posterior alveolar and basal height (MXPABH)	Distance between the midpoint of the alveolar meatus of the upper first molar and the intersection point between the palatal plane and the long axis of the upper first molar
The inclination of the upper incisors (U1-PP)	Measured at the intersection of the long axis of the upper central incisor with the palatal plane
The inclination of Lower incisors (L1-MP)	Measured at the intersection of the long axis of the lower central incisor with the mandibular plane
Mandibular anterior alveolar and basal height (MdAABH)	Distance between the midpoint of the alveolar meatus of the lower first incisor and the intersection point between the mandibular plane and the long axis of the lower first incisor
Mandibular posterior alveolar and basal height (MdPABH)	Distance between the midpoint of the alveolar meatus of the mandibular first molar and the intersection point between the mandibular plane and the long axis of the mandibular first molar
U1 Clinical Crown Length (U.1.L)	Distance between the midpoint of the cervical margin of the tooth and the midpoint of the incisal edge
L1 Clinical Crown Length (L.1.L)	Distance between the midpoint of the cervical margin of the tooth and the midpoint of the incisal edge
Curve of Spee	Perpendicular distance between the deepest cusp tip and a flat plane that was laid on top of the mandibular dental cast, touching the incisal edges of the central incisors and most distal cusp in the arch
U6 Clinical Crown Length (U.6.L)	Distance between the cervical margin of the tooth and the tip of the bucal cusp
L6 Clinical Crown Length (L.6. L)	Distance between the cervical margin of the tooth and the tip of the bucal cusp

Table 3. Descriptive Analysis and Comparison of the Skeletal Variables in Normal and Deep Bite Groups

	Normal Group			Deep Bite Group			t - test
Variable	**Min**	**Mean (S.D)**	**Max**	**Min**	**Mean(S.D)**	**Max**	***P*-Value**
Mandibular plane (°)	18	27.62(5.7)	45	15	25.01(5.4)	41	0.009**
Basal (°)	12	27.60 (6.3)	52	13	23.92 (5.9)	41	0.000***
Saddle (°)	116	128.30 (5.9)	145	11	127.41(6.4)	143	0.338
Articular (°)	119	144.62 (7.5)	160	123	144.67 (7.7)	165	0.963
Gonial (°)	118	130.18 (5.4)	142	114	126.40 (5.5)	142	0.000***
Bjork (°)	384	403.15 (7.3)	423	385	399.79 (7.1)	416	0.002**
Inclination (°)	72	82.15 (3.5)	89	72	81.20 (3.5)	90	0.067
Palatal Plane (°)	4	9.81 (3.1	18	1	10.21(3.3)	20	0.486
Ramus-FH (°)	70	80.44 (4.9)	89	65	79.60 (5.4)	90	0.278
Jaraback (%)	50	63.21 (4.9)	78	45	65.63 (5.3)	79	0.002**
TAFH (mm)	104	125.23 (9.7)	153	106	125.34 (8.6)	150	0.938
UAFH (mm)	46	61.88 (5.4)	80	55	64.68 (4.5)	81	0.000***
LAFH (mm)	51	64.63 (6.4)	83	50	61.15 (5.4)	77	0.000***
LAFH/TAFH(%)	46	51.42 (2.6)	61	42	49.24 (2.3)	57	0.000***
LAFH/UAFH(%)	84	105.21 (12)	140	75	96.08 (9.6)	131	0.000***
Ramus length (mm)	32	47.30 (4.6)	57	35	50.49 (6.3)	69	0.000***
PFH (mm)	65	79.21(6.7)	102	65	83.34 (8)	105	0.000***

Significance (**P*< 0.05, ** *P*<0.01, *** *P*<0.001)

Table 4. Descriptive Analysis and Comparison of the Dentoalveolar Variables in Normal and Deep Bite Groups

	Normal Group			Deep Bite Group			t - test
Variable	**Min**	**Mean (S.D)**	**Max**	**Min**	**Mean (S.D)**	**Max**	***P*-Value**
U1-PP (°)	90	114.39 (7.2)	142	80	111.27 (8.5)	137	0.012*
L1-MP(°)	74	100.33 (7.6)	115	75	97.65 (7.8)	112	0.022*
U.1.L(mm)	7.4	9.6 (0.88)	11.4	8.11	10.1(0 .88)	11.82	0.001**
L.1.L(mm)	5.83	8.42 (0.91)	10.4	6.3	8.31(0.81)	11.1	0.436
U.6.L(mm)	4.2	5.74 (0.76)	7.7	3.95	5.66 (0.89)	8.13	0.555
L.6.L(mm)	3.9	5.90 (0.79)	7.6	3.9	5.47 (0.74)	7.3	0.000 ***
Curve of spee (mm)	0.77	2.44 (0.7)	4.22	1	3.01 (0.8)	4.91	0.000 ***
MX.AABH (mm)	14	23.48(3.6)	35	16	23.67 (3.9)	39	0738
MX.PABH (mm)	9	17.62(3.2)	28	12	17.36 (3.1)	25	0.851
MD.AABH (mm)	27	34.95(3.9)	47	26	35.62 (4.8)	55	0.314
MD.PABH (mm)	17	25.23 (3.6)	35	18	25. 42 (3.9)	38	0.737

