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RESEARCH ARTICLE

ANTERIOR OPEN BITE- A CEPHALOMETRIC EVALUATION OF SKELETAL PATTERN IN BENGALI POPULATION

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ABSTRACT

Background: There are racial variation in the characteristic features of anterior openbite among different population groups in the world. The purpose of this comparative study was to find out significant skeletal differences between Bengali anterior openbite and normal subjects to identify any peculiarity in skeletal factors that may help to categorize the skeletal pattern of anterior openbite in this particular population. **Methods:** Lateral cephalometric film of 30 Bengali subjects having anterior openbite were compared with lateral cephalometric film of 30 normal Bengali subjects by skeletal parameters. **Results:** Statistically significant difference were foundin skeletal pattern between the groups. **Conclusion:** Bengali open bite subjects are mainly characterized by long lower anterior face, vertical growth pattern with downward & backward rotation of mandible.

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INTRODUCTION

Dentofacial esthetics plays an important role in social interaction and psychological well-being, because it affects how people perceive themselves and how they are perceived by the society. People with malocclusion may be at greater risk of developing psychological problems including unfavorable social response, negative stereotyping and low self-esteem. Some malocclusions disfiguring the facial proportion along with the overlying soft tissue curtain can be easily noticed by the common people, especially those almost exclusively limited to anterior part of mouth, like anterior open bite. According to T. M. Graber (Graber T.M. 2005) "Open bite is descriptive of a condition where a space exists between the occlusal or incisal surfaces of maxillary and mandibular teeth in the buccal or anterior segments, when the mandible is brought into habitual or centric occlusion." Depending on the location, open bite is of two types, anterior open bite and posterior open bite. Anterior open bite (AOB) (Houston 1996) Prevalence (William R 2007) of AOB varies greatly between racial/ethnic groups. In U.S. population anterior open bite (negative overbite > - 2 mm) occurs in less than 1 % and is five times more prevalent in blacks than whites or Hispanics. Anterior open bite has been grouped (Nahoum H 1975) into two broad categories. The first category consists of acquired or dental open bite, which do not show any craniofacial disfiguration and the second group consists of skeletal open bite, which shows craniofacial dysplasia in addition to the dental open bite. The term "skeletal open bite" was first coined by Subtelny & Sakuda (Subtelny JD 1964) in 1964.According to Ravindra Nanda(Nanda R 2005), often this malocclusion is the result of combination of both skeletal as well as dento-alveolar factors and skeletal open bite may be camouflaged by over eruption of anterior teeth making classification difficult. Etiology of anterior openbite is multifactorial (Watson WG 1981), broadly divided into, genetic factors and environmental factors. Genetic component (Nanda R 2005), is related primarily to the patient's inherent growth potential and environmental factors that may contribute to this malocclusion may be tongue size (Woldford LM 1996) or posture (Woldford

LM 1996) (Kydd WL 1996), digit sucking habits(William R 2007), mouth breathing(Nahoum H 1975), neuromuscular disturbance(English JD 2002), pathological condition (Wolford LM 1997), iatrogenic. In 1931 Broadbent(Broadbent BH 1931) and Hofrath introduced radiographic cephalometry, which provides a better and more accurate diagnostic way of recording, measuring, quantifying skeletal morphology. The Bengali people(Wikipedia, Encyclopedia)are an ethnic community native to the historic region of Bengal (now divided between Bangladesh and India) in South Asia. They speak Bengali, which is an Indo-Aryan language of the eastern Indian subcontinent, evolved from the Magadhi Prakrit and Sanskrit languages. They primarily belong to Indo-Aryan and Mongolo-Dravidian stock. They are mostly concentrated in Bangladesh and the states of West Bengal and Tripura in India.There is a large racial variation in the incidence and characteristic features of anterior open bite among different population groups throughout the world. The purpose of this study was be to evaluate and characterize skeletal features of anterior open bite and compare them with normal subjects by lateral cephalometric radiograph with the hope that those findings may be useful for diagnosis, treatment planning, prognosis & post-treatment stability for Bengali population in near future.

