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Original Research Article

Estimation of Supine Length from Percutaneous Measurement of Arm Length

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Abstract

Identification of the deceased is important at the time of medicolegal autopsy in case of mutilated dead bodies. Stature is one of the parameters which could help in identification of the deceased especially in cases of mass disasters wherein mutilated or amputated body fragments are brought to the mortuary for the purpose of examination. The aim of the present study was to estimate supine length from percutaneous measurement of arm length in 200 dead bodies (100 male and 100 female) brought to the mortuary of University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi. The results showed significant positive correlation between arm length and supine length (right arm length r = 0.812 and left arm length r = 0.829).

Keywords: Stature, Supine Length, Arm length, Percutaneous measurement.

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Introduction

Identification means determination of exact individuality of a person. When the person is known by his name with complete address, it is known as complete identification. But in certain circumstances when some details like age, sex etc. can only be established it is known as partial identification. The question of identification may arise in living and dead and in civil and criminal cases. Identification is the basic responsibility of investigative agencies. The identification of dead bodies is required in cases of sudden and unexpected deaths, fire explosions, railway, or aircraft accidents.

For establishing the identity points taken into consideration include: (i) Age (ii) Sex (iii) Religion (iv) Complexion (v) General development including stature (vi) Anthropometric measurements (vii) Fingerprints and footprints (viii) Superimposition (ix) Teeth (x) DNA fingerprinting and (xi) Personal belongings.

Stature refers to body length from the crown to the bottom of the feet in standing position. Supine length refers to the body length taken in supine position from the vertex of skull to heel of feet. Body length increases after death by about 2 cm due to loss of muscle tone, relaxation of joints and tensions of inter vertebral discs.[1] Stature varies with race and is determined by genetics of a person, geographical location, environment and climatic conditions.2 Estimation of stature is an important objective in the identification of an individual from dismembered and skeletal remains in forensic case work.[3] Establishing the identity of an individual from mutilated, decomposed and amputated body fragments has become an important necessity in recent times due to increase in mass disaster, be it natural disasters like earthquakes, tsunamis, cyclones, floods or man-made disasters like terror attacks, bomb-blasts, mass accidents, wars, and plane crashes etc.[4]

A Number of multiplication factors and regression equations have been developed from long bones throughout the world. Multiplication factors as given by Pan(1924)for East Indians (Hindus) are as follows: Humerus (5.30), Radius (6.90), Ulna (6.30), Femur (3.70) and Tibia & Fibula (4.48).[1] Estimation of stature from bones is a tedious and time-consuming process and gives erroneous results due to considerable statistical differences between the lengths of fresh and dry bones.

Some of the equations used to estimate the stature include parameters like length between the tips of

one middle finger to that of the opposite when the arms are fully extended, length of arm from acromial process of scapula to tip of olecranon process, length from vertex to symphysis pubis, length from sternal notch to symphysis pubis, length of forearm from tip of olecranon process to tip of middle finger etc.[1] Many studies have been conducted on the determination of stature from percutaneous measurements of various body parts including arm [5], forearm [6], hand [7], foot etc. This is usually conducted by correlating various measurements of body with height of the person using scientifically derived formula such as multiplication factors and regression equations. The regression equations for western population were first evolved by Trotter and Gleser, Dupurtuis and Hadden.[1] The present study is aimed to deduce the correlation between supine length of adult cosmopolitan population of Delhi with their arm length for subsequent determination of supine length.

Material and Methods

Supine length and bilateral arm lengths was recorded from 100 Male and 100 Females dead bodies within the age group of 21 to 45 years brought to mortuary of GTB hospital for medicolegal postmortem examination. Individuals without any anatomical distortion of body in relation to stature were included in the study. Cases with physical deformity, disease or defect affecting the growth in general or of bones and suffering from gigantism or dwarfism were excluded from the study.

Procedure

After breaking rigor mortis by treating the dead body with warm water, supine length and bilateral arm lengths were recorded. The dead body was placed in supine position on autopsy table, with knee and hip joints extended, and neck & feet in same plane.

- Supine length was measured from vertex of head to the base of heel using scientifically standardized graduated anthropometer.
- Arm length was measured as the distance between inferior border of acromial process of scapula and tip of olecranon process of the body in supine position with flexed elbow joint using scientifically standardized graduated Vernier calipers.

The measurements were tabulated, and appropriate statistical tests were applied.

Results

Supine length

Supine length in males ranged from 155 cm to 180 cm with mean supine length of 166.23 cm & standard deviation of 4.75 cm.

In females, supine length ranged from 140 cm to 167 cm with mean supine length of 154.32 cm & standard deviation of 5.30 cm.

Arm length

The descriptive variables of arm lengths of both sides in males and females are as shown in table 1.

Table 1: Measurements of arm length on both sides

Gender	Measurement side	Minimum	Maximum	Mean	Standard deviation
Male (n = 100)	R	34.2	36.6	35.568	0.6334
	L	27.6	36.4	35.352	0.8499
Female (n = 100)	R	28.6	36.5	31.018	2.9672
	L	28.2	35.6	30.538	2.9245

Regression Equation

Linear regression equation derived from both arm lengths for estimation of supine length in males and females showed significantly positive correlation of left arm length with lesser value of standard error as compared to right arm length as illustrated in table 2.

