Evaluation and Comparison of Forehead Angulations Using Cephalometrics between Male and Female Human Subjects

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Abstract: Introduction: Sex identification is one of the important aspects of forensic sciences and many methods have been widely used for the same. Use of cephalometrics to establish age, sex and race has been adopted by forensic odontologists. But forehead angulations and quantitative measurements of its curvature to establish sex have been less explored. With above background a cross-sectional study was designed to evaluate and compare the angulations of the forehead at defined points between human male and female subjects. Materials and Method: Present study was conducted on 100 subjects. Lateral cephalogram obtained from 50 males and 50 females with age range of 18-26 years were transcribed on acetate sheet. Angulations on forehead and one linear measurement were calculated. Data was stored for analysis. Results: Mean values of angle A, B and C were lower and AD segment was higher in male group when compared to female group. Comparison of mean values of angle B and AD segment between males and females showed statistically significant difference (p value < 0.05). Coefficient of variation of AD segment was least among all variables. Conclusion: We concluded that, angle of curvature was higher in females as compared to males supporting the round forehead in female. Further, the proposed hairline in male was found to be slightly higher when compared to female. [Joshi M et al NJIRM 2013; 4(5) : 20-23]

Key Words: Forehead, Forensic, Cephalogram, Angulations

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Introduction: Sex identification is one of the important aspects of forensic sciences. Forensic odontology handles, examines, evaluates and presents dental evidence for forensic investigations. [1] DNA finger typing, cheiloscopy, dental traits and osteometric methods have been adopted by many investigators for morphological assessment of differences in size and shapes of human remains. [2] Although various radiographic methods have been used by forensic odontologists, metric analysis of skull forehead for sex identification using cephalogram have been studied by very few. [3,4] Present study evaluates and compares the angulations of the forehead at various points among human male and female subjects.

Materials and Method: Study was conducted on 100 subjects in the age range 18-26 years during May-November 2010 at a rural hospital in central India. An approval from Institutional Ethics Committee was obtained. Informed consent was taken from all the subjects and the study was carried out in accordance with the World Medical Association Declaration of Helsinki. Study group was divided into Group I with 50 males and Group II with 50 females. Subjects with history of trauma, orthognathic treatment, endocrinal diseases, hereditary, nutritional and developmental disorders, facial asymmetry and systemic diseases were excluded from the study. Lateral cephalograms were taken under standard exposure parameters on planmeca EC proline machine with the highest point of hairline marked with lead marker. Lateral profiles on these radiographs were then transcribed on acetate sheet. Following reference points were recorded and calculated.

Cephalometric landmarks

1. Or (Orbitale): The lowest point on the inferior orbital rim.
2. Po (Porion): The most superiorly positioned point of external auditory meatus located by using ear rods of cephalostat.
3. N (Nasion): The most anterior point on frontonasal suture in midsagittal plane.
4. FH (Frankfort horizontal): A horizontal line from the superior border of the Po to the Or point.
5. S (Sella): The geometric centre of pituitary fossa.

Following facial planes were used as reference planes:

1. Anterior facial plane: This is a plane through nasion representing a true vertical reference plane perpendicular to neutral orbital plane.
2. Superior facial plane: This is plane drawn through nasion parallel to neutral orbital plane.

After tracing these cephalometric landmarks, three points on the forehead region were marked viz. the highest point on forehead, the inferior most point and mid-point of these two points. Parallel lines to the standard reference planes were drawn through each of the points marked on the forehead. Then a tangent to each point was drawn and the angles at these three different points were measured and given the following names:

1. Angle A: The highest angle on forehead.
2. Angle B: The angle of curvature.
3. Angle C: The inferior most angle on forehead.

One linear measurement was calculated i.e. Segment AD. It is the linear measurement from the highest point to the inferior most point on forehead which was drawn with the help of above mentioned points on forehead and two facial planes used in this study.(Fig- 1)

Statistical Analysis: The statistical analysis was carried out by using SPSS10.0 software. This included mean values, standard deviation, student unpaired t-test, significance value, reliability of various parameters in the study.

Results: Cephalometric data obtained from 50 males and 50 females in the age range of 18-26 years was analyzed. Table 2 shows distribution of mean of various parameters under study in group I and group II.

