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Craniofacial cephalometric analysis of Bangladeshi and Japanese adults with normal occlusion and balanced faces: A comparative study

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ABSTRACT

Aims: To determine the cephalometric norm among Bangladeshi adults and to investigate the differences in craniofacial morphology compared with Japanese and Caucasian normative data.

Materials and Methods: Cephalometric radiographs were obtained from 46 Bangladeshi males (mean age 23.8 years) and 52 Bangladeshi females (mean age 24.6 years). Inclusion criteria were the following: Both parents from the same ethnic group, class-I occlusion with an arch length discrepancy less than 2 mm, overbite and overjet from 2 to 4 mm, balanced face, all teeth present except third molar, no previous orthodontic treatment, and no prosthetic replacement of teeth. Nine angular and five linear measurements were constructed for skeletal hard tissue analysis, four angular and six linear measurements for dental hard tissue analysis, and two angular and seven linear measurements for soft tissue analysis. Mean and standard deviations of measurements were determined for each gender. Polygonal chart and profilogram were made. Independent *t*-test was used to determine differences.

Results: The present Bangladeshi population has a smaller lower face height ($P<0.01$) and the antero-posterior position of the maxilla and mandible was found to be significantly ($P<0.01$) more protruded compared with the Japanese and the Caucasian norms. Significantly ($P<0.01$) more protruded upper incisor, less steep occlusal plane, and thinner soft tissue chin were the characteristics in Bangladeshi adults.

Conclusions: Relative to the cranial base (SN), the maxillo-mandibular complex was more anteriorly placed compared with the Japanese and Caucasian adults. Further, the effective length of the maxilla and mandible was shorter compared with the Japanese and Caucasian adults. These findings should be considered carefully during orthodontic treatment planning of Bangladeshi adults.

Key words: Bangladeshi, cephalometry, craniofacial structures, Japanese

INTRODUCTION

Interest of orthodontists in facial contours and their racial variability has brought about decades of craniofacial contour investigations of many racial and ethnic groups. Most of these have the objective of evaluating specific types of malocclusions against standards or "norms" established for the particular racial or ethnic groups. Presently we have excellent data on cephalometric norms of many population groups. These include Japanese,[1,2] American Whites,[3-5] Chinese,[6,7] Australian aborigines,[8,9] Swedes,[10] Africans,[11] Hawaiians,[12] and Canadians.[13] Remarkable differences have been identified in skeletal features and soft tissue profile among White Americans, Europeans, African-Americans, Koreans, Japanese, and Chinese populations. In Asian societies, the frequency of class-III malocclusions is higher than in Caucasians.[14] Facial differences even between White populations of distinct continents or countries have been reported previously.[15]

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However, there has been no conclusive investigation on this matter undertaken on the people of Bangladesh, a part of the Indian subcontinent, ethnically called "Bangali", who have distinct facial and physical characteristics with distinct lifestyle and culture of their own. As the number of patients seeking orthodontic treatment is increasing in recent days, orthodontic treatment is gradually becoming more and more popular in this region. But, because of lack of conclusive findings, cephalometric evaluation of orthodontic patients in Bangladesh has not yet been used as a valuable orthodontic record. There is no norm with which to assess the degree of deviation of orthodontic cases. Most of the orthodontists rely merely on normative data of Japanese or Caucasian population groups. The purpose of this study was to determine the cephalometric norm among Bangladeshi adults and to investigate the nature and degree of their differences with the normative data of Japanese and Caucasian population groups.

MATERIALS AND METHODS

Six hundred dental students of Dhaka Dental College at Dhaka University were screened for the investigation that represents subjects from all over the country. The study was performed in accordance with the guidelines of the Helsinki Declaration (2008). Ethical approval for the study was obtained from both Dhaka Dental College and Hospital Research Ethics Committee (memo no. 341) and Niigata University Research Ethics Committee (approval no. 22-R25-10-10). Consent forms, including the outline of the proposed research and privacy terms, were distributed to all chosen subjects. All subjects were dental students themselves and at one point of their educational course they were required to carry out cephalometric analysis on their own lateral cephalometric radiograph for learning purpose. Among those chosen, subjects who already had their own radiograph were not exposed twice; rather the existing radiograph was used. Inclusion criteria were the following: Both parents from the same ethnic group, class-I occlusion with an arch length discrepancy less than 2 mm, overbite and overjet from 2 to 4 mm, all teeth present except third molars, no previous orthodontic treatment, and no prosthetic replacement of teeth. Facial aesthetic was not considered although any kind of imbalanced faces were excluded. Forty-six Bangladeshi males (mean age 23.8 years) and 52 Bangladeshi females (mean age 24.6 years) met the inclusion criteria. All lateral cephalometric radiographs were taken using the same digital cephalometric machine (Orthopantomograph OP100; Instrumentarium Imaging, Tuusula, Finland) by the same operator with the same cephalometric setup, with subjects positioned in the natural head position, with the Frankfort Horizontal Plane (FHP) of the patient parallel to the floor and the teeth in the maximum inter-cuspation with relaxed lips in order to maintain standardization of radiographs.

