ORIGINAL ARTICLE

Estimation of stature from maxillo-facial anthropometry in a central Indian population

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Abstract

Background: For establishing identity, stature is an important parameter in medico-legal and forensic examination. **Aims:** To estimate stature from facial parameters. **Setting and Design**: Prospective study conducted from December 2007 to September 2008 in the Department of Anatomy, Government Medical College, Nagpur. **Materials and Methods:** A total of 470 healthy medical students were taken, comprising 260 males and 210 females in the age group of 18 to 24 years. **Statistical Analysis:** The data were analyzed using regression analysis and correlation coefficient. **Results:** The average height of males and females was 170.97 (± 6.80) cm and 156.89 (± 5.89) cm respectively. It was observed that in males the total facial height had greater correlation with stature (r = 0.19) and had standard error of ±6.68 cm. In females, nasal height had greater correlation with stature (r = 0.19) and had standard error of ±5.78 cm**. Conclusion:** It can be stated that percutaneous facial dimensions are not good predictors of accurate stature estimation and can be used when other parameters are not available

Key words: Facial height, forensic, identification, nasal height, stature

Introduction

It may happen that highly decomposed or mutilated bodies or fragmentary remains are presented for medico-legal examination. Sometimes only skull or facial remains are brought for examination. It is common in our region where deceased are attacked by wild animals in deep forests and it causes difficulty in identification. Under such circumstances it is important to establish the identity of the deceased. For establishing the identity, stature is an important parameter.

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There is definitive biological correlation of stature with body parts such as extremities, head, trunk and vertebral column.[1-11] Many studies have been conducted for estimation of stature from percutaneous measurements of various body parts such as arm, leg, feet, finger, etc.[12-21] However, few studies are available for stature estimation from face alone.[22-25] It is an established fact that each race requires its own finding for stature estimation because of ethnic, dietary and climatic variations. Hence results of studies done in one population cannot be applicable to other populations entirely.[26] Therefore there is a need for systematic study from this region. Considering this fact, the present study was undertaken to estimate stature from maxillo-facial anthropometry in this region.

Materials and Methods

This was a prospective study conducted from December 2007 to September 2008 in the Department of Anatomy, Government Medical College, Nagpur. The study was

approved by the institutional ethical committee. A total of 470 healthy medical students were taken, comprising 260 males and 210 females in the age group of 18 to 24 years. After 18 years of age the stature is accepted as adult one and multiplication factor more or less remains constant above this age.[27] Students with any obvious congenital or acquired deformity of spine extremity or head were excluded from the study. A prescribed proforma was designed for recording the findings. Measurements were recorded to the nearest millimeter without ruling out soft tissue thickness. The following parameters were recorded:

Stature - The stature was measured in standing position to the vertex in Frankfurt plane by using anthropometric rod.

Total facial height (TFH) - The straight distance between Nasion and Gnathion is measured with closed mouth. It is measured by using sliding caliper. Nasion is the point at which a horizontal tangential to the highest point on the superior palpebral sulci intersects the mid-sagital plane. The subject should be looking straight ahead. Gnathion is the lowest median point on the lower border of the mandible [Figure 1].

Nasal height (NH) - The straight distance between the Nasion and the Nasospinale is measured. It is measured by using sliding caliper. Nasospinale is the point at which a line drawn between the lower margins of the right and left nasal apertures intersects the midsagittal plane [Figure 2].

All the above measurements were taken by one author at a fixed time between 2 to 5 pm only, to eliminate the discrepancies due to diurnal variation. The measurements were taken three times and their mean value was taken as a final measurement. The data were analyzed using regression analysis and correlation coefficient.

Results

The study consists of 470 healthy subjects consisting of 260 males and 210 females. The age-related data is presented in Table 1. The descriptive statistics for the three measurements recorded in the sample are shown in Table 2. In the sample, the average height of the males and females was 170.97 (± 6.80) cm and 156.89 (± 5.89) cm respectively. The results show that the differences between all male and female variables exhibited statistically significant differences ($P < 0.001$). The regression equations were derived and are shown in Table 3. There is separate equation for each facial parameter. The regression equations have been calculated by regression analysis of the data and the values of constants 'a'

Figure 1: Measurement of total facial height with sliding caliper

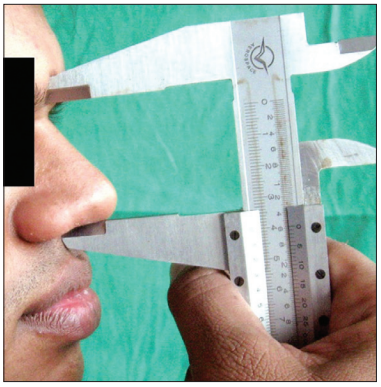

Figure 2: Measurement of nasal height with sliding caliper

Table 1: Descriptive age-wise and sex-wise statistics

Sex	*n* (%)	Mean age (years)	± SD	Median	Minimum	Maximum	Mode
Male	260 (55.31)	19.68	1.39	19	18	24	19
Female	210 (44.68)	19.06	1.06	19	18	24	19
Combined	470 (100)	19.42	1.29	19	18	24	19

SD: Standard deviation

Table 2: Descriptive statistics for sex-wise height and facial parameters (in cm)