MATRIALS AND METHODS

Lateral cephalometric radiographs for this study were collected from the Department of Orthodontics, Dr. R. Ahmed Dental College & Hospital, 114, A. J. C. Bose Road, Kolkata-700014. Clearance from institutional ethics committee was obtained. 30 subjects selected with anterior open bite (clinically having at least 1 mm of open bite) were included and 30 subjects were selected as control group with Angle's class-I molar relationship, normal overbite and having ANB angle of 2-4^0, randomly. All subjects were of Bengali population only, having complete permanent dentition in upper & lower arches except third molars and without any individual tooth malformation or pathology, with no history of previous or ongoing orthodontic intervention.No attempt was made to distinguish differences by gender. Age and sex distribution of both the groups was quite similar.Standardized lateral cephalometric radiographs of all the subjects were selected with same magnification (as all the radiographs were taken with same machine & by same operator). Tracings were done on 0.003-inch acetate matte tracing paper and 3H hard lead pencil for tracing.This is a cross-sectional study and duration of the study is about one and half years.

Specific skeletal parameters used for this study

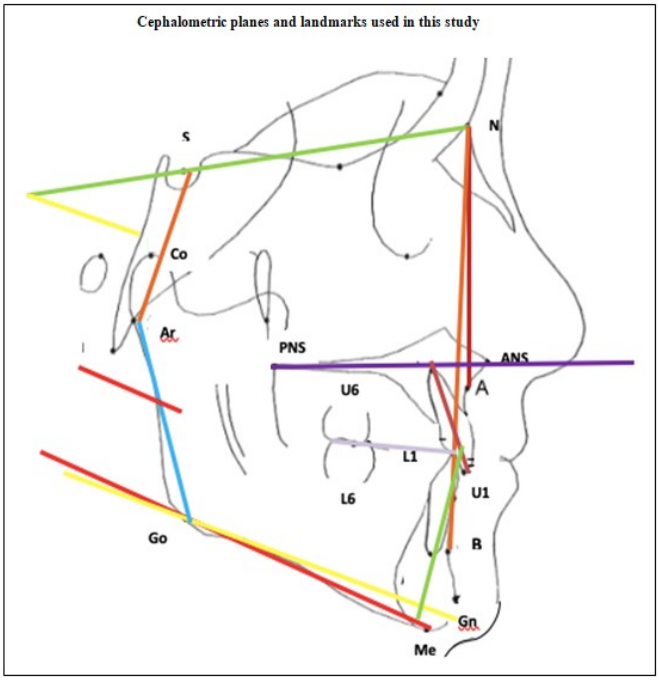
In antero-posterior plane

- SNA: Angle formed between SN plane and NA line(Richard R 1952).
- SNB: Angle formed between SN Plane and NB line(Richard R 1952).
- ANB: Difference between SNA & SNB(Richard R 1952).
- Maxillary Unit length (MxUL): Linear measurement from ANS to Condylion.
- Mandibular Unit length (MdUL): Linear measurement from Gnathion to Condylion.
- Unit Difference: MdUL minus MxUL.

In vertical plane

- Upper Facial Height (UFH): Linear measurement from Nasion to ANS.
- Lower Facial Height (LFH): Linear measurement from ANS to Menton.
- UFH/ LFH: Ratio between Upper & Lower face height.
- Posterior Facial Height (PFH): Linear measurement between Sella to Gonion.
- Anterior Facial Height (AFH): Linear measurement between Nasion to Menton.
- PFH/ AFH: Ratio of Posterior to anterior face height.
- Ar-SN: Angle formed between SN and Sella-Articulare plane.
- SN-GoGn: Angle formed between SN and GoGn plane.
- Gonial angle (GA): Angle formed between Ar-Go and Go-Me plane.
- OP-MP: Angle formed between occlusal plane (OP) & Mandibular plane (Go-Me.
- PP-MP: Angle formed between Palatal plane (PP) & Mandibular plane (Go-Me).
- OP-PP: Angle formed between occlusal plane & Palatal plane.

Data were collected from Cephalometric evaluation for statistical analysis.