Cephalometric Analysis

All radiographs were digitized on a computer by one author in order to eliminate inter-examiner variability, using a cephalometric software program (Winceph 5.5; Rise, Sendai, Japan). Since all linear measurements had no enlargement factor included, no correction was needed for the cephalometric measurements. Nine angular and five linear measurements were constructed for skeletal hard tissue analysis [Figure 1a and b], four angular and six linear measurements for dental hard tissue analysis [Figure 2a and b], and two angular and seven linear measurements for soft tissue analysis [Figure 3]. Mean and standard deviations for hard and soft tissue measurements were determined for each gender. To compare with cephalometric measurements of other population groups, the adult skeletal, dental, and soft tissue norms of Caucasian and Japanese groups were derived from the analyses developed by Riolo *et al*.,[16] McNamara,[17] Miyajima *et al*.,[1] Iizuka and Ishikwa,[2] Ioi *et al*.,[18] Legan and Burstone,[19] Bishara *et al*.,[20] and Burstone.[21] Polygonal charts [Figures 4 and 5], which are composed of several skeletal and dento-alveolar measurements, were created for Bangladeshi males and females with normal occlusion, and were compared with those of Japanese standards analyzed by Iizuka and Ishikawa[2] [Figures 4 and 5]. A profilogram was also made for the Bangladeshi male and female group using the *x* and *y* coordinates of the mean value of selected measurement points. Profilogram comparison [Figures 6 and 7] between Bangladeshi population and Japanese population was done using Sakamoto's Japanese data.[22] Sakamoto's Japanese norm values were divided by 1.1 to compensate for the 10% radiograph enlargement factor in it. The description of the Caucasian and Japanese samples used for comparison is provided in Table 1.

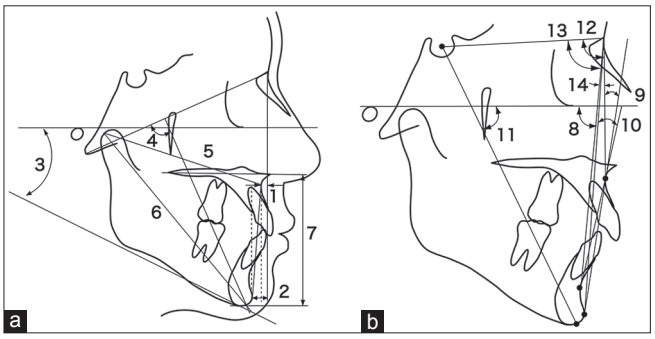

Figure 1: (a) Skeletal hard tissue cephalometric variables: 1 (Nasion perpendicular to point A) – The distance between Nasion perpendicular line and point A measured perpendicular to the Nasion perpendicular line; 2 (Pog to Nasion perpendicular) – The distance between Pogonion and the Nasion perpendicular line measured perpendicular to the Nasion perpendicular line; 3 (Frankfort to mandibular plane angle) – The angle between Frankfort Horizontal Plane (FHP) and the mandibular plane; 4 (facial axis angle) – The angle formed by the Basion–Nasion plane and the plane from foramen Rotundum to Gnathion; 5 (effective mid-facial length) – The distance between Condylion to point A; 6 (effective mandibular length) – The distance between Condylion to Gnathion; 7 (lower face height) – The distance between ANS and Menton measured perpendicular to FHP. (b) Skeletal hard tissue cephalometric variables: 8 (facial plane angle) – The angle between Nasion–Pog line and FHP; 9 (convexity) – The angle between Nasion–point A line and Pog–point A line; 10 (A–B plane) – The angle between Nasion–Pog line and point A–point B line; 11 (*y*-axis) – The angle between FHP and Sella–Gnathion line; 12 (SNA) – The angle between Sella–Nasion line and Nasion–point A line; 13 (SNB) – The angle between Sella–Nasion line and Nasion–point B line; 14 (ANB) – The angle between Nasion–point A line and Nasion–point B line

