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Stature Estimation by Per-Cutaneous Tibial Length amongst People of Nellore District State Andhra Pradesh

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Abstract

Background: Stature estimation plays a crucial role in medico legal cases in identification of unknown bodies and in skeletal remains. A strong relationship exists between stature and various dimensions of different body parts for estimation of stature in forensic investigation.

Aim and objective: To estimate stature from per-cutaneous Tibial length measurements in people of Nellore district State Andhra Pradesh South India.

Type of Study: Descriptive cross sectional study with analytical and comparative components.

Place of Study: Department of forensic medicine and Toxicology Narayana Medical College, Nellore District of Andhra Pradesh State.

Material and Method: Stature: using the stadio-meter, the subject was made to stand barefoot in the standard standing position on its baseboard. For Tibial Length, Top point was the medial most point on the upper border of medial condyle of tibia and the lower point was tip of medial malleolus of the tibia, distance between these two points was measured by using spreading caliper to determine Per-cutaneous Tibial Length.

Observation and Discussion: The regression formulae derived for male was Height (y) = 87.38 + 1.92 * PCTL (x) and for females it was Height (y) = 62.93 + 2.45 * PCTL (x). Our study regression equations provided greater reliability in estimated stature and we derived regression formula. Kaore et al. reported in his study and commented that the regression formulae are more dependable than multiplication factor for stature estimation.

Conclusion: We conclude that the regression equations presented here can be used to estimate ante-mortem stature, with reasonable accuracy, of unknown mutilated or dismembered human lower limb remains from per-cutaneous lengths of tibia and fibula in medico-legal cases, particularly from Nellore district of State Andhra Pradesh.

Keywords: Per-cutaneous Tibial Length; Regression; Stature.

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Introduction

A challenging task for a Forensic Pathologist during post mortem examination of the deceased is to establish the Identity and as a result of increase of incidence of terrorism and advancement of transportation facility, aircraft crashes and mass disasters, mutilated dismembered and skeletonized materials become very common. In such scenario forensic anthropologist is required to assist for partial identification by compiling a biological profile as the possibility of identification *f* individual is narrowed.[1]

Most of the time, parts of human body are available for identification, as being an individual characteristic stature becomes one of the important parameters for personal identification. Stature estimation hence plays an crucial role in medico legal cases in identification of unknown bodies and in skeletal remains. A strong relationship exists between stature and various dimensions of different body parts for estimation of stature in forensic investigation.[32–36] The long bones lengths of lower limb provide better estimates of stature in comparison to the long bones of upper limb.[7]

Long bones and stature relationship is influenced by ethnicity and gender of an individual and there are no universal formulae for estimation of stature from the length of long bones.[8] Various studies had significantly reported the differences in proportion of limb dimensions due to hereditary ethnic, environmental and dietary factors which influence the stature of a person.[9–11] Hence there is a string need for population specific formulae foe stature estimation in medico legal cases.[12–14] Even though there are some difficulties in developing population specific formulae for stature estimation from long bones. Problem with this is unavailability of documented skeletal collections with accurate ante mortem stature record for various different Indian populations[15,16] however even in the absence of documented skeletal collections the regression equations can be developed from per-cutaneous bone measurements in a living populations, even though this may not be very idealistic solutions but it has an advantage of avoiding serious errors that could result due to the use of formulae developed for the another geographical location and population.[17]

Comparatively very fewer studies had been done for estimation of stature from lower limb bones for population of Nellore in State of Andhra Pradesh India, in view of the paucity of information we made an attempt to present a linear regression models to predict stature on the basis of per-cutaneous length of Tibia in a population from Nellore. In this present cross sectional prospective study we aim to estimate stature from per-cutaneous Tibial length measurements in people of Nellore district State Andhra Pradesh South India.

Materials and Methods

In the present study was conducted at Narayana Medical College, Chinthareddy Palem, Nellore State Andhra Pradesh by the Department of forensic medicine and Toxicology on the Consenting volunteers of Nellore District of State Andhra Pradesh. The research was with the aim of estimation of stature from per cutaneous Tibial Length measurements collected in 300 adult volunteers with age of 18 to 40 years.