RESULTS AND ANALYSIS

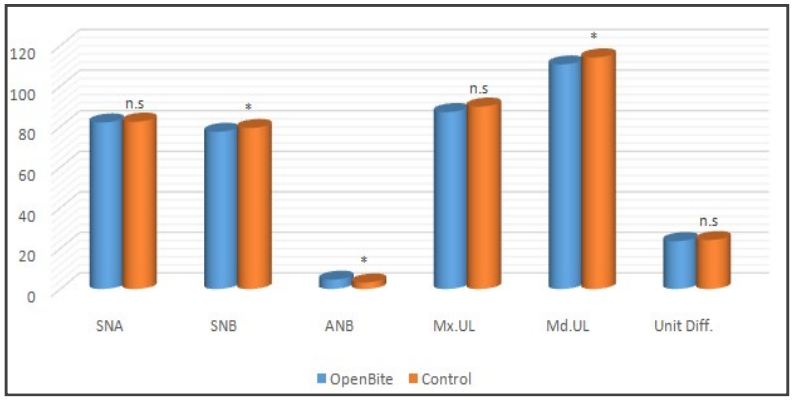
Microsoft office Excel 2007 and Minitab version 15 (Key maker Core Inc., 2011) were the data analysis tools used for this study. Calculation included the Descriptive Statistical analysis of comparison between open bite and Normal subjects by performing the student t-tests (Unpaired t-tests). The results are reported for antero-posterior and vertical, skeletal measures. In Table 1-2 the means, standard deviations, standard errors, t values, p values are given for both the groups after statistical analysis of data through "Unpaired t test". Table 1 and figure 1 shows comparison of Skeleton Antero-posterior Cephalometric Measurements.

Table 1. Comparison of Skeletal Antero-posterior Cephalometric Measurements

	OPEN BITE			CONTROL				
Variables	**Mean**	**SD**	**SE**	**Mean**	**SD**	**SE**	**t value**	**P value**
SNA	82.1	3.12	0.57	82.53	2.08	0.38	-0.63	0.53 ns
SNB	77.53	3.87	0.71	79.4	2.16	0.39	-2.31	0.026 *
ANB	4.6	3.41	0.62	3.2	0.925	0.17	2.17	0.037 *
MxUL	87.25	5.53	1	89.93	5.05	0.92	-1.96	0.055 ns
MdUL	110.72	6.56	1.2	114.2	4.65	0.85	-2.37	0.021 *
Unit Diff.	23.6	4.69	0.86	24.13	3.15	0.57	-0.52	0.607 ns
n.s = non-significant; *significant at 5% level (p< 0.05); ** significant at 1% level (p<0.01)								

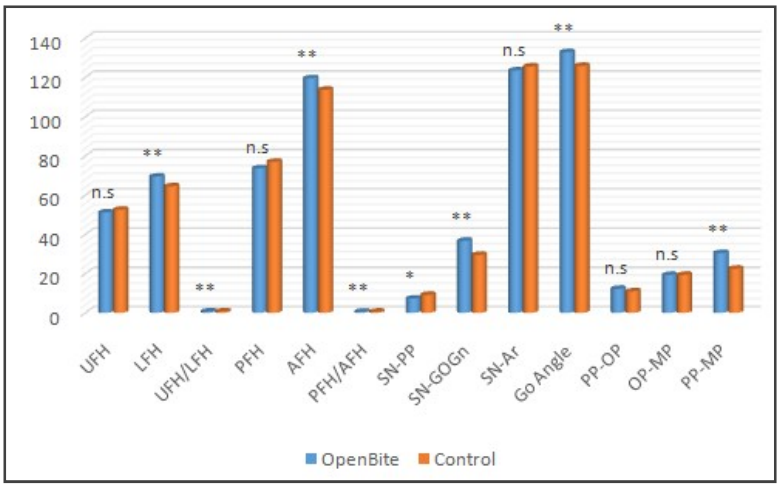
Table 2. Comparison of Skeleton Vertical Cephalometric Measurements

OPEN BITE				CONTROL				
Variables	**Mean**	**SD**	**SE**	**Mean**	**SD**	**SE**	**t value**	**P value**
UFH	51.22	3.4	0.62	52.6	3.97	0.72	-1.45	0.152 ns
LFH	69.55	7.78	1.4	64.55	5.03	0.92	2.96	0.005 **
UFH/LFH	0.74	0.089	0.016	0.81	0.07	0.013	-3.41	0.001 **
PFH	73.77	5.82	1.1	77.02	6.98	1.3	-1.96	0.055 ns
AFH	119.62	7.2	1.3	113.75	8.28	1.5	2.93	0.005 **
PFH/AFH	0.62	0.047	0.009	0.67	0.034	0.006	-4.10	0.00 **
SN-PP	7.3	3.13	0.57	9.2	2.85	0.52	-2.46	0.017 *
SN-GoGn	36.83	7.11	1.3	29.6	3.82	0.7	4.91	0.00 **
Ar-SN	123.67	5.36	0.98	125.6	4.85	0.89	-1.46	0.149 ns
Gonial angle	132.93	6.72	1.2	125.93	4.78	0.87	4.65	0.00 **
PP-OP	12.3	5.22	0.95	11	19.9	3.6	0.34	0.738 ns
OP-MP	19.38	7.78	1.4	19.4	19.4	3.6	0.1	0.917 ns
PP-MP	30.5	8.79	1.6	22.53	4.13	0.75	4.45	0.00 **
n.s = non-significant; * significant at 5% level (p< 0.05); ** significant at 1% level (p<0.01).								



