Estimation of stature from length of ulna in Maharashtrian population

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Abstract

Background: Estimation of stature has a significant importance in the field of forensic medicine and anthropometry.

Objectives: In this study, an attempt was made to estimate linear regression equation from length of ulna.

Materials and Methods: This study was carried out on 200 healthy individuals (100 men and 100 women) of Maharashtrian population, with age ranging from 20 to 25 years, in the Department of Anatomy, Krishna Institutes of Medical Sciences University, Karad, Maharashtra, India.

Results : The study showed positive correlation between total height of individuals and length of ulna, which is 0.73 in men and 0.70 in women.

Conclusion: The lengths of ulna provide good reliability in estimation of stature in forensic examinations.

KEY WORDS: Stature, ulnar length, anthropometry

Introduction

Estimation of stature has a significant importance in the field of forensic medicine and anthropometry. Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of human body and skeleton.[1] The ultimate aim of using anthropometry in forensic science is to help the law enforcement agencies in achieving "personal identity" in case of unknown human remains.[2]

Establishing the identity of an individual from mutilated, decomposed, and amputated body fragments has become important in recent times, due to natural disasters (such as earthquakes, tsunamis, cyclones, and floods) and man-made disasters (such as terror attacks, bomb blasts, wars, and plane crashes). It is important for both legal and humanitarian reasons.[3]

The ulna is a long bone on medial side of forearm. Proximally it has an olecranon process, and at its distal end is a styloid process. The whole length of subcutaneous border of ulna is palpable down up to the styloid process.[4]

The length of ulna has been shown to be a reliable and precise means in predicting stature of an individual.[4] In 1952, Trotter and Gleser[5] published a definitive study on stature calculation for American whites and blacks. Data used were from the cadavers of World War II and the Terry Collection. All six long bones were measured for maximum length along with maximum length of the femur, and tibial length between upper and lower articulating surfaces. Different equations for the estimation of stature were established for whites and blacks, and for males and females.[5]

The equations that were derived by Trotter and Gleser in the early 1950s for Americans were being continuously revised using data from different sources. In 1977, they proposed new equations using radius and ulnar length.[6]

In 1961, Allbrook attempted to develop standards for the estimation of stature from a British sample using ulnar length, which was measured from "the tip of the olecranon process to the distal margin of the head" with forearm flexed and semipronated and hand in the natural position. In 1964, Athawale[7] carried out a study on forearm bones. His study was based on 100 Maharashtrian male adults aged between 25 and 30 years. In 2005, Devi and Nath[8] formulated multiplication factors for stature estimation from upper extremity among male and female Tangkhul Nagas of Manipur.

The purpose of this study was to analyze the anthropometric relationship between ulnar length and stature and to derive regression formulas to estimate stature.
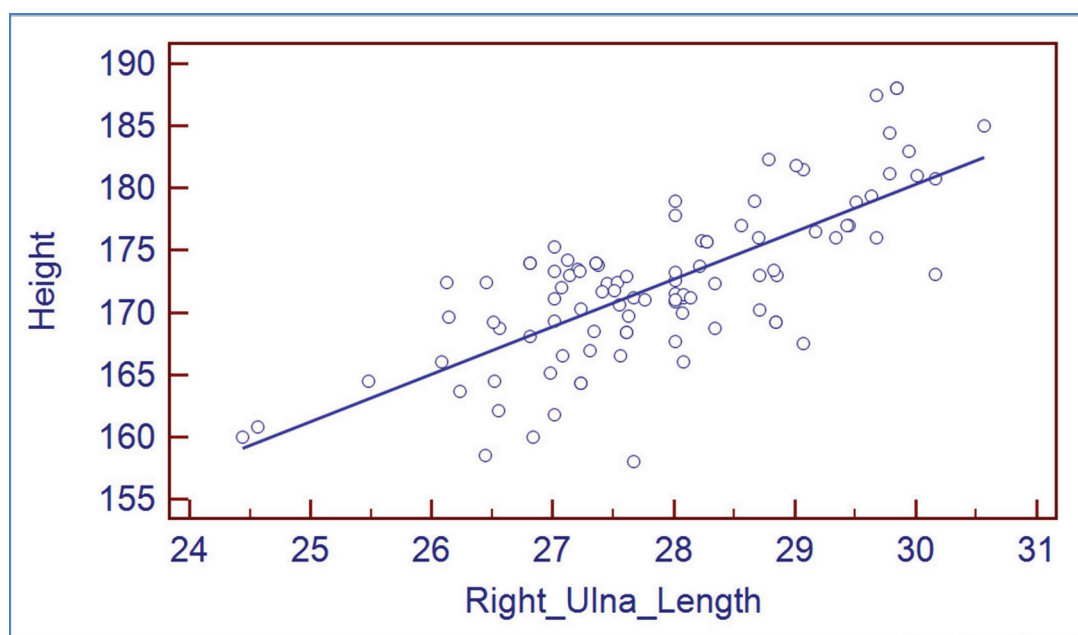
Figure 1: Correlation between length of right ulna and stature in men.

