Ulna: A tool to estimate stature

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Abstract
Identity is utmost important in both civil and criminal cases. In many cases, manmade disaster or natural disaster, accidental cases and homicidal cases forensic experts collect evidences to fix identity of an unknown dead body. Forensic expert job become very difficult when dis-membranous or mutilated body or only a bone or a bundle of bones brought for post-mortem examination. Stature is one of the key factor for fixing identity of an individual. Many study have been conducted to formulate regression formula from different long bones for different groups of race, ethnic and regions. This study aims at formulate a regression formula to estimate stature from percutaneous length of ulna of native of Gujarat. This study was carried out in Department of Forensic Medicine, C. U. Shah Medical College, Surendranagar, Gujarat. Total 800 participants (400 male & 400 Female) were included in study. Their stature and percutaneous length of ulna were estimated with standard methods and manner. Results are analysed and studied. This study shows that there is highly significant in mean length of ulna and stature in both male and female participants ($P<0.05$). Stature and percutaneous ulna length has positive correlation and regression formula is obtained to estimate stature from ulna length for natives of Gujarat.

Keywords: Ulna length, Stature, Identification.

Introduction
In a murder case, accused always tries to mutilate the dead body to eliminate and destroy the evidences. In such cases, it would be very difficult to prove the guilt of the accused. Natural and man-made disasters like earthquakes, floods, cyclones, stampede, fires, transport accidents, industrial accidents, explosions etc cause significant loss of life and mutilation of body to hinder the identification of the person.[1] Identification of victim is fundamental to establish corpus delicti. In Rishipal Vs. State of Uttarakhand, accused was acquitted as prosecution not able to prove case based circumstantial evidence- Corpus Delicti not recovered.[2]

Many tools are taken in to consideration to establish identification. Stature is a key factor, often used by medicolegal experts, for identification of the person with the help of anthropological parameter. Hand length, foot legth and percutaneous length of ulna and tibia are such parameters that can be used to determine the stature of the person whenever these types of cases are encountered. Percutaneous length of long bone is more convenient method for estimation of stature than dry bone as it is a tedious and time consuming process which involves cleaning and preparation of bones.[3] Stature and long bone length are different according to various ethnic and racial groups.[4] Similar research have been done in different parts of world including India, but due to geographical, genetic, dietary etc. variations, there is no uniformity in derivation of equation for estimation of stature. Hence, this research is done in department of Forensic Medicine, C.U Shah Medical College, Surendranagar to derive the equation to estimate the stature for residents of Gujarat from percutaneous ulnar length.

Materials and Methods
This study was carried out in Forensic Medicine Department of C. U. Shah Medical College, Surendranagar, Gujarat after taking ethical approval from Institutional Ethics Committee. Total 800 (400 male & 400 Female) healthy student, age between 18- 25 years, without any physical deformity, chronic illness or any condition affecting the stature or ulnar length were included in study. Informed written consent obtained from each participant. All the measurements were taken at a fixed time between 10:00 - 12:00 hours to eliminate discrepancies due to diurnal variation. Furthermore, the measurements were recorded by the same person to minimize the bias.

Stature of the participants measured in standing posture with standing barefoot, heels touching together and back of head, shoulder blades, buttocks and feet touching the backboard using standard equipment for measuring height.
Percutaneous length of ulna measured from tip of olecranon process to tip of styloid process in position of flexion by resting the hand over the opposite shoulder with fingers extended in the direction of long axis of forearm to render the bony landmarks more prominent with spreading calliper.

Results
All variables were collected and analysed in IBM SPSS Statistics 23 software.

Table 1: Gender wise descriptive analysis of variables. (N=800)

		Male			Female		
		Right Ulna	**Left Ulna**	**Stature**	**Right Ulna**	**Left Ulna**	**Stature**
N	**Valid**	400	400	400	400	400	400
	Missing	0	0	0	0	0	0
Mean		26.526	26.380	169.930	25.534	25.378	159.641
Std. Error of Mean		.1405	.1407	.3584	.1316	.1321	.3792
Median		26.200	26.100	170.000	25.000	24.900	159.720
Mode		26.0	25.8	168.0	24.0	24.9	159.0
Std. Deviation		2.8091	2.8130	7.1679	2.6330	2.6426	7.5846

Table 1 shows, for Male participants mean length of right ulna 26.526 ± 2.81 cm, left ulna 26.380 ± 2.81 cm and mean stature 169.93 ± 7.17 cm. For Female participants mean length of right ulna 25.534 ± 2.63 cm, left ulna 25.378 ± 2.64 cm and mean stature 159.64 ± 7.58 cm. Gender difference in mean length of ulna and stature found to be highly significant (P<0.05)