n.s = non-significant; *significant at 5% level (p< 0.05)

Figure 1. Comparison of Skeletal Antero-posterior Cephalometric Measurements



n.s = non-significant; * significant at 5% level (p< 0.05); ** significant at 1% level(p<0.01).

Figure 2. Comparison of Skeleton Vertical Cephalometric Measurements

The skeletal anterior-posterior measures are given in Table 1 Angle SNB, ANB and liner measurement of MdUL is statistically different in both the groups. SNB value is lesser (p: 0.026) and ANB value is higher (p: 0.037) in open bite than control group. Mandibular length (MdUL) is slightly smaller (0.021) in open bite than control group. The skeletal vertical comparative data are provided in Table 2 there are a number of significant differences observed in this category. The lower facial height (LFH; p: 0.005) and anterior face height (AFH; p: 0.005) were statistically different, with the open bite group, having longer lower anterior face height. The ratio of upper facial height to lower facial height (UFH/LFH) was smaller in the open-bite group (0.74 vs. 0.81) and highly significant statistically (p: 0.01). The ratio of posterior facial height to anterior facial height (PFH/AFH) was significantly different (p: 0.000) between the two groups, having lesser PFH/AFH ratio in open bite group (0.61) than control (0.67). Angle SN-GoGn, angle PP-MP, Gonial angles are statistically different at high level (p values for all are 0.000), all angles are larger in open bite group than control. SN-PP angle is statistically different (p: 0.017) between both groups, having lesser value in open bite group then control group.

DISCUSSION

This study compares the data obtained from lateral cephalometric radiograph between the anterior open bite subjects and subjects with normal occlusion of Bengali population in an attempt to locate and differentiate the changes in different skeletal patterns.Among the antero-posterior skeletal measurements angle SNA (mean value 82.1^0) appears similar in both the groups. A decreased SNB (mean77.53^0), increased ANB (mean 4.6^0) and shorter Mandibular length (mean 110.72 mm) are found in AOB subjects than control group, suggesting a retrognathic position of mandible with respect to anterior cranial base and a skeletal class II tendency in AOB subjects. Maxillary length and maxillo-mandibular unit difference have no apparent association with the presence or absence of anterior open bite in these Bengali subjects as they appeared similar in both the groups. Subtelny&Sakuda(Subtelny 1964), did not observed any change in angle SNA, but angle ANB was smaller in anterior open bite (AOB) subjects than control subjects. F. M. Hapak(Hapak FM 1964), did not found any significant change in SNA angle (mean 79.27^0) and SNB angle (mean75.79^0), in comparison to Riedel's normal values (SNA 80.7^0& SNB 78^0) after his study on Caucasian population. Osmond.G.Jones(Gones OG 1989), after investigation on of North American black patients, he did not found any change in angle SNA (85.7^0), but he observed less value of angle SNB (79^0) in open bite patients than black norms (established by Attemus& Drummond). Frost et al(Frost DE 1980), noticed lesser value of angle ANB in open bite subjects than control subjects. Gloria Lopez-Gavito et al(Lopez GG 1985), observed the mandible was retrognathic with significantly smaller values for the SNB angle and higher values for the SNA, ANB angles in open bite subjects. W. M. Tsang et al(Tsang WM 1998) found, a decreased SNA angle in the Chinese AOB subjects and the SNB angle remained similar to the control group. C. T. Kao(Kao CT 1997) & T. H. Huang noticed SNA and SNB values of AOB group were smaller than the corresponding values of normal group among Taiwan population. The skeletal vertical dimension is a major factor in the increased tendency towards open bite in this present study.