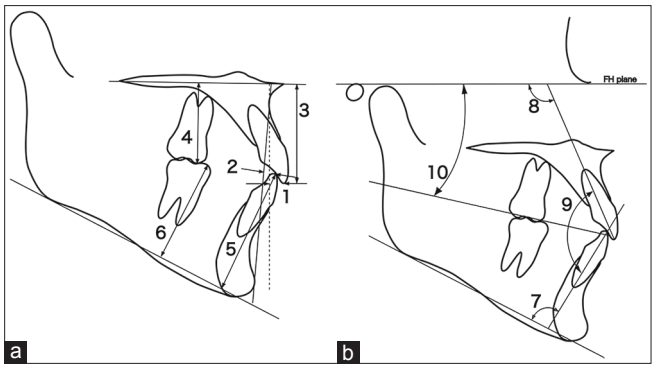

Figure 2: (a) Dental hard tissue cephalometric reference landmarks and variables: 1 (upper incisor to point A vertical) – The distance between the facial surface of the upper incisor and point A measured perpendicular to the Nasion perpendicular line; 2 (lower incisor to A–Po line) – The distance between the edge of the lower incisor and a line from point A to pogonion; 3 (upper incisor to palatal plane) – The distance from the edge of the upper incisor to the palatal plane; 4 (upper molar to palatal plane) – The distance from the mesial cusp of the upper first molar to the palatal plane; 5 (lower incisor to mandibular plane) – The distance from the edge of the lower incisor to the mandibular plane; 6 (lower molar to mandibular plane) – The distance from the mesial cusp of the lower first molar to the mandibular plane. (b) Dental hard tissue cephalometric landmarks and variables: 7 (lower incisor to mandibular plane angle) – The angle formed by the long axis of the lower incisor and the mandibular plane; 8 (upper incisor to FHP angle) – The angle formed by the long axis of the upper incisor and the FHP; 9 (inter-incisal angle) – The angle formed by the long axis of the upper and lower incisors; 10 (occlusal plane angle) – The angle formed by the occlusal plane and FHP

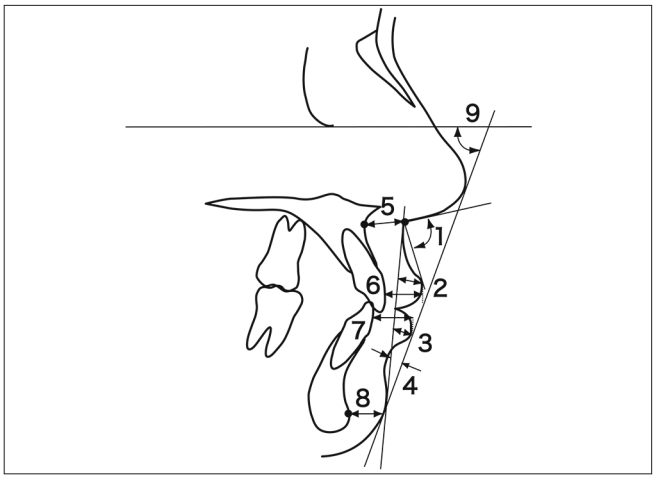

Figure 3: Soft tissue cephalometric landmarks and variables: 1 (nasolabial angle) – The angle formed by a line tangent to the base of the nose and a line tangent to the upper lip; 2 (upper lip protrusion) – The distance between labralesuperius and a line from sub-nasale to soft tissue pogonion; 3 (lower lip protrusion) – The distance between labraleinferius and a line from sub-nasale to soft tissue pogonion; 4 (labiomental sulcus) – The maximum depth from a line connecting soft tissue pogonion and the lower lip; 5 (point A to sub-nasale) – The distance from point A to sub-nasale measured parallel to the FHP; 6 (incision superioris to upper lip) – The distance from incision superioris to upper lip measured parallel to FHP; 7 (incision inferioris to lower lip) – The distance from incision inferioris to lower lip measured parallel to FHP; 8 (pogonion to pogonion') – The distance from hard tissue pogonion to soft tissue pogonion measured parallel to FHP; 9 (*Z* angle) – The angle formed by the intersection of FHP and a line connecting soft tissue pogonion and the most protrusive lip point

Method Error

Twenty randomly selected radiographs from the total observations were traced and digitized twice by the same investigator, with an interval of 14 days between tracings to help eliminate memory bias. Methodological tracing errors were assessed using Dahlberg's formula.[23] The error difference in angular cephalometric measurements ranged from 0.17 to 0.35 degrees and for linear measurements from 0.18 to 0.36 mm [Table 2]. Error was considered negligible.

Table 1: Gender distribution of the Caucasian, Japanese, and Bangladeshi samples used for comparison

Author and year	Mean age (years)		Sample size (*n*)	
	Male	Female	Male	Female
Skeletal and dental norms				
Riolo *et al.* (1974)	16	16	23	9
McNamara (1984)	30.8	26.7	38	73
Miyajima *et al.* (1996)	36	39	44	81
Iizuka and Ishikawa (1957)	23.6	19.6	50	50
Sakamoto (1959)	23.6	19.6	49	50
Ioi *et al.* (2007)	25.1	23.6	25	24
Soft tissue norms				
Legan and burstone (1980)	20-30	20-30	20	20
Bishara *et al.* (1985)	Adulthood	Adulthood	20	15
Burstone and marcotte (2000)	27.4	21.2	20	20
Ioi *et al.* (2007)	25.1	23.6	25	24
Present study	23.8	24.6	46	52

Table 2: Examiner reliability in measuring cephalometric variables used in the study

