



Cephalometric Study of Craniofacial Width Dimension and Dentofacial Vertical Proportion of Face in Bengali Normal Adults

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Abstract

Introduction: Present cephalometric study has been done to appraise the vertical proportions of face and dentition along with craniofacial width dimensions in Bengali adult population with normal dentition.

Materials and Methods: 50 samples of Bengali ancestry age group ranging from 18 to 27 years were selected from the patient reported in Dr R Ahmed Dental College and Hospital, Department of Orthodontics and Dentofacial Orthopaedics. Standard frontal and lateral cephalograms were taken and tracing done on each cephalograph, all the transverse and vertical measurements were statistically analysed. Seven different transverse width and eight different vertical height parameters were measured and their proportions were calculated and compared.

Results: Statistical Analysis was performed with help of Epi Info (TM) 3.5.3 to establish different cephalic norms. The vertical relationship between the posterior and the anterior facial skeletal structures in Bengali normal adult male subjects showed a more horizontal growth pattern. The transverse dimension of the Bengali face is less than the other Asian races as well as transverse dimension of female face of the Bengali people are also less than male of the same race.

Conclusion: In a multicultural society, ethnic differences are assuming greater importance while making diagnosis and treatment plans of patients from various racial and ethnic background.

Keywords: Lateral Cephalogram; Postero Anterior Cephalogram; Bengali; Transverse Facial Width; Vertical Facial Dimension

Introduction

Orthodontic diagnosis, treatment planning and prognosis are intimately related to the concept of dentofacial balance. Orthodontists have established standards of facial aesthetics based on normal occlusion. With the introduction of cephalometric roentgenography by Broadbent in 1931, the orthodontists are in a position to correlate it with the relative proportions of dentofacial structures seen beneath the soft tissue draping.

Facial patterns are of utmost important in orthodontic diagnosis and treatment. There may be a great deviation in the individual pattern from the so-called "normal" or ideal type or pattern. It is generally accepted that the shape of face is determined by both genetic influence and local environmental factors [1].

The craniofacial structure may vary according to the geographic distributions, racial variations, environmental alterations and food

habits. It also varies from individual to individual of the same race, age and sex. Thus it clearly indicates that a face of particular individual bears individual's individuality. Growth in width and growth in depth are highly correlated. For evaluation of facial type and calculation of various craniofacial indices, these two parameters are highly essential [2].

Postero-anterior cephalogram illustrates the three-dimensional isomorphic skeletal structure bilaterally on to dimensional plate and thereby helps to study the symmetry of drawing midline through the central structures. Lateral cephalometric x-ray offers an ideal medium for studying dentofacial vertical proportions.

T M Graber [3] indicated that one can achieve very effective change towards dentofacial balance by guiding growth and development, influencing growth direction in proper time. Face grows most in height, next in depth and least in width. Greatest possible

change will be in height. Thus vertical dimension cannot be ignored during normal course on orthodontic treatment. Moreover it is very difficult to achieve a stable correction in vertical dimension unless it is detected and recognised in the right time.

Standards of skeletal balance any dimension will vary according to the vital statistics of the area, ethnic makeup of the community, socio-economic stratification, age, sex, etc. So it is not rational to apply the average mean values obtained from the vast wealth of European and American standards in orthodontic diagnosis and treatment planning of Bengali people.

Present cephalometric study has been done to appraise the vertical proportions of face and dentition along with craniofacial width dimensions in Bengali adult population with normal dentition.

Materials and Methods

Sample selection

The subjects for this study were obtained from the department of Orthodontics and Dentofacial Orthopaedics of Dr. R. Ahmed Dental College and Hospital, 114, A.J.C. Bose Road, Kolkata-700014. Sample consisted of 50 subjects (25 males and 25 females) of Bengali ancestry. Subjects included in this study were within the age group of 18-27 years, selected randomly based on the following criteria

- Subjects will be Bengali adult male and female of 18-27 years age group.
- Subjects having normal health and adequate structure.
- Subjects having all set of complementary teeth.
- Having skeletal and dental class occlusion and with or without minimum crowding or rotation.
- Have not undergone any orthodontic and maxillofacial surgical treatment.