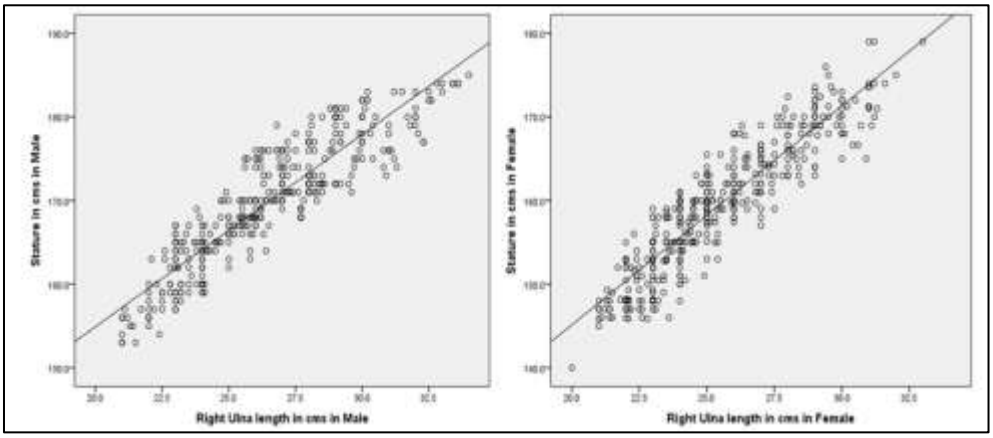

Fig. 1: Scatter diagram showing correlation of length of right ulna and stature in

Figure 1 shows Right ulna length in cm on X-axis and Stature in cm on Y-axis. There is positive correlation of percutaneous right ulna length and stature in both gender with p-value <0.0001. Same correlation also established for left ulna and stature.

Table 2: Regression formula derivatives for calculating stature from percutaneous Ulna length

Participants	**Constant (a)**		**Regression coefficient (b)**		**Correlation coefficient (r)**		**Correlation determination (r^2)**		**Std. Error of the Estimate**	
	Right	Left	Right	left	Right	Left	Right	Left	Right	Left
Male	108.93	109.39	2.30	2.295	0.901	0.901	0.812	0.811	3.11	3.12
Female	92.75	93.52	2.62	2.606	0.909	0.908	0.827	0.824	3.16	3.18

Table 2 shows constant (a), regression coefficient (b), Correlation coefficient (r) and correlation determination (r^2) for right ulna and left ulna for both gender.

Regression formula to estimate stature from ulna length are as follow-

For Male

1. Stature in cm = 108.93 + 2.30 × (Percutaneous right ulna length) ± 3.11
2. Stature in cm = 109.93 + 2.29 × (Percutaneous left ulna length) ± 3.12

For Female

1. Stature in cm= 92.75 + 2.62 × (Percutaneous right ulna length) ± 3.16
2. Stature in cm= 93.52 + 2.61 × (Percutaneous left ulna length) ± 3.18

Discussion

In the first study of its kind, Rollet assessed the correlation between stature and long bone length. He measured the lengths of the radius, ulna, humerus, fibula, tibia and femur of adult French cadavers and published a report with the methods of measurement, the individual measurements, and tables of stature estimations.[5]

Pearson (1899) used Rollet's data to create regression formulae for estimating stature. He used only long bone lengths of the right side. Pearson contributed greatly to the advancement of stature estimation.

Allbrook D. estimate the stature from ulna by formulating regression formula - stature=88.94 + 3.06 × (ulnar length) ± 4.4 (standard error).[6]

Athawale MC observed definite correlation between stature of individual and length of long bones. The regression formula derived was –stature =56.9709 + 3.9613× (ulnar length) ± 3.64(standard error).[7]

Sarojini Devi et al. found correlation coefficient (r=0.619 for male and 0.584 for female) and formulated regression formula for estimation of stature by using upper arm length among Maring tribes in Chandel, Manipur.[8]

Table 3: Regression coefficient in different populations

Study	Region	Male		Female	
		Right	Left	Right	Left
Present study	Gujarat	2.30	2.295	2.62	2.606
Anupriya and Kalpana *et al.*[9]	Tamil Nadu	3.631	3.551	3.745	3.839
Prasad *et al.*[10]	Maharashtra	2.92	2.92	2.37	2.37
Mondal *et al.*[11]	West Bengal	4.19	3.26	3.89	4.39
Mehta *et al.*[12]	Madhya Pradesh	3.562	3.285	3.562	3.285

Table 3 shows Regression coefficients of different study and present study. It clearly proves that regression coefficient of one region is not applicable for another region.

This study clearly shows sex differences found to be highly significant for percutaneous ulna length and stature which is correlate with study of Tanuj Kanchan et al.[13]

Conclusion

Establishment of identity is utmost important in both civil and criminal cases. Stature is one of the key indicator to established identity. Present study proves that stature and percutaneous ulna length has positive correlation and regression formula is formed to estimate stature from ulna length.

There are different study throughout world to estimate stature from long bones, but there are vast variation in formula derived. Hence, it is necessary to research among population of different regions, ethnic groups to obtain a reliable formula to estimate stature.

Conflict of Interest

The Authors declare that there is no conflict of interest.

Conflict of Interest: None

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