The open-bite group, on average, have longer lower anterior faces than the normal control group as indicated by the increased lower (mean 69.55 mm) and anterior facial height (mean 119.62 mm) in AOB subjects. As the mean difference of upper face height between both groups was not statistically significant, LFH may be the important contributing factor in causation of increased anterior facial height in AOB subjects which is further supported by lower UFH:LFH in AOB group (mean 0.74) than control (mean 0.81) subjects. The average ratio of PFH: AFH (mean 0.61 in AOB, 0.67 in control) was statistically different and reflected as an increase in anterior facial height. No difference is found in posterior facial height between both the groups in the present study. In a cephalometric analysis proposed by Wylie (Wylie W 1952)& Johnson, the vertical proportions of the normal face were measured along the line Nasion-Menton. The anterior nasal spine (ANS) served as the point of separation between the upper and the lower face. The ratio of upper face height to total face height (UFH/TFH) was reported as 0.436 for males and 0.432 for females. Nahoum (Nahum HI 1971), demonstrated that the UFH/LFH ratio was lesser for open bite subjects and was reasonably constant at all ages. Upper face height was smaller, but lower face height was sufficiently larger so as to make the total face height of open bite subjects slightly greater when compared to the normal subjects. Thomas. J. Cangialosi (Cangialosi TJ 1984), observed decreased upper face height to lower face height ratio and decreased posterior face height to anterior face height ratio in open bite group than control group. S. K. Nanda(Nanda SK 1988) , noticed increased lower anterior face height in open bite persons but posterior face height and ramal height were not significantly different between open and deep bite subjects. David. E. Frost et al(Foster DE 1980), did not found any difference in UFH between open bite & control group. They observed increased total anterior face height and shorter posterior face height in anterior open bite group than normal control. Richard.

A Beane et al (Beane RA 2003), found significantly longer lower anterior face height and it was an important contributing factor which was responsible for increased total anterior face height. It was also reflected in lesser value of PFH/AFH. W. M. Tsang et al(Tsang WM 1998), after study a on Chinese people, they noticed that both the total and the lower anterior facial height (AFH and LAFH) were significantly longer in the AOB group than in the control group but, the upper anterior facial height was found not to be a significant factor which indicated that the increase in the AFH is a result of the elongated lower face. Hapak(Hispak FM 1964) , Subtelny&Sakuda(Subtelny JD 1964), Fields(Fields HW 1984), also found relatively constant upper face height and increased lower anterior face height in AOB subjects in previous studies. Richardson(Richardson A 1969), Sassouni(Sassouni V 1964)& Nanda, Hapak(Hapak FM 1964) , G.L.Gavito(Gavito GL 1985), noticed increased lower face height in AOB subjects. Fields(FieldsHW 1984), Sassouni& Nanda(Sassouni V 1964), observed no difference in posterior face height between AOB & normal subjects, though some previous studies by Cangialosi(Cangialosi TJ 1984), Subtelny&Sakuda(Subtelny JD 1964) had reported that open bite patients tend to have shorter posterior face height.The main contributing skeletal elements of the face are jaw bones which are attached to the under surface of cranial base, so inclination of cranial flexion affects the jaw position.

In present study, no differences are noticed in cranial base angle (NS-Ar), PP-OP and OP-MP angle between both the groups. Subtelny & Sakuda (Subtelny JD 1964) did not found any difference in the angulations cranial base between AOB and control subjects. W. M. Tsang et al(Tsang WM 1998) observed cranial base angle (NS-Ar) was smaller in AOB deformity in Chinese population. Richardson(Richardson A 1969), reported that the cranial base flexure in African-Americans is more obtuse in both males and females. When comparing the cranial base of black and white adult subjects, David D'Alosio(David DA 1992) and Pangrazio- Kulbersh found that the cranial base in blacks was shorter, steeper, and flatter. In the present study, the SN-PP angle is smaller in AOB (mean 7.3^0) group than control (mean 9.2^0) group, suggesting upward canting of palatal plane anteriorly in relation to anterior cranial base in Bengali open bite subjects, which may contribute to the degree of severity of anterior open bite. So it may be anticipated that the lack of compensatory remodelling mechanism in response to internal rotation of maxilla during growth period is operating in AOB subjects. Increased angulations are noticed in SN-GoGn angle (mean 36.83^0), Gonial angle (mean 132.93^0) and MP to palatal plane angle (mean 30.5^0) in AOB subjects. All these measurements indicate a downward rotation of the mandible in the open-bite group and are major indicators of open bite tendency. It may be expressed in the following way when the palatal plane is tipped downward posteriorly; it carries the molars downwards, resulting a concomitant backward rotation of mandible. So there is a consequent increase in lower anterior face height and increase in palate-mandibular basal angle this phenomenon is beautifully described by Bjork (Bjork A 1983) and Skeiller (1983). Nahoum(Nahoum HI 1972) foundthat, the angles SN-MP and PP-MPwere greater but SN-PP was smaller in the open-bite subjects. He found increased FM-MP angle (33.4^0), Y axis (65.92^0), and NS-GoGn angle (38.56^0).Thomas. J. Cangialosi (Cangialosi TJ 1984) found significantly greater SN-GoGn angle for the open bite group as compared to the normal group. The means were 38.3^0 for the open bite subjects and 29.8^0 for the normal subjects. The gonial angle for the open bite group was also found significantly greater, with a mean of 132.5^0 as compared to 123.9^0 for the normal group. The PP-GoGn angle, was found to be greater in open bite, with means of 3 1.4^0 for open bite patients and 21.9^0 for normal subjects.