Fig 1: Three angles and one linear measurement traced on acetate sheet on forehead

Table 1: Distribution of mean of all parameters under study in Male and Female group

Parameters	Male (n=50)	Female (n=50)
	Mean ± SD	Mean ± SD
Angle A*	18.0±6.54	19.04±4.54
Angle B†	19.89±2.26	22.05±2.68
Angle C‡	3.72±2.97	4.67±2.63
AD segment (cm) §	5.94±0.12	5.80±0.29

(* The highest angle on forehead, † The angle of curvature, ‡The inferior most angle on forehead, § It is the linear measurement from the highest point to the inferior most point on forehead)

Table 2: Comparison of mean values of all parameters in male and female patients

Parameters	Male (n=50)	Female (n=50)	Student's Unpaired 't' test value	'p' value	Significance 'S' – Significant, 'NS' – Not Significant.
	Mean ± SD	Mean ± SD			
Angle A*	18.0±6.54	19.04±4.54	0.63	p>0.05	NS
Angle B †	19.89±2.26	22.05±2.68	3.08	p<0.05	S
Angle C ‡	3.72±2.97	4.67±2.63	1.20	p>0.05	NS
AD segment (cm) §	5.94±0.12	5.80±0.29	2.25	p<0.05	S

(* The highest angle on forehead, † The angle of curvature, ‡ The inferior most angle on forehead, § It is the linear measurement from the highest point to the inferior most point on forehead)

Table 3 shows comparison of mean values of various parameters under study in group I and group II. It shows significant difference between the mean values of Angle B, AD Segment in male and female group ($p<0.05$).

Table 4 and Table 5 show reliability of parameters under study among group I and group II respectively. It shows that coefficient of variation is lower in AD segment followed by angle B.

Table 3: Reliability of the parameters in Male group: (Coefficient of Variation)

Parameters	Male (n=50) Mean ± SD	Coefficient of variation (CV)
Angle A*	18.0±6.54	36.33%
Angle B†	19.89±2.26	11.36%
Angle C‡	3.72±2.97	79.83%
AD segment (cm) §	5.94±0.12	2.02%

(* The highest angle on forehead, † The angle of curvature, ‡ The inferior most angle on forehead, § It is the linear measurement from the highest point to the inferior most point on forehead)

Table 4: Reliability of the parameters in Female group: (Coefficient of Variation)

Parameters	Female (n=50) Mean ± SD	Coefficient of variation (CV)
Angle A*	19.04±4.54	23.89%
Angle B†	22.05±2.68	12.15%
Angle C‡	4.67±2.63	45.34%
AD segment (cm) §	5.80±0.29	5.0%

(* The highest angle on forehead, † The angle of curvature, ‡ The inferior most angle on forehead, § It is the linear measurement from the highest point to the inferior most point on forehead)

Discussion: Accurate identification of sex from human skull is of vital importance in forensic investigations. Methods like osteometric analysis are considered to be accurate and can be used for identification of sex of an individual. Identification of sex only on the basis of human skull is an important perspective. It is evident that forehead pattern of skull is flat in males and round in females. [5] Lateral cephalogram are important in this regard as it can visualize many fixed bony landmarks on skull. In one of the studies, accuracy of video superimposition for identifying unknown human skulls was examined with the conclusion that skull or photograph superimposition is reliable when two or more photographs, clearly depicting the facial features from different angles are used in the comparison. [6]

In another study, 52 skulls were used in forensic cases and the anatomical consistency of cranio-facial superimposition images were investigated for evaluating the validity in personal identification by the superimposition method. This study stated that the outline from the trichion to the gnathion in the lateral or oblique view is the preferable portion for personal identification. Cranio-facial superimposition method is reliable for individualization when two or more facial photographs taken from different angles are used in the examination. [7] To some extent present study is similar to this study in the context for trichion to nasion measurements.

Many studies have been conducted on the slope of the forehead for sex identification. Present study is probably the first and new attempt to evaluate the angulations of the forehead at various points. In this study, we found that the mean values of Angle A, B and C was lower in male group as compared to female group (Table 1). Also, the mean value of AD segment is higher in male group as compared to female group. When compared between male and female group for Angle B and AD segment, statistical significant difference ($p<0.05$) was observed. From this it is clear that trichion in males is at higher level than in females. Also, the forehead pattern in males was flat against the rounded in females. Our findings are corroborative with the established fact that males have flat forehead whereas in females it is rounded. [5] Although the values of angle B could not delineate the sex specifically but they were found to be statistically significant. The rounded forehead in females and steeper in males may be attributed to the direct sex specific stimulatory effect of testosterone and estradiol on chondroprogenitor cell proliferation and maturation of membranous bones. [8] Table 4 and Table 5 predict reliability of the parameters in male and female group respectively. It was observed that coefficient of variation was lower in AD segment and angle B.

This shows that these variables are more reliable than other variables in both study groups for identification of sex.

Conclusion: Present study is the innovative approach to make use of forehead angle measurements as an important landmark in sex identification, although digital analysis of forehead angulations at several points could be more appropriate method of evaluation. We conclude that, angle of curvature was higher in females as compared to males supporting the round forehead in female. Further, the trichion in males was found to be slightly higher than in females.

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Conflict of interest: None
Funding: None