Overbite Depth Indicator (ODI) Values in a Nigerian Population of Adults with Anterior Open Bite

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Abstract

Background: The Overbite Depth Indicator (ODI) is defined as the angle of the A-B plane to the mandibular plane combined with the palatal plane to the Frankfort horizontal plane. It has been reputed to be a better diagnostic criterion for the presence of dental open bite than any other commonly used skeletal cephalometric measurement or ratio.

Objective: The purpose of the study was to evaluate the overbite depth indicator (ODI) in a population of Nigerian adults with anterior open bite.

Methods: A set of fifty pre-treatment cephalometric radiographs of adults (aged 18-25 years) with anterior open bites was compared to a set of fifty pre-existing cephalometric radiographs of normal persons of the same age range. The angles of the A-B plane to the mandibular plane (AB-MP angle) and the palatal plane to Frankfort horizontal plane (FH-PP angle) were measured. Arithmetic means and standard deviations were calculated for each measurement and their sum (ODI). The critical level of statistical significance was defined as $p<0.05$.

Results: The mean ODI was significantly reduced in anterior open bite subjects (63.13 o ± 6.71) compared to the controls, (66.85o ± 4.46).

Conclusion: The findings show that Nigerians generally have an open bite tendency. Factors contributing to the decreased ODI were significantly related to the mandible in open bite males and to the palate in the females.

Keywords: Overbite, depth indicator, Adults, Nigerias

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Introduction

Lateral cephalometric radiographs are a routine component of the diagnostic records taken in clinical orthodontic examinations. They are also frequently used as a research tool for evaluating the effects of orthodontic treatment and describing facial growth.[1] Orthodontists have used cephalometrics to investigate the relationship between dental occlusion and skeletal balance of the face.

Persons with long or disproportionately excessive lower vertical facial heights have been described by the term 'long face syndrome'.[2] It has been related to a posteriorly directed growth pattern of the condyle leading to increase in anterior facial height.[3]

Hyperdivergence and hypodivergence are terms which were introduced as diagnostic criteria. The hyperdivergent facial type indicates an open bite or open bite tendency, whereas hypodivergency expresses a facial type with a deep bite or deep bite tendency. Both are verified or designated by the degree of the mandibular plane angle.[4] However the correlation between the mandibular plane angle and overbite depth is not a dependable factor on which to base diagnosis and treatment plan as a deep bite can be observed in those with a hyperdivergent profile and an open bite in those with a hypodivergent facial type.

The Overbite Depth Indicator (ODI) was defined by Kim[3] as the angle of the A-B plane to the mandibular plane combined with the palatal plane to the Frankfort horizontal plane. If the latter angle is positive, it is added to the former angle; if it is negative, it is subtracted from the former angle. It is the arithmetic sum of the angle of the A-B plane to the mandibular plane and the angle of the palatal plane to Frankfort horizontal plane and determines the vertical maxillo-mandibular relationship (Figure 1).

The overbite depth indicator is found to be a better diagnostic criterion for the presence of dental open bite than any other commonly used skeletal cephalometric measurement or ratio. [1,6]

Studies were also conducted by Kim to determine which of 15 cephalometric parameters would produce the highest correlation with incisal overbite depth. They showed the A-B plane to the mandibular plane to have the highest correlation. However when combined with the palatal plane to the Frankfort horizontal plane, the correlation was even higher. [5]

The reason for choosing the Frankfort horizontal plane as opposed to the cranial base line is that the former presents a better orientation of facial posture and is practically parallel to the palatal plane in normal individuals.

Studies done on a Nigerian population recorded an anterior open bite prevalence of 14.4% in 6year olds, gradually decreasing to 2.4% in 11 year old children. [7] In orthodontic populations, prevalences of 11.2% and 5.4% have been recorded. [8,9]

It has frequently been observed that malocclusions which initially presented with the same degree of openness can respond differently to treatment.[5] The ODI clearly distinguishes the over bite from the open bite. Kim5 demonstrated that the lower the ODI figure, the greater the chance of there being an open bite or a tendency toward an open bite. Conversely, a high ODI relates to a deep bite or a tendency toward one.

