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Original Research Article

Stature and Gender Determination Skull Measurements Among Adults in Southern Rajasthan.

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Abstract

Background: Personal identification plays a major role in criminal and civil cases. it is accomplished by many routes but in cases of mutilated, partial or decomposed remains, the anthropometric measurements are vital in identifying the individual.

Materials and Methods: The present study was conducted to ascertain the utility of using cranial measurements in determining gender and stature among the selected study population of adults in Southern Rajasthan. The study was conducted at Geetanjali Medical College and Hospital, Udaipur. The study involved a pool of 100 subjects. The measurements taken were done using lateral radiographs and clinical examination. The study concluded that human skull exhibits anatomic variability between genders. For gender determination, all the 14 lateral cephalometric measurements were used together in discriminant model to differentiate between males and females.

Results: The resulting equations were statistically significant and could predict gender with an accuracy of 82% in males and 85% in females using the given parameters. Hence, the accuracy of the given model comes out to be 83.5% to predict gender for the adult Target population.

Conclusion: Lateral cephalogram apart from giving information about facial relationships, planning for orthognathic surgery, orthodontic treatment, and assessing the growth in children are also helpful aid in identification. With availability of the skull as only skeletal remains, it is possible to determine sex and estimate stature from various cephalometric dimensions for establishing identity.

Keywords: Anthropometry, Skull measurements, Gender, Stature

Introduction

Induction Forensic anthropological association with identification has been well established for its use in criminal as well as civil matters with respect to establishing an identity to mutilated or decomposed remains. One of the main goals of forensic anthropology [1] is to determine the identity of a person from the study of some skeletal remains. In the last few decades, anthropologists have focused their attention on improving those

techniques that allow a more accurate identification.

Necessity for personal identification arises in both natural mass and artificial disasters and in cases where severely mutilated, decomposed, dismembered body parts are found to conceal identity of an individual.[2] For social, economic, and medico-legal purposes, identity establishment is essential.

Radiographs have been used for the identification of skeletal remains and the determination of gender. Various researchers have stated that the radiographs are cost-effective, easily available, and reliable in providing accuracy of 80%–100% as far as the identification is concerned.[3,4]

Lateral cephalometric projection being standardized type of radiography with wide application provides objective evidence for dental, skeletal, and soft tissue alterations.[5]

As craniofacial bones are least prone for disintegration and highly resistant under extreme conditions, they can be used for gender determination.[6]

Gender is primarily being determined from the pelvis and secondarily from the skull and is based on its morphological and morphometric features. Of all the bones, after pelvis, the skull is the next most easily sexed portion of the skeleton.[7]

Different body parts have allometric relationship with one another, and hence, this relationship can be explored to get estimates of the stature from the bones of the skeleton. Furthermore, the long bones contribute in stature and correlate positively with stature of person and hence are used to obtain the most common stature estimates.[8-10]

The purpose of the study was to determine stature and gender using digital lateral cephalograms in the adults in the target population.

The present study had used 14 linear cephalometric parameters to determine stature and gender. Among these 14 variables, nine variables have been used by various researchers, either independently or in groups of 2 or 3, to determine stature and gender.

Stature estimation forms a criterion for the personal identification and assists in narrowing down the investigation process.[11]

Material and Methods:

The study design for the estimation of gender and stature among adults of South Rajasthan population was observational and cross-sectional. The study was performed from July 2021 to January 2022 in the Department of Anatomy and Neurosurgery at Geetanjali Medical College and Hospital, Udaipur, Rajasthan. A sample size of 100 (50 males and 50 females) in the age range of 21–50 years was calculated for the estimation and determination of stature and gender in adult target population Using R statistical analysis software at 95% confidence interval and power of 80%.

Sampling technique used in this study was non-probabilistic method using convenience sampling with the prescribed inclusion criteria.

Inclusion criteria

Healthy, normal adults of Southern Rajasthan population

Individuals of age 21 years and above.

Exclusion criteria

- Individuals with a history of, or clinical features suggestive of, trauma or surgery of the skull, vertebral column, and long bones.
- Individuals with developmental anomalies of the skull.
- Individuals who have undergone orthodontic and orthognathic treatment.
- Individuals with a history of or clinical features suggestive of endocrinal

disturbances, hereditary, nutritional, and developmental disorders, facial asymmetry.
- Cases of kyphosis, scoliosis, other vertebral column anomalies, and stature defects.
- Individuals with completely edentulous upper and lower jaws.