The subjects were confirmed to be descent from Nellore district and were specifically selected with residence of Nellore district only, irrespective of their caste, religion, dietary habits and socio-economic status. The study was a predominantly descriptive cross sectional study with analytical and comparative components. Sufficient permissions and consents are procured before the measurements of the volunteers are taken and clearance from the Institutional Ethical committee is obtained in advance. Measurements taken by single investigator and with the same instrument to avoid any technical or inter observer error and to maintain reproducibility and measurements were taken thrice and their men value were considered for stature estimation.

Stature: Using the stadio-meter, the subject was made to stand barefoot in the standard standing position on its baseboard. Both feet are in close contact with each other and head oriented in Frankfurt's plane. The height was then recorded in centimeter from the standing surface to the vertex in the weight bearing position of foot.

Tibial Length: Measurement of Per cutaneous Tibial Length subject was asked to stand and keep his/her foot on a table to maintain the angle between the flexor surface of leg and that of the thigh at 90° and both points were surfaced mark by using sketch pen. Top point was the medial most point on the upper border of medial condyle of tibia and the lower point was tip of medial malleolus of the tibia, distance between these two points was measured by using spreading caliper to determine Per cutaneous Tibial Length.

Exclusion Criterion: Those with any apparent disease, orthopedic deformity, morphologically showing the congenital malformations, Dwarfism/Achondroplasia, features of nutritional deficiencies and injuries to extremities, using medication thought to alter growth, neuromuscular weakness or abnormal tone or with any other major medical illnesses or growth disturbance were excluded from the study.

Statistical Analysis: Descriptive statistics like range, mean, standard deviation, standard error, coefficient of variation etc. of height and length of right Tibia was done. Comparing the stature and

Tibial length between male and female, Association between Stature and Tibial length were present by scatter diagram. Association between Stature and Tibial length were positively correlated, also checking the significance of correlation by using t-test for correlation. So, on the basis of that we calculate the simple regression equations of Stature on Tibial length, by using regression equation we can predict the Stature value by using independent variable Tibial length. We evaluated the significance at 5% level of significance. The complete statistics was done by MS-Excel.

Fig. 1: Measurement of per-cutaneous tibial length by spreading caliper.

Results

Per cutaneous Tibial length statistics of Right side of tibia in both male and female is as per (Table 1) and showed bilateral symmetry in length of tibia in both male and female, the mean per cutaneous Tibial Length for male 39.73 cam and for females it was 37.95 cam and combined for both male and female it was 38.84 cm.

Table 1: Descriptive statistics of height and Tibial length

Characteristics	Male		Female		Combined	
	Height	PCTL	Height	PCTL	Height	PCTL
Range	144.8–178.4 cm	33.8–44.1 cm	140–176 cm	32.8–43.9 cm	140–178.4 cm	32.8–44.1 cm
Mean	163.62	39.73	155.84	37.95	159.73	38.84
St. Deviation	9.40	2.91	10.11	3.01	10.49	3.09
Std. Error	0.77	0.24	0.83	0.25	0.61	0.18
Coefficient of Variation (CV)	5.74	7.33	6.49	7.93	6.57	7.95

As per (Table 2) our observation revealed that the standing stature of many subjects were same but on the contrary their per cutaneous Tibial Length differed, means that contribution of Tibial length to the stature of a person differed from person to person, keeping this point in view mean of stature and per cutaneous Tibial length was taken into consideration and data was analyzed as shown in Table 2, the observed mean stature was 163.62 ± 9.4 and 155.84 ± 10.11 and mean per cutaneous Tibial length was 39.73 ± 2.91 and 37.95 ± 3.01 for male and females respectively which was highly significant ($p < 0.0001$) for both gender.

Table 2: Comparison of height and PCTL between male and female.

Variables	Male	Female	Mean Difference	*t*-test	*p*-value	Significance
	Mean ± SD	Mean ± SD				
Height	163.62 ± 9.4	155.84 ± 10.11	7.8 ± 3.09	6.91	0.000001	Highly Significant
PCTL	39.73 ± 2.91	37.95 ± 3.01	1.8 ± 3.03	5.21	0.000001	

As per (Table 3 & 4) Correlation Coefficient (r) of stature and per cutaneous Tibial Length for male and female was 0.5946 and 0.7287 respectively and it was statistically significant. As there was a high correlation between the stature and per cutaneous Tibial length, we derived a simple regression analysis between males and females and a simple regression formula was derived to predict stature from per cutaneous Tibial length. The regression formulae derived for male was Height (y) = 87.38 + 1.92 * PCTL (x) and for females it was Height (y) = 62.93 + 2.45 * PCTL (x). As well the predicted stature so derived was acceptable within a range of error and was in close approximation with that of the observed stature.