Significance (**P*< 0.05, ** *P*<0.01, *** *P*<0.001)

Table 5. The Percentage of Individuals Within Each Skeletal Variable in the Deep Bite Group

Variable	Less than 1 SD,%	Mean ± 1 SD, %	More than 1 SD, %
Mandibular plane (°)	28.2	65.9	5.9
Basal (°)	38.8	54.1	7.1
Saddle (°)	18	67	14
Articular (°)	15.3	71.8	12.9
Gonial (°)	40	58	2
Bjork (°)	27	63.5	9.4
Inclination (°)	18	63.5	23.5
Palatal Plane (°)	18.8	67.1	14.1
Ramus-FH (°)	17.7	71.7	10.6
Jaraback (%)	5.9	65.9	28.2
TAFH (mm)	16.5	69.4	14.1
UAFH (mm)	2.4	74.1	23.5
LAFH (mm)	30.5	66	3.5
LAFH/TAFH(%)	48.2	49.4	2.4
LAFH/UAFH(%)	45.9	49.4	4.7
Ramus length (mm)	8.7	50	41.3
PFH (mm)	6.3	54.2	39.5

Table 6. The Percentage of Individuals Within Each Dentoalveolar Variable in the Deep Bite Group

Variable	Less than 1 SD,%	Mean ± 1 SD, %	More than 1 SD, %
U1-PP (°)	32.1	60.7	7.1
L1-MP(°)	23.5	68.3	8.2
U.1.L(mm)	9.2	56.3	34.5
L.1.L(mm)	19.5	71.3	9.2
U.6.L(mm)	20.8	60.8	18.4
L.6.L(mm)	29.9	64.4	5.7
Curve of spee (mm)	8.1	54.7	37.2
MX.AABH (mm)	12.9	75.3	11.8
MX.PABH (mm)	15.3	68.2	16.5
MD.AABH (mm)	22.4	55.	22.6
MD.PABH (mm)	18.7	62.5	18.8

The lower first molar length, U1.PP and L1.MP angles were significantly less in the deep bite group compared with the normal group. The curves of spee and upper incisor lengths were statistically greater in the deep bite group. No statistically significant differences were found in the lower incisor length, MXAABH, MXPABH, MdAABH, MdPABH between deep bite and normal groups (Table 4). The increased curve of spee had the greatest variance (37.2%) from the normal limit. In 34.48 % of deep bite subjects, the maxillary incisors had a greater clinical crown length and in 29.88%, the mandibular first molar had a lesser clinical crown length. The retrusive maxillary and mandibular incisors were seen in 32.1% and 23.5%, respectively (Table 6).

DISCUSSION

It is difficult to treat deep bite successfully [3]. Thorough knowledge of dental and skeletal features of deep bite patients helps clinicians to provide a more stable treatment. The purpose of this study was to compare deep bite and normal overbite in skeletal and dentoalveolar features in an Iranian population and to determine the most and least effective and contributory variables causing deep bite.

In our study, the ratio of the lower anterior facial height to the total anterior facial height was one of the most significant findings between the two groups. When the distribution of the subjects was calculated, only one half of the deep bite subjects were within the normal range of LAFH/TAFH (49.4%). There were disagreements about LAFH and TAFH in deep bite patients in previous studies, as some studies did not observe any sensible change in these measurements. Al-Zubaidi and Obaidi [9] found no differences in LAFH between normal bite and deep bite, but Beckmann et al. [5], and Trouten et al. [4] stated that TAFH and LAFH were less than normal in deep bite subjects.

In our study, although there was no change in TAFH, LAFH was decreased significantly in the deep bite group. This finding was in agreement with studies carried out by Beckmann et al. [5], and Adams and Kerr [18], mentioning a strong correlation between LAFH and overbite. These contradictory results could be attributed to the different methodologies such as case selection criteria.

LAFH/UAFH was reduced in 45.88% of the deep bite subjects. The upper anterior facial height was significantly increased in the deep bite group. In 23.5% of the deep bite patients, UAFH was more than the normal range. This finding was in agreement with the study performed by Nanda [19], stating that deep bite subjects in their study have an increase in the upper anterior facial height. It is possible that the increased UAFH compensated the decreased LAFH, leading to no change in the height of TFH.