The lateral and frontal cephalogram was taken for all subjects selected under this study. Lateral and Postero-anterior cephalogram were traced upon a 0.003 mm matte acetate tracing paper with 3H lead pencil. Each cephalogram was traced twice. The average measurement for each cephalogram was taken in an attempt to minimize error. The tracings were analyzed using linear measurements accordingly. Linear measurements were done to an accuracy of 0.5 mm. The mean, standard deviation and range values of each measurement were tabulated. All the measurements values of different parameters were collected, arranged properly and comput-

ed for statistical analysis. On the basis of the data obtained from the study, values for all the discussed parameters were established for the Bengali population. (FIGURE A, B, C and D)

Following Measurements were used for width measurements on postero anterior cephalogram.

- **Bizygomatic width:** The distance between the most lateral aspects of the right and left zygomatic arches.
- **Inter-orbital width:** The distance between the inner bony walls of the right and left orbits. Measured between the points where the radiographic shadow of the cribriform plate intersects the inner orbital margin on each side.
- **BIMASTOID width:** The distance between the right and left apices of the mastoid process.
- **Bimaxillary width:** The distance between the most lateral and inferior aspects of the right and left zygomatico-maxillary sutures.
- **BIGONIAL width:** The distance between the right and left antegonion.
- **Bimaxillary canine width:** The distance between the tips of right and left maxillary canine.
- **BIMANDIBULAR canine width:** The distance between the tips of right and left maxillary mandibular canine.

For assessment of vertical dentofacial features, following landmarks were used on lateral cephalogram.

- **NASION (N):** The most anterior point on the fronto-nasal suture in the mid sagittal plane.
- **SELLA (S):** Geometric centre of the pituitary fossa.
- **ANTEGONION (AG):** The highest point on the antegonial notch.
- **ANTERIOR NASAL SPINE (ANS):** The anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening.
- **POSTERIOR NASAL SPINE (PNS):** The posterior spine of the palatine bone constituting the hard palate.
- Incisal edge of the upper central incisors (U1)
- Incisal edge of the lower central incisors (L1)
- Tip of the mesiobuccal cusp of the lower first permanent molar (M_L)
- Tip of the mesiobuccal cusp of the upper first permanent molar (M_U)

Following planes were used.

- **Maxillary plane:** A plane joining ANS to PNS
- **Mandibular plane:** A plane tangent to inferior border of mandible passing through mention and gonion.

Following measurements were made.

- **Anterior facial height (AFH):** The vertical measurement in mm. between nasion and menton.
- **Nasal height:** the distance in mm. between nasion and menton.
- **Lower anterior facial height:** The distance in mm. between ANS and menton.
- **Posterior facial height:** The distance in mm. from sella to gonion.
- **Lower incisal height:** The perpendicular distance in mm. from incisal edge of lower central incisor to mandibular plane
- **Upper incisal height:** THE perpendicular distance in mm. from incisal edge of upper incisor to the maxillary plane
- **Upper molar height:** The perpendicular distance in mm. from the tip of the mesio-buccal cusp of upper first permanent molar to maxillary plane.
- **Lower molar height:** The perpendicular distance in mm. from the tip of mesio-buccal cusp of lower first permanent molar to the mandibular plane.

From this measurement, following proportions were derived in percentage

- **Nasal height:** Anterior facial height
- **Posterior face height:** Anterior face height
- **Upper incisal height:** Lower face height
- **Upper molar height:** Lower face height
- **Lower incisal height:** Lower face height
- **Lower molar height:** Lower face height

Result and Analysis

Statistical Analysis was performed with help of Epi Info (TM) 3.5.3. Epi Info is a trademark of the Centers for Disease Control and Prevention (CDC). Descriptive statistical analysis was performed to prepare different frequency tables and to calculate the means

with corresponding standard errors. t-test was used to compare the means. $p < 0.05$ was taken to be statistically significant.

Lateral and postero-anterior cephalometric radiographs were used to measure different facial and dental heights and various transverse facial widths. The collected data was statistically analyzed for evaluation of Bengali standard norms as shown in the Table 1-4 and the figures 1-4.