Table 3: Association between height and PCTL of male and female.

Variables	Correlation (r) between Height & PCTL	t-test	p - value	Significance
Male	0.5946	8.996	0.00001	
Female	0.7287	12.9447	0.00001	Highly Significant
Combined	0.6985	16.84993	0.000001	

Table 4: Regression analysis of height on PCTL of both sex.

Regression analysis of Tibia	Male (Average Height = 163.62)	Female (Average Height = 155.84)	Combined (Average Height = 159.73)
Independent Variable (x) = PCTL	39.73	37.95	38.84
Intercept	87.38	62.93	67.513
Regression coefficient	1.92	2.45	2.375
Correlation Coefficient (r)	0.5946	0.7287	0.6985
Coefficient determination (R^2)	0.3491	0.5278	0.4862
Std. error of estimate (SEE)	7.58	6.9472	7.52
Significance (p)	0.000001	0.00001	0.000001
Regression Formula	Height (y) = 87.38 + 1.92 * PCTL (x)	Height (y) = 62.93 + 2.45 * PCTL (x)	Height (y) = 67.513 + 2.375 * PCTL (x)
Predicted average height (y)	163.66	155.91	159.76

The positive correlation of Length of Tibia (mean = 39.73 ± 2.91 cm) on X-axis and Height of male subjects (mean =163.62 ± 9.4) on y–axis as per Fig. 2 indicates that increase in length of tibia leads to increase in total stature of male subject (r = 0.5946, p < 0.0001). The significant correlation was further interpreted by linear regression. Similarly as per Fig. 3, the positive correlation of Length of Tibia (mean = 37.95 ± 3.01 cm) on X-axis and Stature of female subjects (mean = 155.84 ± 10.11 cm) on y–axis, indicates that increase in length of tibia leads to increase in total height of female subject (r = 0.7287, p < 0.0001). The significant correlation was further interpreted by linear regression.

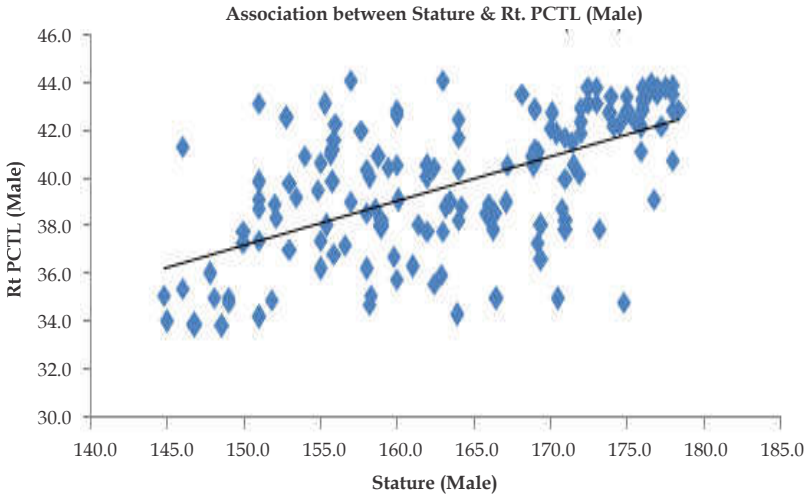

Fig. 2: Scatter plot of Stature and Right PCTL of male.