Materials and Methods

This study was carried out on 200 healthy individuals (100 men and 100 women) of Maharashtrian population aged from 20 to 25 years. The measurements were taken using standard anthropometric instruments in centimeters to the nearest millimeter according to the techniques described by Vallois.[9] The subjects included in the study were healthy and free from any apparent symptomatic deformity of upper extremities.

Standard vernier caliper (60-cm long with accuracy of 0.01 cm; http://en.wikipedia.org/wiki/vernier calipers) was used for measuring ulnar length. Standard flexible steel tape (http://en.wikipedia.org/wiki/Tape-measure) was used for measuring total height of the individual.

Stature and spinal stability are subject to marked diurnal variations. Body height is affected by changes from recumbent to the upright posture. The diurnal variations appear to be due to changes that occur within cervical, thoracic, and lumbar regions of the spine. The greatest change in vertebral column length is found in adolescents and young adults. The height loss occurs within 3 h of rising in morning with an overall loss

of about 15 mm. Thus, height of each individual was measured between 2 pm and 5 pm to avoid errors. Length of ulna was measured with the help of spreading caliper from tip of olecranon process to the tip of styloid process with elbow flexed and palm spread over opposite shoulder. Measurements of lengths of right and left ulnae were taken separately.[10]

The data of each person were recorded and then analyzed to determine stature from lengths of ulnae. The comparison of means of all parameters for men and women was done using Student's *t*-test (unpaired *t*-test; http://en.wikipedia.org/wiki/Student's_t-test).

Results

The noted parameters are fed in computer in Microsoft Windows XP Professional and analyzed with Microsoft Excel 2003 (version 11.5612.56) using its standard functions.

Table 1 shows that mean height of male subjects is 172.31 ± 6.282 cm, and mean of length of right and left ulnae are 27.90 ± 1.20 and 27.75 ± 1.17 cm, respectively, with range

Table 1: Range of all parameters in male and female subjects

Parameter (cm)	Mean ± SD		Range (min–max)	
	Male	**Female**	**Male**	**Female**
Height	172.31 ± 6.282	172.31 ± 6.282	158–188	158–188
Length of right ulna	27.90 ± 1.20	27.90 ± 1.20	24.44–30.56	24.44–30.56
Length of right ulna	27.75 ± 1.17	27.75 ± 1.17	24.67–30.61	24.67–30.61
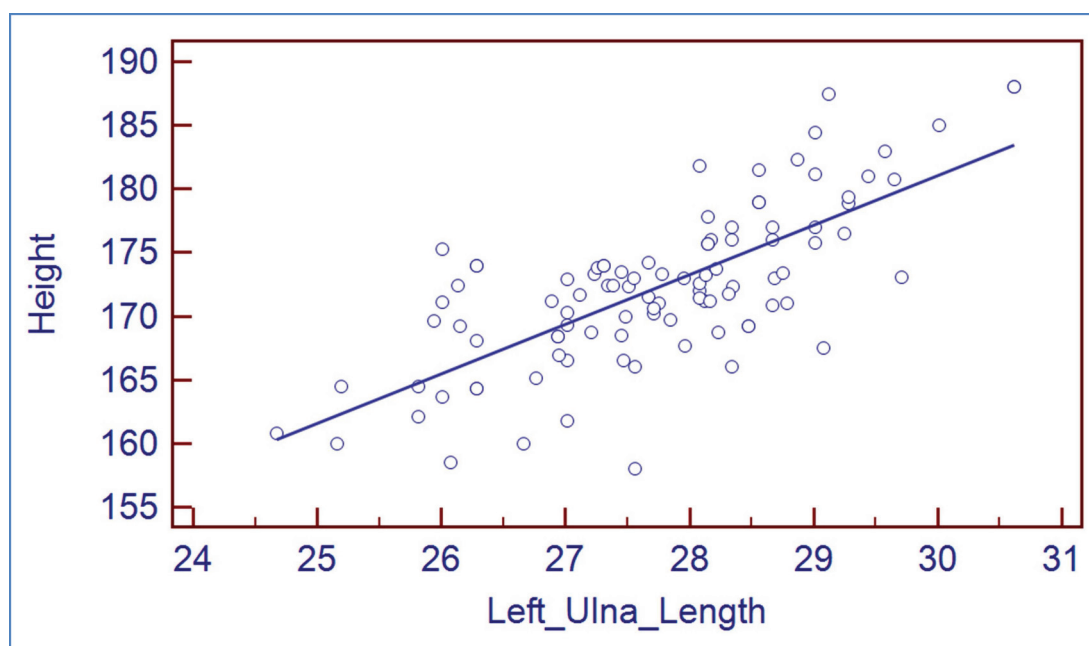
Figure 2: Correlation between length of left ulna and stature in men.

of 24–30 cm. The table shows that mean height of female subjects is 158.84 ± 6.128 cm, and mean of length of right and left ulnae are 25.41 ±1.242 and 25.32 ± 1.54 cm, respectively, with range of 22–34 cm.