The mean SN-PP angles for open bite and normal subjects were 7.1^0 and 8.2^0, respectively, but were not statistically significant. Gloria Lopez-Gavito et al(Gavito LG 1985) noticed that, in the open bite sample, the palatal plane was canted up anteriorly toward the cranial base, resulting in a significantly smaller SN-PP angle. Although total anterior facial height (N-Me) did not show significant differences between the two groups, the patients with open bite exhibited a significantly reduced upper anterior facial height (N-ANS), while the lower anterior facial height (ANS-Me) was increased. David. E. Frost et al(Fostr DE 1980) found significant difference in SN-OP angle (20.3^0 in AOB & 14.3^0 in CG), PP-OP angle (13.4^0 in AOB & 6.9^0 in CG).Richard .A Beane et al(Beane RA 2003) observed increased angle SN-GoGn, increased mandibular plane angle and increased angle PP-MP in open bite group than control group.C. T .Kao(Kao CT 1997) & T. H. Huangafter a study on Taiwan ethnic group they found, open bite samples having high mandibular plane angle & Frankfort –mandibular plane angle ,increased lower gonial angle, long anterior face height.W. M. Tsang et al(Tsang WM 1998)found angular measurements were significantly larger in the Chinese AOB subjects: the mandibular plane to anterior cranial base (SN-MP), the gonial angle (GOA), and the lower gonial angle (LGOA).In some previous studies Nahoum (Nahoum HI 1971) , G.L.Gavito(Gavito GL 1985), Trutone (Trutone JC 1983), observed reduced palatal plane angulation in respect to anterior cranial base with upward anterior canting of palatal plane in open bite subjects. These are consistent with the findings for white subjects of Sassouni and Nanda(Sassouni 1964). Hapak(Hapak FM 1964) indicating a downward growth of the mandible as a key factor in the formation of the AOB. With the combination of an upward and forward rotated maxilla and a downward and backward rotated mandible, it was not surprising to find that the palatal plane to mandibular plane angle (PP-MP) was significantly larger in the AOB subjects. Enlow's (Enlow DH 1982) counterpart analysis, proposed that a combination of craniofacial components work together to produce a vertical dysplasia. In the case of the open bite, a high mandibular plane angle, obtuse gonial angle, long lower face, increased dental proclination have consistently been identified as contributors to this vertical problem. In this study, all these factors are present to a greater degree in Bengali open-bite subjects than in the normal sample. The findings in this study may have some important clinical implications. When treating a Bengali patient with an open bite, it is clear that the clinician should avoid increasing the anterior facial height. Extrusion of the posterior teeth should be prevented to avoid downward & backward rotation of mandible and increase in anterior face height, though I have not found any difference in posterior height of the molars between the two groups. Nahoum (Nahoum HI 1975) stated that patients with an UFH/LFH ratio below 0.650 are poor risks for conventional orthodontic treatment and that a surgical procedure should be considered in these cases. Knowledge of difference in skeletal morphology in persons with open bite and normal persons can also help in determining those cases that will require a combination of orthodontics and surgery to obtain a satisfactory functional and esthetic result.

CONCLUSION

This study confirms the findings of past studies that the skeletal pattern plays a significant role in producing an anterior openbite malocclusion. The conclusive findings appear from this study that, Bengali anterior open bite subjects are associated with greater anterior face height mainly contributed by lower anterior face, larger SN-GoGn angle, the gonial angle and the PP-MP angle. Finally, it can be concluded that, Bengali open bite subjects are mainly characterized by long lower anterior face, vertical growth pattern with downward & backward rotation of mandible.

Conflict of interests: None.

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