The purpose of this study was to evaluate the overbite depth indicator (ODI) in a population of Nigerian adults with anterior open bite. The study will provide valuable information and assist in determining those patients with an open bite tendency. This will in turn aid in planning treatment mechanics.

Methods

Subjects consisted of 50 Nigerian young adult patients (23 males and 27 females)aged 18-25 years with an anterior open bite who presented for orthodontic treatment and required cephalometric radiographs as part of their routine diagnostic records. Control subjects were50 students of the College of Medicine University of Lagos (24 males and 26 females aged 18-25 years) who were observed to have good facial symmetry (clinically), well aligned maxillary and mandibular arches, all teeth present except the third molars, with no history of trauma, no previous orthodontic treatment, and no maxillofacial or plastic surgery.

Each subject was placed in a cephalostsat. All cephalometric radiographs were taken using the Planmeca® digital cephalometric X-ray unit (magnification 1.0). All information linked to the participants was anonymized.

The radiographs were traced on 0.003" matte acetate orthodontic tracing paper. Cephalometric landmarks were identified, (Table I) cephalometric planes were drawn and measurements were made on each radiograph. All radiographs were traced manually using a 0.5mm HB lead pencil, with angular measurements made using a protractor to the nearest 0.5o Each value was measured twice, and the mean for the two measurements was used.

Criteria for diagnosis

The anterior open bite subjects were all born of Nigerian parents and at least 18 years but not over 25 years having all teeth present except the third molars, with no history of trauma, no previous orthodontic treatment, and no maxillofacial or plastic surgery. Criteria for diagnosis of the anterior open bite subjects, was the presence of at least 1mm anterior open bite.

Cephalometric Landmarks

The following cephalometric landmarks were identified on the radiographs:

Point A: subspinale. The most posterior point on the curved bony outline of the maxilla.

Point B: supramentale. The most posterior point on the curved bony outline of the mandible.

Me: menton. The lowest point on the symphyseal shadow of the mandible.

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Go: gonion. The most anterior inferior point on the angle of the mandible.
ANS: anterior nasal spine. Tip of the bony anterior nasal spine.
PNS: posterior nasal spine. The intersection of a continuation of the anterior wall of the pterygopalatine fossa and the floor of the nose.
Po: porion. The most superior point on the bony external auditory meatus
Or: orbitale. The lowest point on the inferior rim of the orbit.

Cephalometric Planes

PP: Palatal plane, from ANS to PNS.
MP: Mandibular plane, from menton to gonion.
FH: Frankfort horizontal, from porion to orbitale

ODI (Overbite Depth Indicator)

Overbite depth indicator (ODI) is the sum of the angle of the A-B plane to the mandibular plane (MP) and the angle of the palatal plane to the Frankfort horizontal (FH) plane and determines the vertical maxilla-mandibular relationship (Fig. 1).

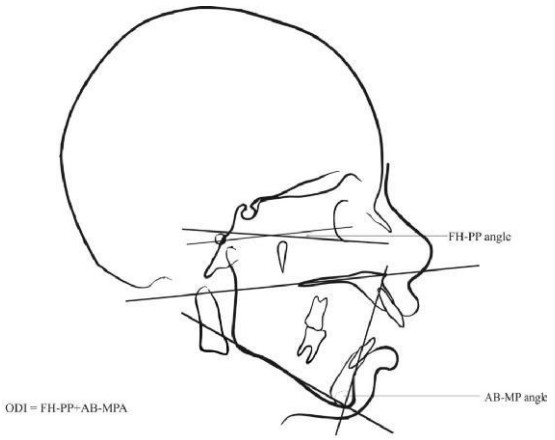

Figure 1: Overbite Depth Indicator (ODI)

a. Mandibular plane to A-B plane angle

This angle is formed by mandibular plane and A-B plane and represents the facial cone, in accordance with the disposition of the structural facial components, the angle may be closed. An open angle is related to deep bite, while a closed angle is related to an open bite.

b.Frankfort horizontal plane to palatal plane angle

This angle is formed by Frankfort horizontal plane and the palatal plane and represents the palatal position. A positive angle indicates that the palate is tipped downward and forward. A negative angle indicates that the palate is tipped upward and backward and it is related to open bite, while the positive angle is related to a deep bite.