Table 2 shows that there is no statistically significant sidewise variation in ulnar length of men and women.

Table 3 shows that correlation coefficients for right and left ulnae are 0.736 and 0.733, respectively, in case of male subjects, and those for right and left ulnae of women are 0.703 and 0.556, respectively.

Table 4 shows regression equation for height with ulna length in men and women. The equation is as follows:

Height = a (constant) + b (slope) × ulnar length ± standard error

Y = height/stature (cm). In men, 65.77 and 64.17 are intercept (constant or a) and 3.819 and 3.896 are regression coefficient (b) for right and left ulnae, respectively. In women, 70.75 and 102.82 are intercept (constant or a) and 3.466 and 2.212 are regression coefficient (b) for right and left ulnae, respectively.

Figures 1 and 2 show positive correlation between ulnar length and height of subjects, indicating that increase in length of ulna leads to increase in total height of male subjects. The significant correlation was further interpreted by linear regression equation. Figures 3 and 4 show positive correlation between ulnar length and height of subjects, indicating that

Table 2: Comparison of length of right and left ulna

Subjects	Length of right ulna (cm)	Length of left ulna (cm)	*P*-value	*t*-Value
Male	27.90	27.75	0.387	0.867
Female	25.41	25.32	0.425	0.671

Table 3: Correlation of height with length of ulna in male and female subjects

Subjects	Correlation coefficient (*r*)		Coefficient of determination (*r²*)		P-value
	Right	Left	Right	Left	
Male	0.736	0.733	0.541	0.538	<0.0001
Female	0.703	0.556	0.494	0.309	<0.0001

Table 4: Regression equation for height with length of ulna in male and female subjects

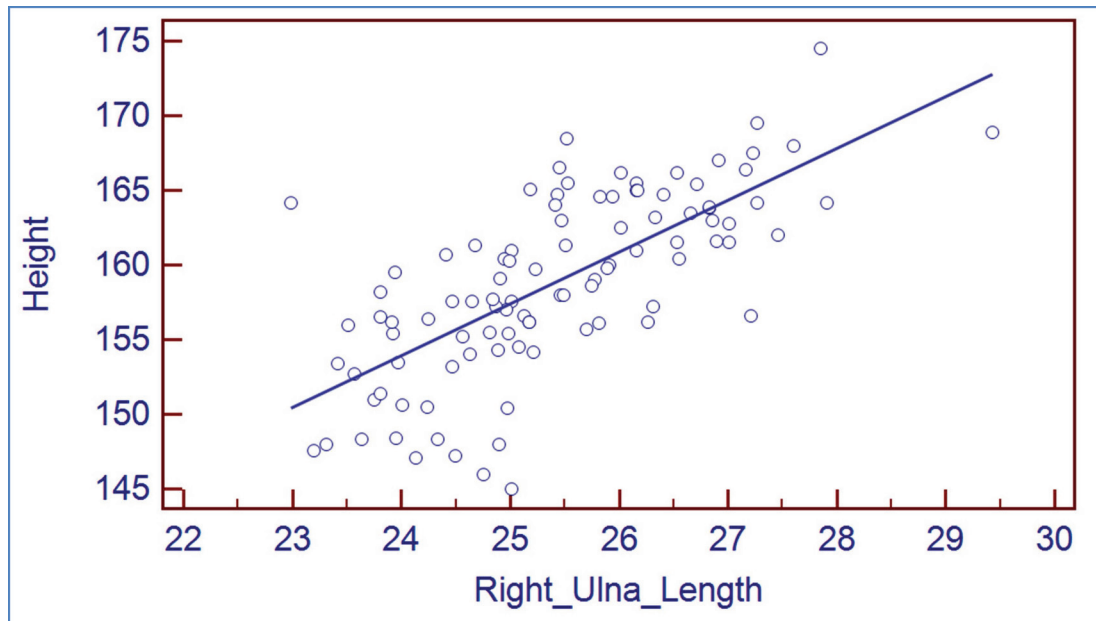| Parameter	Sex	Side	Regression equation	Correlation coefficient
Ulnar length	Male	Right	Y = 65.77 + 3.81 right ulnar length	0.736
		Left	Y = 64.17 + 3.89 left ulnar length	0.733
	Female	Right	Y = 70.75 + 3.46 right ulnar length	0.703
		Left	Y = 102.82 + 2.21 left ulnar length	0.556