Parameters	Male (n = 25)	Female (n=25)	T-value (t ₄₈)	P-value
Nasal Height	56.8 ± 2.9	55.1 ± 2.5	2.22	<0.05*
LAFH	71.9 ± 6.5	69.1 ± 3.9	1.85	>0.05
TAFH	124.5 ± 4.6	122.7 ± 4.8	1.35	>0.05
TPFH	87.8 ± 5.0	86.4 ± 3.6	1.14	>0.05
U1H	29.0 ± 2.2	28.4 ± 1.8	1.06	>0.05
UMH	26.9 ± 3.0	25.4 ± 2.5	1.92	>0.05
L1H	43.7 ± 2.9	42.5 ± 2.3	1.62	>0.05
LMH	36.3 ± 3.3	35.3 ± 3.0	1.12	>0.05

Table 1: Comparison of vertical parameters.

Parameters	Male (n = 25)	Female (n = 25)	T-value (t ₄₈)	P-value
(NH/TAFH) x 100	45.3 ± 2.7	45.0 ± 2.9	0.37	>0.05
(TPFH/TAFH) x 100	70.6 ± 4.3	70.5 ± 3.9	0.08	>0.05
(U1H/LAFH) x 100	40.7 ± 5.0	41.2 ± 3.3	0.41	>0.05
(UMH/LAFH) x 100	37.8 ± 5.9	36.8 ± 4.2	0.69	>0.05
(L1H/LAFH) x 100	61.2 ± 6.5	61.6 ± 3.7	0.26	>0.05
(LMH/LAFH) x 100	50.8 ± 5.8	51.2 ± 5.9	0.24	>0.05

Table 2: Comparison of Various Vertical Proportions.

Parameters	Male (n = 25)	Female (n = 25)	T-value (t ₄₈)	P-value
ZY-ZY	13.1 ± 0.5	11.9 ± 0.5	8.48	<0.01**
OR-OR	2.9 ± 0.4	2.5 ± 0.2	4.47	<0.01**
MAS-MAS	11.0 ± 0.5	10.4 ± 0.7	3.48	<0.01**
MAX-MAX	8.4 ± 0.4	8.0 ± 0.5	3.12	<0.01**
Ag-Ag	9.4 ± 0.6	8.7 ± 0.7	3.79	<0.01**
U3-U3	3.4 ± 0.2	3.2 ± 0.2	3.54	<0.01**
L3-L3	2.6 ± 0.3	2.5 ± 0.3	1.18	>0.05

Table 3: Comparison of transverse parameters.

t-test showed that the means of ZY-ZY, OR-OR, MAS-MAS, MAX-MAX, Ag-Ag, U3-U3 of males were significantly higher than that of females ($p < 0.01$). Mean of L3-L3 was higher for males than that of females but it was not statistically significant ($p < 0.05$).

Parameters	Male (n = 25)	Female (n = 25)	T-value (t ₄₈)	P-value
(Ag-Ag /ZY-ZY) x 100	72.0 ± 5.8	72.7 ± 5.5	0.43	>0.05
(OR-OR/MAX-MAX) x 100	34.9 ± 5.5	31.7 ± 3.8	2.39	>0.05
(U3-U3/L3-L3) x 100	131.8 ± 15.8	128.0 ± 19.2	0.76	>0.05

Table 4: Comparison of various transverse proportions.



Figure A: Lateral Cephalometric Radiograph.



Figure B: Postero-anterior Cephalometric Radiograph.

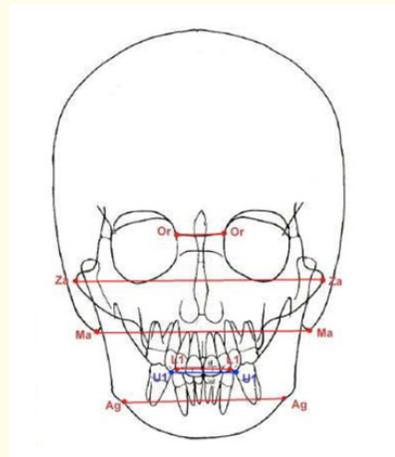


Figure C: Various measurements done on Postero-anterior cephalographic tracing.

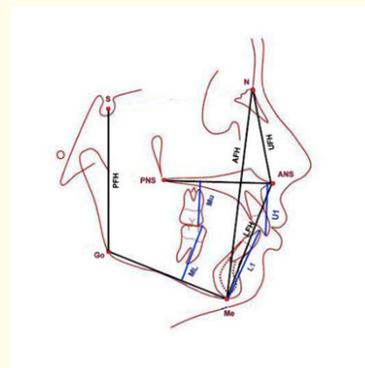


Figure D: Various measurements done on lateral cephalographic tracing.