All statistical analysis was performed using Epi Info 3.5.1 (2008) software. Standard descriptive analysis of data was computed for each cephalometric variable. Arithmetic means and standard deviations were calculated for each measurement. The critical level of statistical significance was defined as $p<0.05$. Independent t-tests were used to identify differences in means of measurements between the male and female open bite and control subjects.

Ethical Considerations

Informed consent was obtained from the control population and research approval was granted by the health research and ethics committee of the Lagos University Teaching Hospital.

Results

The mean age of the anterior open bite subjects was 22 years ± 2.29 while that of the control subjects was 21.68 years ± 1.92. The mean overbite depth indicator was lower in anterior open bite subjects (males, 63.57^0 ± 5.69 and females, 62.76^0 ± 7.57) than in their control counterparts (males, 67.27^0 ± 4.01^0 and females, 66.46^0 ± 4.89^0). These findings were significant in both makes and females ($p=0.01$ and 0.04 respectively). The difference in mean ODI values between the male and female anterior open bite subjects was not statistically significant (0.68).

The component parts of the ODI, namely the FH-PP and AB-MP angles revealed the following on analysis:

Mean FH-PP angle: While reduced in both

Table 2: Mean values of ODI and its two angular components (AB-MPA AND FH-PP) In male and female anterior open bite and control subjects

	Male				Female				Total			
AB-MPA (degrees)	**Mean**	SD	t value	p value	**Mean**	SD	t value	p value	**Mean**	SD	t value	P value
OB	**63.11**	5.66			**64.17**	7.53			**63.68**	6.69		
C	**66.52**	3.66	2.46	0.018*	**66.08**	4.58	1.11	0.272	**66.29**	4.13	2.35	0.021*
FH-PP (degrees)												
OB	**0.46**	2.38			**-1.41**	3.58			**-0.55**	3.2		
C	**0.75**	2.81	0.39	0.7	**0.38**	1.44	2.37	0.02*	**0.56**	2.19	2.03	0.046*
ODI (AB-MP Angle + FH-PP angle)												
OB	**63.57**	5.69			**62.76**	7.57			**63.13**	6.71		
C	**67.27**	4.01	2.59	0.013*	**66.46**	4.89	2.11	0.04*	**66.85**	4.46	3.26	0.002*

sexes in the anterior open bite group compared to the controls, the value, was only significant in the female anterior open bite sample ($-1.41^0 \pm 3.58^0$) compared to the control ($0.38^0 \pm 1.44^0$) with p=0.02. This indicates an upward tilt anteriorly, of the palate.

Mean AB-MP angle: the value also generally reduced in those with anterior open bite and was of significance in the male sample ($63.11^\circ \pm 5.66^\circ$) compared to the control ($66.52^\circ \pm 3.66^\circ$) with p=0.02.

*- Significant at p<0.05

OB- Open Bite
C- Control

Discussion

Anterior open bite may be defined as a deviation in the vertical relationship of the maxillary and mandibular dental arches. In an open bite there must be a definite lack of contact, in the vertical direction, between opposing segments of the anterior teeth . 10 Anterior open bite, though low in incidence, is high on the clinician's list because of its potential for frustration and failure, representing one of the most difficult malocclusions to treat to a successful and stable result. 11

No studies have been done in Nigeria on the overbite depth indicator. The ODI analyses and differentiates open bites and deep overbites with cephalometric values. It shows, even in the absence (clinically) of a deep or open bite when a patient has a tendency toward either and this should be taken into consideration when planning treatment e.g. in planning for use of interarch elastics.