Variable	Dahlberg's value
Nasion perpendicular to point A (mm)	0.18
Pogonion to nasion perpendicular (mm)	0.17
Frankfort to mandibular plane angle (degree)	0.18
Facial axis angle (degree)	0.21
Effective mid-facial length (mm)	0.19
Effective mandibular length (mm)	0.21
Lower face height (mm)	0.34
Upper incisor to point A vertical (mm)	0.32
Lower incisor to A–Po line (mm)	0.34
Lower incisor to mandibular plane angle (degree)	0.31
Upper incisor to palatal plane (mm)	0.21
Upper molar to palatal plane (mm)	0.26
Lower incisor to mandibular plane (mm)	0.24
Lower molar to mandibular plane (mm)	0.26
Nasolabial angle (degree)	0.26
Upper lip protrusion (mm)	0.29
Lower lip protrusion (mm)	0.32
Labiomental sulcus (mm)	0.31
Point A to sub-nasale (mm)	0.26
Incision superioris to upper lip (mm)	0.29
Incision inferioris to lower lip (mm)	0.35
Pogonion to pogonion' (mm)	0.24
Z angle (degree)	0.36

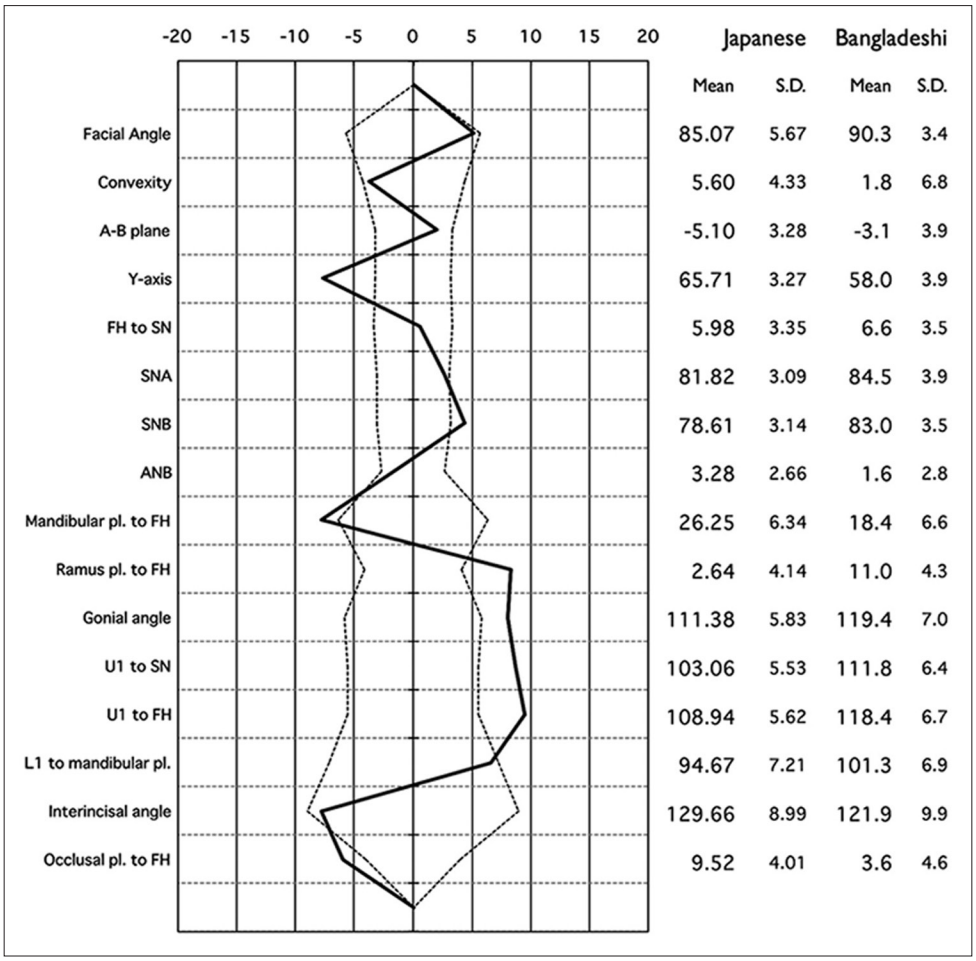

Figure 4: A polygon representation of the Bangladeshi male sample using means and standard deviations plotted against Iizuka and Ishikawa's Japanese data. The dark black line indicates the mean for the Bangladeshi sample. Low angle face and more protrusive dental occlusion were revealed

Statistical Analysis

Independent *t*-test was used to compare the mean differences of each cephalometric measurement between the Bangladeshi and other population groups. The minimum level of statistical significance was set at $P<0.01$.

RESULTS

The mean and standard deviations of the cephalometric measurements for the Bangladeshi males and females are shown and compared with the Japanese and Caucasian groups as in Tables 3 and 4.

Skeletal Relationship

Skeletally, the mandibular antero-posterior position in the Bangladeshi males and females was significantly more protruded compared with that of the Japanese and Caucasian groups. In the vertical dimension, Bangladeshi adults, both males and females, showed a significantly smaller mandibular plane angle and a significantly larger facial axis angle compared with the Japanese group, but the differences were not significant when compared with the Caucasian group. Bangladeshi adults had a significantly smaller lower facial height than both the Japanese and the Caucasian group.