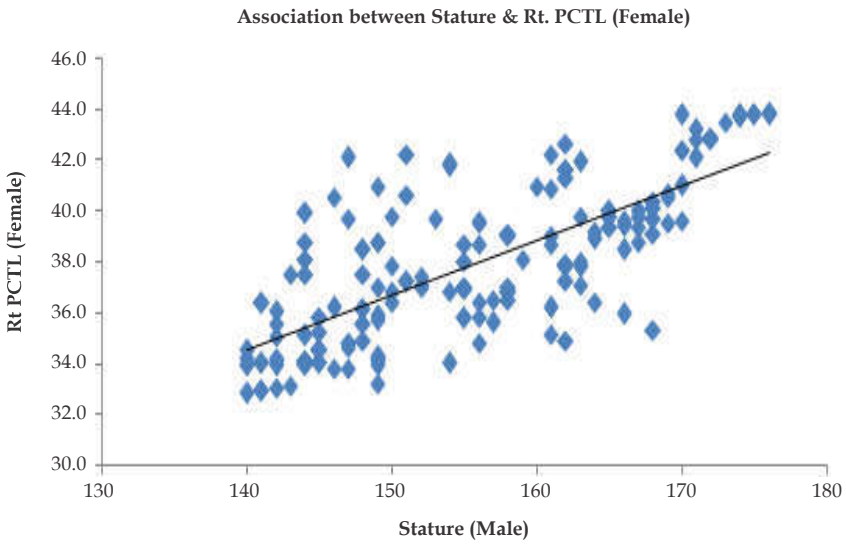

Fig. 3: Scatter plot of Stature and Right PCTL of female.

Discussion

The stature estimation is one of the essential part in forensic anthropology wherin the rising frequency of mass disasters causes bony fragments and dismembered human remains, external examination done before autopsy include the measurements that help the regression equation to be used in estimating living stature.[27-31] Regression equations as being postulated for stature estimation are population and sex specific, necessitates the researches to be done on a regional foundation. Hence we had undertaken this study to derive equations for estimation of stature of Nellore male and female populations in state of Andhra pradesh.

It was in (1952) Trotter and Gleser[19] concluded that increase in stature after 18 years is insignificant and there is no statistical significant alteration after age 18. For the same reason the current study was done on persons aged ≥18 years. To remove the impact of the epiphyseal growth element in regression equations construction, it is preferred to select the individual aged more than 21. Observations of El-Meligy et al.[20] were conducted on both male and female Egyptian and Indian students aged from of 19–21 years and 18–24 years, respectively. In our study the mean of the measured stature and per cutaneous tibial length showed significant increase in males than in females of the same age and population group. It can be based on the fact of epiphyseal union occurs earlier in female than male comparatively. Hence males have a chance for bony growth of about two years than females which was conveyed as surpass of the somatometric measurements of the adult male.[21]

In our study regression equations provided greater reliability in estimated stature and we derived regression formula. It was Kaore et al.[22] who reported in his study and commented that the regression formulae are more dependable than multiplication factor for stature estimation. Kate and Muzumdar[23] also compared the derived regression equation in Maharashtrian and Punjabis with that of Pearson's regression formulae which was derived from English bone and stated that Pearson's regression equation does not give exact results on Indian population, even Kore et al.[22] also had a similar view and suggested that the regression formula derived by Albrook.[24] for stature estimation in British population is also not suitable to estimate stature in Indian population.

On completion of union of epiphysis and the diaphysis the individual stature stop growing which usually occur by the age of 18 to 20 years hence all the individuals considered for the purpose of this study was either at or above 18 years of age. In this study, the mean height for male was 163.62 ± 9.4cm and for female was 155.84 ± 10.11 cm; and the mean PCTL for male was 39.73 ± 2.91 which was significantly ($p < 0.0001$) greater than the female which was 37.95 ± 3.01 cm. Our findings are similar to that of Chavan et al.[25] and many others, who observed that there was no statistically significant difference in the length of tibia in both males and females. It was Mukta Rani[26] who compared the bilateral per-cutaneous measurement of tibia and expressed that left tibia is longer than the right tibia in both gender. Similarly Allbrook[24] in 1961, compared both estimated stature derived from length of dried tibia and from the average per-

cutaneous tibial length. He stated that there was no difference in stature estimated from two different sets of tibia. The average stature was 170.06 cm for British male population. As well Chavan et al.[25] estimated the mean height of male and female to be 167.89 cm ± 6.21 cm and 151.41 cm ± 5.04 cm respectively. Mean PCTL was 37.32 cm ± 2.18 cm for male and 34.44 cm ± 2.10 cm for female.

Conclusion

In both genders stature estimated by regression formulae for per-cutaneous Tibial length of people of Nellore district was similar to average measured stature with an error of less than 1 cm which was statistically insignificant $p > 0.05$. We conclude that the regression equations presented here can be used to estimate ante-mortem stature, with reasonable accuracy, of unknown mutilated or dismembered human lower limb remains from per-cutaneous lengths of tibia and fibula in medico-legal cases, particularly from Nellore district of State Andhra Pradesh. However the formulae derived cannot be generalized to all population groups, hence it is necessary to derive regression equations which are region wise and population specific. Thus the data of this study are recommended in anthropological studies for stature estimation amongst the ethnic group under study

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