In the present study, one component of the ODI, the mean FH-PP angle was generally lower in anterior open bite than the control group but significantly lower in the female anterior open bite sample compared to control female subjects. It was also significant in the pooled sample population compared to the control. This indicates an upward tilt of the palate anteriorly and a superior placement of the anterior nasal spine. This was similarly observed by several investigators[14–15]

However these findings differed from Kim et al.[18] who analysed pre-treatment cephalometric radiographs of twenty six Caucasian non-growing patients with anterior open bite (17 years and older) and reported an FH-PP angle of 2.63° compared to -0.55° seen in this study. The group studied by Kim et al.[18] therefore had a downward tilt of the palatal plane and an inferior placement of the anterior nasal spine.

The AB-MP angle can be closed (reduced) by a decrease in posterior facial height and an increase in anterior facial height. The mean AB-MP angle exhibited a trend, being generally lower in open bite subjects than controls. It was significantly lower in male

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anterior open bite subjects (63.11^0) than the control group (66.52^0). The significance was also reflected in the pooled sample probably as a result of an increase in anterior and lower facial height. Beane et al.[17] and Klm[5] also obtained AB-MP angle values which were lower in open bite subjects (67.96^0, 67^0 respectively) than the control (70.97^0, 74^0 respectively). The latter however used a Caucasian sample with a mean age of 12 years and set the requirements in the open bite group at 0mm for anterior open bite.

Jones[19] in a cephalometric study which was carried out on thirty two black North American open bite patients showed the ODI to be smaller for this group (66.14^0) than for the white norms(74.5^0) established by Steiner.[20] His study however compared ODI in black open-bite patients with Caucasian ODI norms. Beane et al.[17] reported a value of 69.18o in black American anterior open bite patients. Both these readings are far below readings by Kim et al.[18] 71.63^0 in a non-growing anterior open bite Caucasian population aged 17-37 years (deficiencies in this study include few males in the sample population). This suggests an open-bite tendency in blacks. A national survey of malocclusion in the United States[21] carried out from 1988 to1991 showed that 6.6% of blacks had an open bite compared with 2.9% of whites indicating a greater tendency of anterior open bite occurrence in this population. The open bites in blacks were more severe as well as being more prevalent.

The ODI has been touted as the most reliable indicator of open bite tendency and the lower the ODI, the greater the chance of an anterior open bite being present. [1,5,6]

A clinical and cephalometric evaluation by Freudenthaler et al.[22] on 122 Caucasians revealed that the ODI differed significantly between the deep and normal bite groups as well as between the deep and open bite groups. In the present study, the generally low readings indicate an open bite tendency in the Nigerian population as a whole when compared with other black populations. The mean value was significantly lower in both male (63.57^0) and female (62.76^0) open bite groups when compared with the controls. The pooled value (63.13^0) was also significantly lower when compared with that in the control group (66.85^0). The ODI value for AOB patients in this study was lower than values obtained in a black American[17] anterior open bite population of 69.18^0 and even lower for a Caucasian[18] open bite population of 71.63^0. This seems to infer that Nigerians have an even greater tendency towards an open bite than black Americans. Katsaros and Berg[23] stated that a value of 68^0 or less is an indication of skeletal open bite tendency in the population they studied, but this value should probably be reviewed for a black population. The control values recorded by Beane et al. [17] of 72.09^0 and even the present study (66.85^0) are lower than Kim's norms of 74.5^0 in a Caucasian[5] population indicating that norms for the latter cannot be used as a yardstick when treating a black population. The mean ODI in open bite Koreans[24] of 60.86^0 was on the other hand much less than what was recorded in the present study which could have been as a result of forward positioning of the B point in this population in which Class III skeletal pattern is common.

Conclusion

Findings showed that both components of the ODI (the AB-MP and FH-PP angles) were significantly decreased in those with anterior open bite when compared with normal subjects. It also revealed that although the ODI was decreased in both male and females with AOB, the decrease was affected by the FH-PP angle in females and the AB-MP angle in males.

The findings confirm that the overbite depth indicator of Kim is a reliable indicator for open bite tendency. They also show that Nigerians generally display a tendency toward an open bite when compared to Caucasians.

Contributors

Adediran VE, was responsible for the study design, acquisition, analysis and interpreting the data and writing of the study
daCosta OO, was responsible for the concept, study design, acquisition, analysis, interpreting the data and writing the study
Utomi IL, was responsible for study design, acquisition, analysis and editing

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