The reduced gonial, basal and FH-GoMe angles indicate upward and forward growth of the mandible. The horizontal growth pattern is a key factor in the formation of deep bite malocclusion. The counterclockwise rotation of the mandible was confirmed by decreased LAFH. A number of previous studies reported that the decreased gonial angle is a dominant feature of deep bite malocclusion [1, 4, 8,10, 20]. In the present study, the Jaraback index was statistically greater in the deep bite than the normal group, which was because of the increased PFH and ramus length in the deep bite group. This finding is in agreement with the study conducted by Sassouni and Nanda [20]. They found that increase in the ramus height and PFH are strongly associated with deep overbite. However, this finding has not been supported by Ceylan and Eroz [8], who reported that the ramus length was not statistically significant between the normal and deep bite individuals. Our findings showed that SN-PP and inclination angles were similar between the two groups. There was no rotation in the palatal plane in our study cases. However, others reported that the palatal plane tends to be angulated in a more downward position

[1, 4, 8, 10]. This disagreement might be allotted to assume more overlap of the incisors for deep bite groups in those studies (more than 5 mm or 80% coverage of the lower incisors). There seems to be widespread agreement on the influence of the curve of spee on the amount of overbite, as several authors have reported that the curve of spee was increased in cases of deep bite [4, 7, 8, 10, 21, 22, 23]. Based on the dentoalveolar relationship in our study, the component with the largest deviation from normal limit was the curve of spee in 37.2% of deep bite patients. Such excessive curve of spee causes muscle imbalance and improper function that can cause lower incisors to over-erupt, the premolars to infra-erupt, and the lower molars to be mesially inclined leading to an increase of overbite [21]. Excessive vertical overlapping of the anterior teeth may be due to supraocclusion of the incisor teeth or infraocclusion of the molar and premolar teeth or a combination of both [1]. The mandibular first molar height was statistically different between the two groups in our study. The short mandibular first molar height was observed in 29.8% of the deep bite patients, as Proffit stated “the insufficient eruption of the posterior teeth can cause upward and forward rotation of the mandible and increase overbite”. Another important finding was the increased length of the maxillary incisors. The majority of the patients in the deep bite group had an increased crown length of the maxillary incisors (34.48%), indicating the reverse curve of spee in the maxillary arch, although this issue has not been investigated in this study.

The incidence of the increased crown length of the maxillary incisors was greater than the decreased crown length of the mandibular first molars. Excessive overbite may result from supraocclusion of the incisor teeth than infraocclusion of the posterior teeth.

The mean values for U1.PP and L1.MP angles were evaluated to assess the effect of positioning of the incisors on overbite. Reduced U1.PP and L1.MP angles were found in 32.1% and 23.5%, respectively. Sangchaream and Christopher [24] reported that the retroinclination of the maxillary incisors and mandibular incisors have a direct effect on the amount of overbite.

Beckmann et al. [6] reported that the upper incisors were more inclined and the mandibular incisors were slightly protruded, and this slight change in the inclination of the mandibular incisors has no effect on overbite.

The study conducted by Al-Zubaidi and Obaidi [9] showed no significant difference in the maxillary and mandibular anterior alveolar and basal height (MXAABH, MdAABH) when compared with normal overbite. Ceylan and Eroz [8] found no statistical difference in the maxillary and mandibular anterior and posterior alveolar height (MXAABH, MXPABH, MdAABH, MdPABH) between normal and deep overbite and their findings concur with our results. Trouten et al. [4] observed smaller maxillary posterior alveolar and basal height (MXPABH) in deep bite. According to these studies, deep bite malocclusion is a multi-factorial phenomenon, and both skeletal and dental variables may affect overbite. The controversies among the results presented here and previous studies might be due to race, age and the amount of overbite in the subjects. In addition, using normal cephalometric values in the control group is the advantage of our study.

The normal level of cephalometric variables mentioned in text books are not the result of research on our population, so we first measured all skeletal and dentoalveolar variables for each subject with a normal overbite, and then the mean of variables ± 1SD was selected as the normal range [25].

CONCLUSION

The lingual inclination of the maxillary and mandibular incisors was observed that may affect overbite.

The main findings associated with a deep bite malocclusion were:

1. The counterclockwise rotation of the mandible was confirmed by the significant decrease in the lower anterior facial height.
2. The upper anterior facial height increased to compensate the decreased lower anterior facial height so the total anterior facial height did not change.
3. The Jaraback index was increased because of the increased growth of the posterior region of the face.
4. The maxillary incisor crown length was increased and the mandibular first molar crown length indicating the reverse curve of spee in the maxillary arch and the deep curve of spee in the mandibular arch, respectively.

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