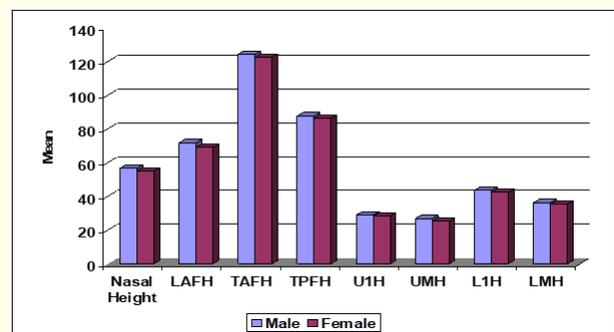


Figure 1: Graphical Representation Vertical Parameters.

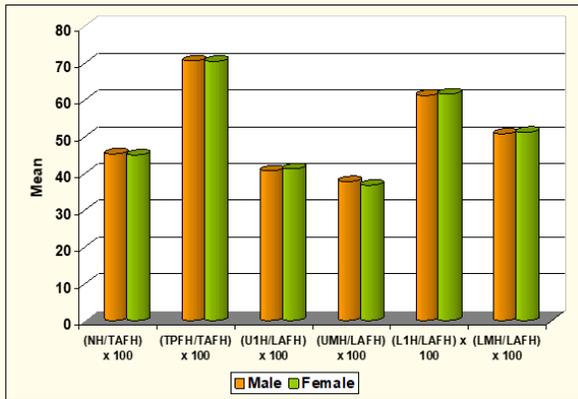


Figure 2: Graphical representation of various vertical proportions.

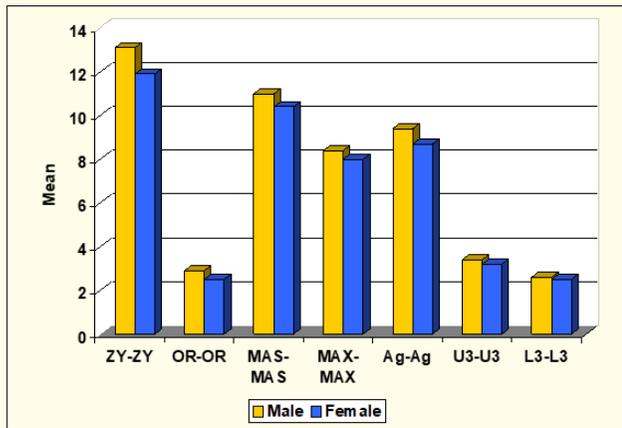


Figure 3: Graphical representation of transverse parameters.

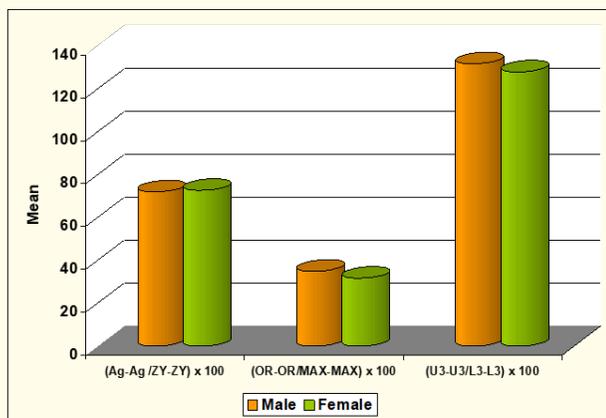


Figure 4: Graphical Representation of various transverse proportions.

Discussion

Investigations on craniofacial growth revealed that the greatest possible change in face would be in height during growth [4]. Present cephalometric study considered different skeletal and dental variables in vertical dimension. In order to relate these values to a well-balanced facial pattern, fifty subjects with good occlusion were analyzed cephalometrically to find out the relationship of different vertical measurements in normal occlusion in Bengali population. The selection of cases, although entirely subjective, were dependent upon clinically obvious balance in all dimensions.

Related to vertical dentofacial proportions

Data on vertical dimension were expressed in the following manner: a) N- ANS represented nasal height and (b) N - Me represented total anterior face height. Nasal height divided by total anterior face height into 100, represented a 'proportion' expressed in percentage of the nasal height to the total anterior face height.