The protocol of the study was approved by the institutional ethics committee. Those subjects who were willing to participate in the study were only included in the study after obtaining written and informed consent. Each subject was explained about the purpose and entire procedure of the study. Subjects were given freedom to leave the study at any point of time.

All the study subjects were subjected to detailed case history and thorough clinical examination and later on to lateral cephalometric radiographic examination. Using the standard procedure, digital lateral cephalograms were recorded with SIRONA orthophos XG 5 machine, with exposure time of 14.9 s, tube voltage used of 60–90 kV, and tube current used of 3–16 mA, and viewed using Using Sidexis, (Dentsply Sirona global, Italy). Cephalometric landmarks were identified and plotted, and linear measurements were traced and recorded. Three observers independently measured 14 linear measurements from digital lateral cephalograms of 100 study subjects. All three observers were blinded about the study subject information (single blinding). Following linear measurements were recorded:

1. Basion to ANS (Ba-ANS): Linear measurement from basion (Ba) to ANS.
2. Upper facial height (N-ANS): Linear distance between nasion (N) and ANS.
3. Length of cranial base (Ba-N): Linear measurement from basion (Ba) to nasion (N).
4. Total face height (N-M): Linear measurement from nasion (N) to menton (M).
5. Frontal sinus height (FsHt): Linear distance between V1 and V2.
6. Perpendicular distance from mastoidale to SN plane (Ma- SN): Perpendicular distance from mastoidale (Ma) to sella-nasion (SN) plane.
7. Perpendicular distance from mastoidale to Frank-Furt horizontal (FH) plane (Ma-FH): Perpendicular distance from mastoidale (Ma) to FH plane.
8. Mastoid height from cranial base (MaHt: Ma-B1B2): Anterior and posterior parameter of mastoid width at the level of cranial base, respectively.
9. Mastoid width at the level of cranial base (MaWd: B1- B2): Mastoid width at the level of the cranial base.
10. Nasion to gnathion (N-Gn): Linear measurement from nasion to gnathion.
11. Sella to menton (S-M): Linear measurement from sella to menton.
12. Sella to gnathion (S-Gn): Linear measurement from sella to gnathion.
13. Gonion to gnathion (Go-Gn): Linear measurement from gonion to gnathion.
14. Gonion to menton (Go-M): Linear measurement from gonion to menton.

Measured living stature or standing height of each subject is recorded using a wall-mounted stadiometer. The subject was asked to stand barefooted close to the wall with feet apposed, looking straightforward, with a stable head, stadiometer placed in contact with vertex marks the height of the subject on scale, and the reading was recorded.

All observations were mentioned as mean and standard deviation. All the data were checked for correctness and completeness.

Results

Mean height was higher in males than the females so do all cephalometric parameters except B1B2 which was higher in females. All parameters differs significantly sex-wise. Multiple linear regression equations were derived from lateral cephalometric parameters having significant r values (Pearson's Correlation coefficient).

Table 1: Stature and Cephalometric parameters relation.

Parameter	Males			Females		
	Min	Max	Mean	Min	Max	Mean
Height	135.60	194.2	171.18	150.2	175	160
N-ANS	3.92	6.14	4.88	3.65	6.14	4.64
N-M	9.26	12.64	11.30	7.92	12.19	10.46
N-Gn	9.08	12.10	10.69	8.10	11.75	9.91
S-M	7.74	13.26	11.95	9.17	13	11.15
S-Gn	9.61	13.17	11.84	8.90	12.73	11
Go-Gn	6.05	8.54	7.35	5.07	7.92	6.88
Go-M	5.70	7.92	6.91	4.90	7.56	6.45
Ba-ANS	7.65	11.84	9.81	7.83	11.30	9.28
Ba-N	8.10	11.75	10.15	8.46	11.84	9.63
FsHt	1.25	5.07	3.05	1.25	4.90	2.71
Ma-SN	2.67	5.78	4.13	2.4	7.56	4
Ma-FH	1.78	3.92	2.70	1.6	3.92	2.60
Ma-B1B2	0.27	1.51	0.67	0.36	1.51	0.65
B1B2	0.89	2.67	1.72	0.98	4.18	1.74

Using the lateral Cephalometric Parameters Prediction equation for Stature was derived Multiple regression equation for stature in females using lateral cephalometric parameters. Parameters like N-M, N-Gn, S-m, S-Gn, Go-M and Ma-B1-B2 are predictors of stature in females as opposed to N-ANS, Go-Gn, Ba-ANS, Ba-N which in addition predicts stature for males' stature.