Figure 3: Correlation between length of right ulna and stature in women.
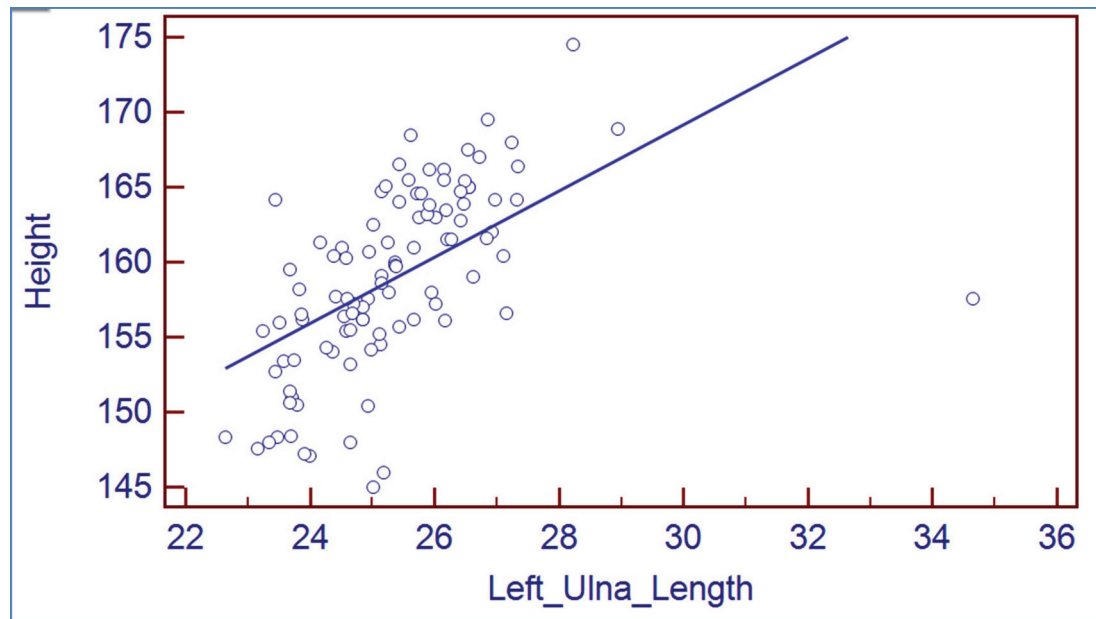

figure 4: Correlation between length of left ulna and stature in women.

increase in length of ulna leads to increase in total height of female subjects. The significant correlation was further interpreted by linear regression equation.

Figures 1 and 2 clearly show that linear relationship exists between stature and ulna in men. figures 3 and 4 clearly show that linear relationship exists between stature and ulna in women.

Discussion

This study was carried out on apparently healthy individuals (100 men and 100 women) in the Department of Anatomy, Krishna Institutes of Medical Sciences University, Karad, Maharashtra, India.

In this study, mean value of right ulnar length is 27.90 cm and that of left ulnar length is 27.75 in men. Our findings correlate with those of Duyar and Perlim.[11] They studied 254 healthy male subjects and derived new ulna-based height estimation formula. His study was based on the need for population-specific stature estimation in Turkish population. Our findings also correlate with those of Illayperuma *et al.*[4] They studied 258 subjects (140 males, 118 females) in Sri Lanka and concluded that significant correlation exists between total height and ulna among Sri Lankans, indicating strong relationship between the two parameters. Our findings also correlate with those of Mondal[10] who studied 300 male subjects in Burdwan district of West Bengal, India.

In this study, mean value of right ulnar length is 25.41 cm and that of left ulnar length is 25.32 cm in women. Our findings correlate with those of Thummar[12] study. He studied 310 subjects (191 males and 119 females) in Bhavnagar, Gujarat, India. Our findings also correlate with those of Illayperuma *et al.*[4] They studied 258 subjects (140 males and 118 females) in Sri Lanka and concluded that significant correlation exists between height and ulna.

Conclusion

Database is prepared and tabulated. In this study, men showed higher mean values in each anthropometric measurement than among women. It is observed that a single anthropometric measurement of ulna can estimate stature of an unknown person with great accuracy. Mean values of ulnar length and stature in this study are comparable with the data of other workers. Correlation between various parameters can help in medicolegal cases for identification of body parts as well as for identification in war casualties. The derived regression equation can be of help in artificial limb centers for construction of prosthesis required in cases of amputations following gangrene, trauma, frostbite, and so on. This study is helpful to provide database for biometrics. The data collected can be used for future anthropological studies.

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