Dental Relationship

Bangladeshi adults had a significantly more protruded upper incisor compared with the Japanese and Caucasian groups. Vertically, the distances of the upper incisor or molar to the palatal plane and the lower incisor or molar to the mandibular plane were significantly smaller in Bangladeshi subjects than both the Caucasian and Japanese groups. A smaller occlusal plane angle showed that the cant of the occlusal plane was significantly less steep compared with the Japanese and Caucasian groups.

Soft Tissue Analysis

The Bangladeshi group had significantly more protruded lip positions when compared with the Caucasian group, but it was significantly less in females as compared with the Japanese females. In males, there was no significant difference in lip protrusion between the Bangladeshi and Japanese group. In addition, the thickness of the soft tissue chin in the Bangladeshi adults was significantly thinner than that of the Japanese and Caucasian groups.

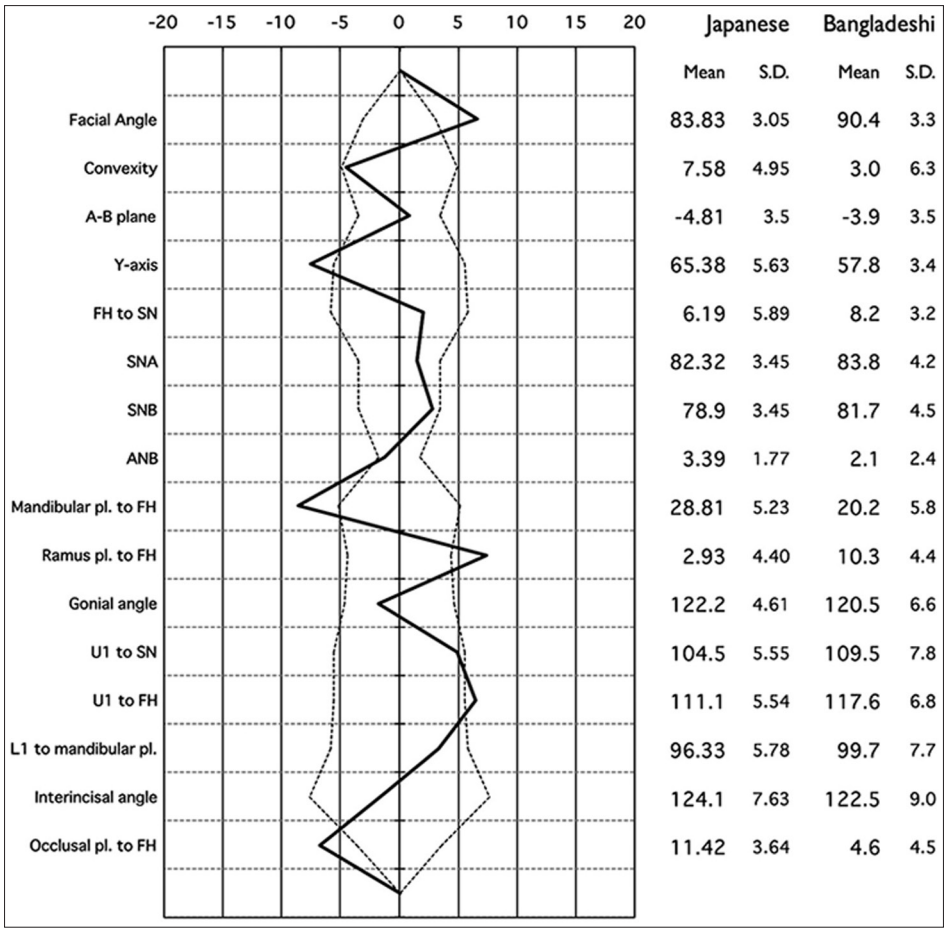

Figure 5: A polygon representation of the Bangladeshi female sample using means and standard deviations plotted against Iizuka and Ishikawa's Japanese data. The dark black line indicates the mean for the Bangladeshi sample. Low angle face and more protrusive dental occlusion were revealed