Model predicts 83 .50 % values correctly for the gender analysis.

Discussion:

Mean height and lateral cephalometric measurements were significantly higher in men than in women, in this study group population, which supports previous studies that reported consistently smaller stature and cephalofacial/ cranial measurements for women than for men in different populations. These results are consistent with the findings of Patil and Mody,[12] Sahni et al.,[13] Agnihotri et al.,[14] Giurazza et al.,[15] Kalia et al.,[16] and Badam et al. [17]

Mahalakshmi and David [11] studied 10 linear cephalometric variables in 156 subjects comprising 76 males and 80 females in the age range of 25–55 years in the South Indian population. Mean height for male was statistically higher (167.87 ± 6.58) than for female (154.09 ±5.76). G-Op was found to be a significant predictor of stature in males as well as in females. Ma-Ht (0.90) was found to be significantly and positively correlated with stature among males, and N-M (0.26) was found to be positively and significantly correlated with stature among females. Inverse relation (negative beta- coefficient) was observed between N-ANS, V1-V2, and Ma- FH in males, but none of these factors significantly influenced stature.

The findings for females in the present study were similar to that of Mahalakshmi and David's findings. Using 14 lateral cephalometric parameters, the present study has accuracy of 83.5% for gender prediction. However, discriminative power observed in the present study is the highest for Ba-N-78% followed by S-Gn - 77%.

All the parameters together were able to explain 61.5% of the variation in stature in males. It was observed that MaHt, V1-V2, G-OP, Ba-N, N-M, BA-ANS, Ma-Width, and Ma-SN were major variables in the determination of sex.

Patil and Modi [12] evaluated 10 lateral cephalometric parameters among 150 (75 males and 75 females) Central Indian subjects for stature and gender estimation in the age group of 25–54 years using conventional radiographs. Mean height for males (164.81 ±5.84) and females (151.88 ±4.34) differ significantly. They concluded that maximum length of the skull (G-Op) was highly reliable in determining height of a person in both males and females. The difference between the average actual and average estimated heights for male and female was 0.15 and 0.22 cm, respectively, which was negligible which indicated reliability of regression formulae.

Similarly, our study observed negligible difference among mean actual stature and mean estimated stature for males (0.03 cm) and females (0.02 cm), respectively, which were smaller than those of Patil and Mody and indicated higher degree of reliability of our regression equations for stature.

Conclusion:

Lateral cephalogram apart from giving information about facial relationships, planning for orthognathic surgery, orthodontic treatment, and assessing the growth in children are also helpful aid in identification. With availability of the skull as only skeletal remains, it is possible to determine sex and estimate stature from various cephalometric dimensions for establishing identity.

Likewise, skull has well-defined, standardized, and easily localizable anatomical landmarks,[16] and the cephalometric radiographs are a good method which reproduces and determines the linear measurement from these landmarks for stature estimation.[12] Hence, making cephalometric radiographs of a skeleton should be a routine procedure for the purpose of identification.

Likewise, skull dimensions also have some definite relationship with the stature. With unavailability of long bones and only availability of the skull as skeletal remains, the relationship between stature and skull dimension would be helpful for determining stature. Gender determination has an imperative role in establishing biological profile of deceased. It narrows the possibility for the identification by 50%. [18,19]

The results of the present study revealed that the human skull exhibits anatomic variability between genders. For gender determination, all the 14 lateral cephalometric measurements were used together in discriminant model to differentiate between males and females. The resulting equations were statistically significant and could predict gender with an accuracy of 82% in males and 85% in females using the given parameters. Hence, the accuracy of the given model comes out to be 83.5% to predict gender for the adult Target population.

The discrepancy in the results of various studies for stature and gender determination may be elucidated, due to the differing number of parameters and differing population.

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