Sex	Variable	*n*	Mean (± SD) (in cm)	SE	Minimum	Maximum	Median	95% CI	CV (%)
Male	Height	260	170.97 (±6.80)	0.42	151	189.60	171	0.83	3.97
	TFH	260	11.43 (±1.04)	0.06	9.60	18.80	11.40	0.12	9.09
	NH	260	4.69 (±0.42)	0.02	3.70	5.70	4.70	0.05	8.95
Female	Height	210	156.89 (±5.89)	0.40	142	172.70	156.60	0.80	3.75
	TFH	210	10.66 (±0.75)	0.05	7.50	14.40	10.60	0.10	7.03
	NH	210	4.57 (±0.38)	0.02	3.50	5.60	4.60	0.05	8.31

SD: Standard deviation, SE: Standard error of mean, CI: Confidence interval, CV: Coefficient of variation, TFH: Total facial height, NH: Nasal height

Table 3: Statistical analysis with derivation of regression equation

Sex	Variable	b	r	r^2	*P* value of r	a	SEE	Intraobserver error (in cm)	Regression equation
Male	TFH	1.28	0.197	0.038	0.001,S	156.34	±6.68	0.39	Stature (cm) = 156.34 + 1.28 × TFH
	NH	3.01	0.186	0.034	0.003,S	156.86	±6.69	0.98	Stature (cm) = 156.86 + 3.01 × NH
Female	TFH	1.12	0.144	0.026	0.002,S	144.96	±5.84	0.53	Stature (cm) = 144.96 + 1.12 × TFH
	NH	3.11	0.196	0.038	0.000,S	142.71	±5.78	1.06	Stature (cm) = 142.71 + 3.11 × NH

b: Regression coefficient, r: Correlation coefficient, a: Intercept, SEE: Standard error of estimate, TFH: Total facial height, NH: Nasal height

and 'b' are calculated; where 'a' is the regression coefficient of the stature and 'b' is the regression coefficient of any of the facial dimensions. Therefore stature = a + bx, where x is any facial parameter. It is observed that in males TFH had greater correlation with stature (r = 0.19) and had standard error of ±6.68 cm. In females, NH had greater correlation with stature (r = 0.19) and had standard error of ±5.78 cm.

Discussion

Estimation of stature for the purpose of identification has a significant forensic importance. This technique is based on a principle that bones or human body parts correlate positively with the stature. Whenever someone wants to estimate stature from a given bone or human body part, there must be a known relationship of that bone or human body part with the stature.[21]A medical examiner never knows what sort of exhibit may be presented to him or her by the Investigating Officer for forensic examination. Therefore new methods based on sound principles are needed to be devised to meet such requirements. Thus there is a need to investigate whether any possible significant correlation exists between stature and facial dimensions? Considering this fact, an attempt had been made in the present study to estimate stature from facial parameters and for this purpose we employed TFH and NH.

While reviewing the literature, we found that few studies have been conducted so far and the comparative data is presented in Table 4.[22-25] Jiobonkumar *et al*., (2006) had studied 199 male Kabui people of Imphal valley, and they noted that TFH was a better parameter to estimate stature.[22] Similar findings were noted by Krishnan (2008), Kharyal *et al*., (2008) and Agnihotri *et al*., (2011).[23-25] In the present study we have noted that THF (r = 0.19, SEE = ± 6.68) is a better parameter in males than NH (r = 0.18, SEE = ± 6.69) whereas NH (r = 0.19, SEE = ± 5.78) is a better parameter than TFH (r = 0.02, SEE = ± 5.84) in females for estimation of stature. This difference could be attributed to geographic, climatic or ethnic variation.

Stature can be estimated, either by multiplying the parameter with the derived multiplication factor or can be measured by employing regression equation. Now most of the researchers considered that regression analysis is best for stature estimation.[23,28] Statistically speaking, correlation coefficient is considered significant if it is above 0.5.[25] While analyzing the present study, we have noted that TFH and NH have lower value in both sexes. Therefore these are not preferable parameters but can be utilized in the absence of other better parameters such as long bones or when only facial remains are presented for forensic examination.

Table 4: Comparative data of different studies

Study	Parameter	Sex	Correlation coefficient	SEE
Jiobonkumar *et al*. (2006)[22]	Height vs. TFH	Male	0.21	--
Krishnan (2008)[23]	Height Vs TFH	Male	0.45	± 5.82
Kharyal *et al*. (2008)[24]	Height Vs TFH	Male	0.39	± 6.65
	Height Vs NH	Male	0.36	± 6.83
	Height Vs TFH	Female	0.35	± 4.96
	Height Vs NH	Female	0.22	± 5.16
Agnihotri *et al*. (2011)[25]	Height Vs TFH	Male	0.32	--
	Height Vs NH	Male	0.19	--
	Height Vs TFH	Female	0.16	--
	Height Vs NH	Female	0.15	--
Present study	Height Vs TFH	Male	0.19	± 6.68
	Height Vs NH	Male	0.18	± 6.69
	Height Vs TFH	Female	0.14	± 5.84
	Height Vs NH	Female	0.19	± 5.78

TFH: Total facial height, NH: Nasal height, SEE: Standard error of estimate

The method of using TFH and NH has several advantages as the method is easy, the anatomical landmarks are standard, well-defined and easy to locate and required least instrumentation. The disadvantage is that the parameters may have insignificant correlation in comparison with bare bone measurements since the study is conducted with intact soft tissues covering the face. However, such a study assumes significance when the body is mutilated into multiple parts or only isolated facial structure is presented for forensic examination.

Conclusion

From the present study it can be concluded that stature can be estimated from various facial dimensions similar to stature estimation from other parts of the human body. However, the correlation is not strong enough to use it as a primary method. Based on the results it can be stated that percutaneous facial dimensions are not good predictors of accurate stature estimation.

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