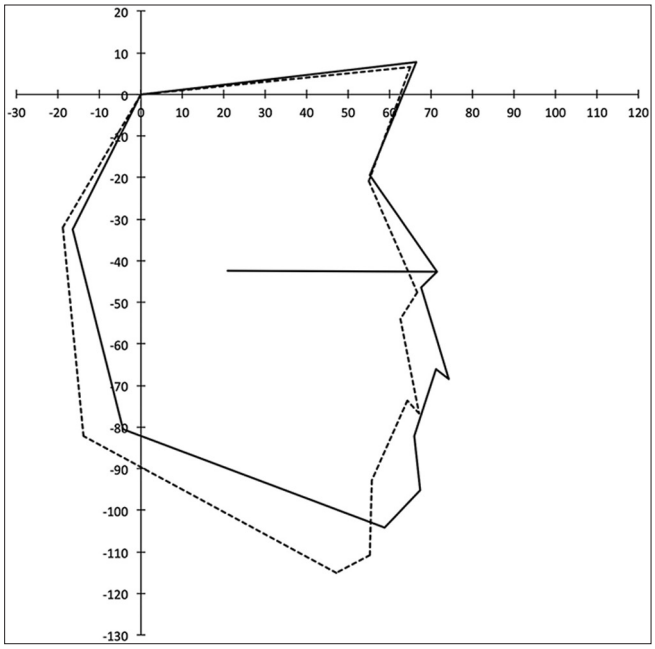

Figure 6: Superimposition of Japanese (dotted line) and Bangladeshi (solid line) profilograms for males was done by superimposing on FHP and registering on the Sella. Both upper and lower jaw relative to the cranial base in the Bangladeshi males were more anteriorly positioned than the Japanese sample

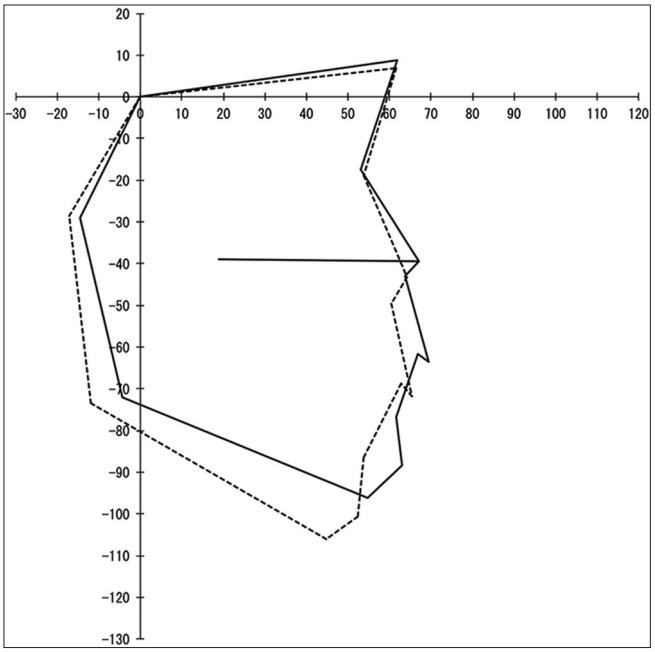

Figure 7: Superimposition of Japanese (dotted line) and Bangladeshi (solid line) profilograms for females was done by superimposing on FHP and registering on the Sella. Both upper and lower jaw relative to the cranial base in Bangladeshi females were more anteriorly positioned than the Japanese sample

Table 3: Mean and standard deviation of the cephalometric variables for the Bangladeshi males and comparison with the Japanese and Caucasian groups

Variables	Bangladeshi		Japanese males		Caucasian	
	Mean	SD	Mean	SD	Mean	SD
Skeletal relationship						
Facial plane angle	90.3	3.4	85.1	*	87.8	*
Convexity	1.8	6.8	5.6	*	0.0	NS
y-axis	58.0	3.9	65.7	*	59.4	NS
SNA	84.5	3.9	81.8	*	82.0	*
SNB	83.0	3.5	78.6	*	79.9	*
ANB	1.6	2.8	3.3	*	2.0	NS
A–B plane	−3.1	3.9	−5.1	*	−4.6	NS
Nasion perpendicular to point A (mm)	1.1	3.4	−0.3	NS	1.1	NS
Pogonion to nasion perpendicular (mm)	0.8	6.0	−6.8	*	−0.3	NS
FHP to mandibular plane angle	18.4	6.5	25.1	*	21.3	NS
Facial axis angle	92.6	4.5	86.3	*	90.5	NS
Effective mid-facial length (mm)	83.4	4.7	96.9	*	99.8	*
Effective mandibular length (mm)	112.4	6.1	130.4	*	134.3	*
Lower facial height (mm)	61.5	6.0	74.8	*	74.6	*
Dental relationship						
Upper incisor to FHP	118.4	6.7	108.9	*	114.9	NS
Occlusal plane to FHP	3.6	4.6	9.5	*	9.3	*
Inter-incisal angle	121.9	9.9	129.7	*	135.4	*
Upper incisor to point A vertical (mm)	7.3	2.6	5.5	*	5.3	*
Lower incisor to A-Po line (mm)	3.8	2.3	4.2	NS	2.3	*
Lower incisor to mandibular plane angle	101.3	6.8	97.8	NS	92.3	*
Upper incisor to palatal plane (mm)	23.4	3.4	31.7	*	33.0	*
Upper molar to palatal plane (mm)	22.5	2.5	26.6	*	27.9	*
Lower incisor to mandibular plane (mm)	40.1	3.6	48.8	*	48.9	*
Lower molar to mandibular plane (mm)	31.9	3.2	40.2	*	38.0	*
Soft tissue relationship						
Nasolabial angle	94.6	13.3	93.4	NS	102.0	NS
Upper lip protrusion (mm)	5.5	2.1	6.3	NS	3.0	*
Lower lip protrusion (mm)	5.3	2.2	5.6	NS	2.0	*
Labiomental sulcus (mm)	5.2	1.2	5.7	NS	4.0	NS
Point A to sub-nasale (mm)	15.4	1.7	16.5	NS	19.7	*
Incision superioris to upper lip (mm)	12.1	2.4	14.3	*	13.7	NS
Incision inferioris to lower lip (mm)	13.5	1.8	14.8	*	15.5	*
Pogonion to pogonion' (mm)	9.9	2.2	14.3	*	13.3	*
Z angle	73.6	7.7	69.5	NS	75.5	NS