In the present study, the mean value of this proportion was 45.3 ± 2.7 in male and 45.0 ± 2.9 in female. Nasal height was 45.3% of the total anterior face height \pm with an s. d. 2.7 in male and 45% with s.d. ± 2.9 in female the Bengali normal adult population.

Subtelney and Sakuda when comparing skeletal relationship in openbite malocclusion and normal occlusion, reported that the nasal height in normal occlusion should be 44.9% of the total face height with a s. d. ± 2.25 . [5]. That value was approximately similar to the value obtained in the present study.

Bishara, S.E. and Jacobson, J.R [6]. In a study on longitudinal changes of vertical facial heights in the three normal facial types, found that the percentage, expressed in details as shown earlier, of (N-ANS) to (N-Me) had a mean value of 44.1% with a s. d. ± 1.6 in the average facial type.

In the long face type, this value was $44.3\% \pm 2.6\%$ and in short face type, it was $45.1 \pm 1.5\%$. Obviously, the corresponding value in the present study was closer to the values of short face type.

Total posterior face height (PFH) expressed the resultant vertical growth at the condyle [7]. Whereas, the total anterior facial height (AFH) expressed the sum of vertical growth occurring at the maxillary sutures, maxillary alveolar processes and the mandibular alveolar processes. The proportionality of vertical growth in the an-

terior and the posterior aspect of the face quantitatively described the position of the mandible in relation to the cranial base.

When the vertical growth at the AFH exceeded the growth at the PFH, a backward rotation of the mandible would follow. Conversely, when the vertical growth at the PFH exceeded the growth at the AFH, a forward rotation of the mandible would follow. When both the vertical dimensions were proportionate, a parallel growth of the mandible would follow.

The percentage ratio of posterior face height to the anterior face height in the present study expressed a mean value 70.6% in male with a s. d. \pm 4.3 and 70.5% in female with s. d. \pm 3.9.

Bell, W.H, Proffit, W.R. and White, P.R. of dentofacial relationship in their text [8]. It was found from the chart that posterior face height (S-Go) was 64.23% of the anterior face height. This gave an impression that in normal Bengali adult population, posterior face height was definitely higher than that of Caucasian group.

Nanda, S.R [9]. Reported that the mean value for normal subjects was 65% with an s. d. \pm 4.0. The values smaller than the mean value were associated with the open bite. Conversely, the values larger than the mean value were associated with skeletal deep bite condition. So, the vertical skeletal factors would have some effects in producing different vertical incisal relationships. From the values obtained in the present study, it could be assumed that in normal Bengali male subjects there was a tendency to have a slight deep bite condition.

The relative vertical positions of the teeth were primarily determined by the force acting on the dentition in the vertical plane, namely, inherent eruptive forces and the forces of mastication. So the vertical stability of the teeth was a balance of neuromuscular activity along with the Skeletal growth and appositional and resorptional changes along the periodontal ligaments [10].

All vertical dental heights were expressed as the percentage proportion of the lower anterior face height in the present study. The values are given below.

Bell, W. H.; Proffit, W.R. and white, R.P. (1980) mentioned the values of different dental heights in normal subjects [11]. Although

these values were not identical with the values in the present study, there were a similarity in variations between the different dental heights. It might be due to racial variation. It was also found that in normal subjects the lower incisor and lower molar erupted more in comparison to the upper incisor and the upper molar.

Related to craniofacial width dimension.

- Bizygomatic width (ZYG-ZYG):** In the present study, bizygomatic width of Bengali adult male is 13.1cm, s. d. \pm 0.5, and that of female is 11.9 cm s. d. \pm 0.5.

In a different study, Gianelly and Goldman [12] reported that bizygomatic width of American male is 12.6cm and that of female is 12.1cm. During changing dentition, bizygomatic width of Philadelphia male is (12.2-12.86) cm and that of female is (11.31-12.5) cm. In Iowa children, bizygomatic width of male is 11.3cm and in female is 10.9cm. The range of bizygomatic width for Bengali male and female are within the \pm 3 S.D level of the norms and their P values are $P < 0.01$. So the established norms are statistically significant and thereby concluded that upper face width of Bengali is less than Chinese and Japanese. The upper faces of American females are wider than Bengali females [13].
- Interorbital width (OR-OR):** Inter-orbital width of Bengali male is 2.9 cm s. d. \pm 0.4 and in female is 2.5 cm s. d. \pm 0.2.
- Bimastoid width (MAS-MAS):** The bimastoid width of Bengali male is 11.0 cm, s. d. \pm 0.5 and in female is 10.4 cm s. d. \pm 0.7.