The norms for Caucasians and Japanese were derived from analyses developed by Riolo *et al.*,[16] McNamara,[17] Miyajima *et al.*,[1] Iizuka and Ishikwa,[2] Ioi *et al.*,[18] Legan and Burstone,[19] Bishara *et al.*,[20] and Burstone and Marcotte.[21] NS indicates non-significant (*$P<0.01$)

DISCUSSION

As improvement of facial aesthetics has rapidly become one of the desirable objectives of orthodontic treatment, the concept of normal has become indispensable for an orthodontist. However since soft tissue, dental, and skeletal structures exhibit different patterns for different ethnic groups, it has become relevant to define the norms for successful diagnosis and treatment planning.

In this study, subjects were selected from the largest university in the capital city in Bangladesh, where students come from different regions of the country, representing almost the entire Bangali ethnic group. During selection of the Bangladeshi sample group, no profile assessment was attempted. This was because of two reasons. First, it was hoped that, because no assessment was used, the sample would be more representative. The second reason was that such an assessment is very subjective and depends on the concept of aesthetics of the observer. Such a procedure could lead to a bias toward a specific facial type. Consideration must also be given to the sample size of the Japanese and Caucasian samples. It is acknowledged that there were fewer subjects in the Caucasian groups. Since the sample sizes for the Bangladeshi groups, the main focus of this study, are thought to be adequate, interpretation of the result should be reliable and useful to evaluate whether there were any interesting trends.

Some researchers studied the normative analysis without regard to the sex difference; others have investigated males

Table 4: Mean and standard deviation of the cephalometric measurements for the Bangladeshi females and comparison with the Japanese and Caucasian groups

Variables	Bangladeshi		Japanese		Caucasian	
	Mean	SD	Mean	SD	Mean	SD
Skeletal relationship						
Facial plane angle	90.4	3.3	84.8	*	87.8	*
Convexity	3	6.3	7.5	*	0.0	NS
y-axis	57.8	3.4	65.4	*	59.4	NS
SNA	83.8	4.2	82.3	NS	82.0	NS
SNB	81.7	4.5	78.9	*	79.9	NS
ANB	2.1	2.4	3.3	*	2.1	NS
A–B plane	−3.9	3.5	−4.8	NS	−4.6	NS
Nasion perpendicular to point A (mm)	1.7	2.7	−0.7	*	0.4	*
Pogonion to nasion perpendicular (mm)	1.1	5.3	−7.3	*	−1.8	*
FHP to mandibular plane angle	20.1	5.8	26.5	*	22.7	NS
Facial axis angle	91.9	4.7	86.6	*	90.2	NS
Effective mid-facial length (mm)	78.7	3.6	91.5	*	91.0	*
Effective mandibular length (mm)	105.2	4.7	121.5	*	120.2	*
Lower facial height (mm)	56.7	3.9	71.0	*	66.7	*
Dental relationship						
Upper incisor to FHP	117.6	6.8	111.1	*	114.9	
Occlusal plane to FHP	4.6	4.5	11.4	*	9.3	*
Inter-incisal angle	122.5	9.0	124.0	NS	135.4	*
Upper incisor to point A vertical (mm)	6.4	1.9	5.3	NS	5.4	*
Lower incisor to A–Po line (mm)	3.5	1.8	4.9	*	2.7	NS
Lower incisor to mandibular plane angle	99.7	7.7	99.5	NS	94.9	*
Upper incisor to palatal plane (mm)	22.3	2.4	31.9	*	30.0	*
Upper molar to palatal plane (mm)	20.8	1.5	25.3	*	24.8	*
Lower incisor to mandibular plane (mm)	36.5	2.5	46.1	*	41.5	*
Lower molar to mandibular plane (mm)	28.2	2.1	38.2	*	32.6	*
Soft tissue relationship						
Nasolabial angle	101.8	10.6	99.0	NS	102.0	NS
Upper lip protrusion (mm)	4.3	1.2	6.5	*	3.0	*
Lower lip protrusion (mm)	4.6	1.4	6.1	*	2.0	*
Labiomental sulcus (mm)	4.1	1.2	4.6	NS	4.0	NS
Point A to sub-nasale (mm)	13.3	1.6	13.9	NS	15.3	*
Incision superioris to upper lip (mm)	9.9	1.6	11.3	*	10.9	NS
Incision inferioris to lower lip (mm)	11.3	2.1	12.4	NS	12.9	*
Pogonion to pogonion' (mm)	8.2	1.7	13.4	*	11.1	*
Z angle	74.7	6.5	67.5	*	71.3	NS

The norms for Caucasians and Japanese were derived from analyses developed by Riolo *et al.*,[16] McNamara,[17] Miyajima *et al.*,[1] Iizuka and Ishikwa,[2] Ioi *et al.*,[18] Legan and Burstone,[19] Bishara *et al.*,[20] and Burstone and Marcotte.[21] NS indicates non-significant (*$P<0.01$)

and females separately. Although some researchers did not find any significant difference between the sexes, others established considerably important differences. When comparisons were made between the sexes in the Bangladeshi population, no significant differences in the pattern of dental and skeletal structures were found except for the overall size of the face, which was expressed by the smaller mid-facial length, mandibular length, and decreased lower facial height in the females' sample. The soft tissue drape in the females' sample showed some significant differences such as a larger nasolabial angle with decreased upper lip protrusion and a smaller labiomental sulcus than the compatriot male group.

The findings of this study were mainly compared with the standard values of the Japanese and Caucasian population as these values have sometimes been used in Bangladesh for orthodontic diagnosis because of lack of data from own population. In this analysis, both linear and angular measurements were analyzed to aid in diagnosis and treatment planning for both orthodontic and orthognathic surgery cases, and then compared with previously reported Caucasian and Japanese data. Although all subjects of the Bangladeshi, Japanese and Caucasian populations fall within the limit of normal occlusion and balanced faces, some fundamental variations in the craniofacial structures of the Bangladeshi population were evident. The maxillary position relative to the Nasion perpendicular line in Bangladeshi males was nearly the same as that of Caucasians or Japanese; but in female, the maxilla is more anteriorly positioned than the other groups. The mandibular position relative to the cranial

base, as measured by the facial axis angle, demonstrated a much more protruded position in both males and females when compared with Japanese, but not very significantly different from Caucasians. It appears that relative to the cranial base (SN), the maxillo-mandibular complex was more anteriorly placed compared with Japanese. The effective length of the maxilla and mandible was also shorter than Japanese. These findings agreed with the fact that the Japanese tended to have a more vertical mandibular growth pattern than Caucasians.[24] According to Proffit *et al*.,[25] divergence of the face is influenced by a patient's ethnic and racial background. American Indians and Asians, for example, tend to have anteriorly divergent faces, whereas Whites of northern European ancestry are likely to be posteriorly divergent. In the present study, the Bangladeshi adults showed more anteriorly divergent faces [Figures 6 and 7] than the Japanese adults. An important difference appears with the larger facial angle and lower mandibular plane angle in Bangladeshi adults. When coupled with a greater ramus inclination, as indicated by the larger Ramus plane to the FH plane angle [Figures 4 and 5] it gives the Bangladeshi sample a growth pattern in which the face appears to be shorter and more horizontally developed [Figures 6 and 7] than both the Caucasians and Japanese groups. The mandible appeared to be squared-off and bite force was considered to be stronger. The lower face height in both Bangladeshi males and females was significantly smaller than that of the Caucasians and Japanese groups.

The upper incisors in the Bangladeshi adults were significantly more protruded and tipped forward, whereas the lower incisors were rather retarded when compared with the Japanese group, although they occlude in the normal range of overbite and overjet due to a more horizontally developed mandibular pattern. The mean values in the dental vertical position may be useful to determine which teeth contribute more to the overall facial pattern and vertical disharmonies of open or deep bites.

In the Japanese group, although the upper incisor is relatively less protruded, upper lip protrusion is more because of a thicker upper lip. The *Z* angle, which describes the combined situation of the values of mandibular plane angle, incisor position, and soft tissue thickness, was higher in the Bangladeshi adults than the Japanese group and almost similar to those in the Caucasian group. This angle, which is more indicative of the soft tissue profile, is responsive to the maxillary incisor position, horizontal mandibular position, and vertical facial height. The results of the present study are useful in understanding the dentoalveolar compensation in normal occlusions of different skeletal types among the Bangladeshi, Japanese, and Caucasian populations. When determining the orthodontic treatment need, profile analysis can also be taken into account instead of using orthodontic aesthetic indices, which are subjective.[26] Therefore this study adds valuable information when assessing profile in the Bangladeshi population.

CONCLUSION

Relative to the cranial base (SN), the maxillo-mandibular complex was more anteriorly placed compared with the Japanese and Caucasian adults. Further, the effective length of the maxilla and mandible was shorter compared with the Japanese and Caucasian adults. These findings should be considered carefully during orthodontic treatment planning of Bangladeshi adults.

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