Bimastoid width of Bengali male is more than Chinese male and the bimastoid width of Bengali female is more or less equal to the bimastoid width of Chinese male.
- Bimaxillary width (MAX-MAX):** Bimaxillary width of Bengali male is 8.4 cm, s. d. \pm 0.4 and in female is 8.0 cm, s. d. \pm 0.5.

Thus bimaxillary width of Bengali male and female is less than that of Chinese people.
- Bigonial width (AG-AG):** Statistical value on bigonial width for Bengali male is 9.4 cm, s. d. \pm 0.6 and that for female is 8.7 cm, s. d. \pm 0.7. Bigonial width of Bengali people is less than Chinese, Japanese and American people.

- **Maxillary intercanine width (3-3):** The statistical value for Bengali male is 3.4 cm, s. d. \pm 0.2 and for female is 3.2 cm, s. d. \pm 0.2. The maxillary intercanine width of Bengali people is less than Chinese and various groups of American people.
- **Mandibular intercanine width (3-3):** In Bengali adult male, statistical value for mandibular intercanine width is 2.6 cm \pm 0.3 and for female is 2.5 cm, s. d. \pm 0.3. The range of mandibular intercanine width is within the + 3 S.D. of mean value for Bengali population and the significance level is $P < 0.01$. Thus the mandibular intercanine width of Bengali population is less than Chinese and American people.
- Posterior face height was 70.55% of anterior face height. So, the vertical relationship between the posterior and the anterior facial skeletal structures in Bengali normal adult male subjects showed a more horizontal growth pattern.
- Proportional vertical analysis of all the dental heights with respect of lower anterior face height showed that the lower molars and lower incisor teeth were erupted more in comparison to the upper molars and upper incisor teeth to have a normal dental occlusion and balanced skeletal facial profile.

The percentage proportion of one parameter to other is calculated and tabulated in table 4.

- **Percentage proportion of bigonial width to bizygomatic width ($100 * GO-GO/ZYG-ZYG$):** For Bengali male, the statistical value is 72.0%, s. d. \pm 5.8 and for female is 72.7%, s. d. \pm 5.5. In all the racial groups, bigonial width is three-fourth of bizygomatic width though Bengali male shows less significant value of percentage proportion.
- **Percentage proportion of interorbital width to bimaxillary width ($100 * OR-OR/MAX-MAX$):** For Bengali male, statistical value is 34.9%, s. d. \pm 5.5 and for Bengali female is 31.7%, s. d. \pm 3.8. In Bengali population interorbital width is around one-third of bimaxillary width.
- **Percentage proportion of mandibular intercanine width to maxillary intercanine width ($100 * 3-3/3-3$):** The statistical value of this percentage proportion for Bengali male is 131.8%, s.d. \pm 15.8 and for female is 128.0%, \pm 19.2. In all the above-mentioned races mandibular intercanine width is four-fifth of maxillary intercanine width.

Conclusion

The dentoskeletal patterns in vertical dimension were measured and following observations were made.

- Nasal height was 45.15% of the total anterior face height. So, the maxilla was well developed vertically with respect to total anterior face height.

The transverse dimensions of craniofacial skeleton of Bengali adult subjects were measured and following observations were made.

The measuring variables of this experiment are bizygomatic, interorbital, bimaxillary, bigonial, maxillary intercanine and mandibular intercanine widths. The results are statistically computed and the norms are established.

It is observed that the transverse dimension of the Bengali face is less than the above mentioned races as well as transverse dimension of female face of the Bengali people are also less than male of the same race.

In all the races including Bengali people, bigonial width (Lower face width) is three-fourth of bizygomatic width (upper face width), inter-orbital width (Bidacryon width) is one-third of bimaxillary width (Mid-face width), and mandibular inter-canine width is four-fifth of maxillary inter- canine width.

For standardization of the accumulated norms and to establish the feasibility of the same for clinical application on Bengali people, further experiments are necessary with large number of samples, through a meticulous screening procedure, considering health, stature and facial forms of the subjects.

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