Table 2: Regression equation for estimation of supine length

Gender	Measurement side	Regression equation for Supine length	Std error of estimate(+/-) cms	Correlation coefficient (r)
Male	R (Figure 1)	135.750+0.857× AL	4.727	0.114
	L (Figure 2)	123.366+1.212× AL	4.646	0.217
Female	R (Figure 3)	135.750+0.857× AL	4.727	0.114
	L (Figure 4)	110.743+1.427× AL	3.278	0.786
Combined	R (Figure 5)	92.842 + 2.538 × AL	4.559	0.812
	L (Figure 6)	94.262 + 2.004 × AL	4.360	0.829

The Arm length on left side showed significantly more positive correlation with supine length in male, female, and combined cases as compared to right side. Left arm length in total cases gave better prediction of supine length with highest correlation coefficient and lower standard error of prediction.

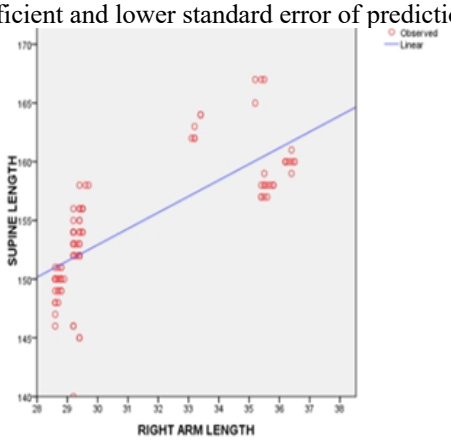

Figure 1: Regression equation for supine length from right arm length in males

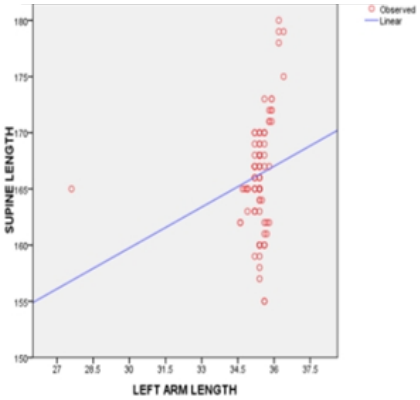

Figure 2: Regression equation for supine length from left arm length in males

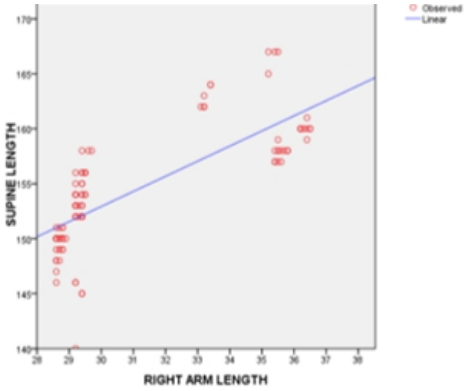

Figure 3: Regression equation for supine length from Right arm length in females

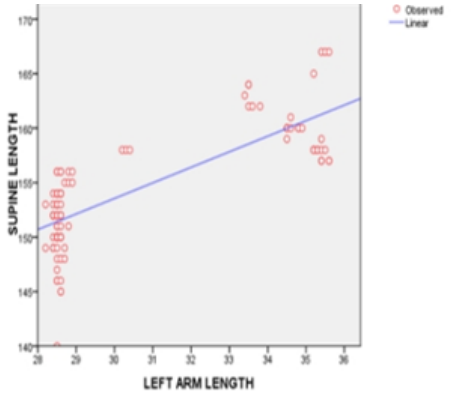

Figure 4: Regression equation for supine length from left arm length in females

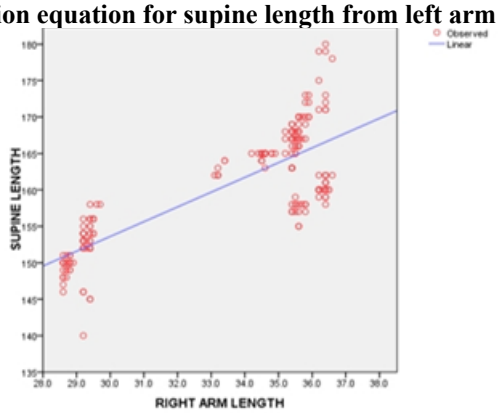

Figure 5: Regression equation for supine length from Right arm length in combined cases

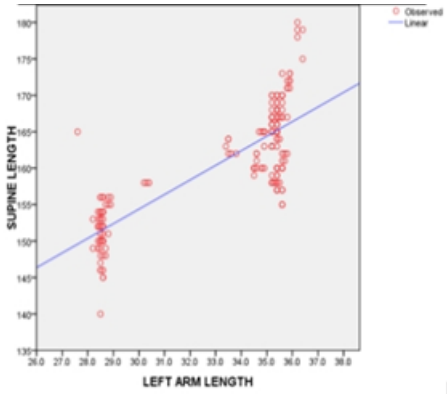

Figure 6: Regression equation for supine length from Left arm length in combined cases

Multiplication Factor

Multiplication factor was derived for both arm length for estimation of supine length. In males' multiplication factor was 4.673 and 4.702 for right and left arm lengths respectively. Among females the multiplication factor was 4.975 and 5.053 for right and left arm lengths respectively.

Discussion

Stature estimation is an important factor in identification of commingled remains in forensic examinations. Of the two basic methods i.e., anatomical, and mathematical method for estimating living stature from long bones and body parts, the anatomic method is generally preferred over mathematical method when the complete skeleton or cadaver is available.

The anatomical method involves the direct reconstruction of stature by measuring and adding together the lengths or heights of a series of contiguous skeletal elements from the skull through the foot. Many authors consider that the anatomical method provides the best approximation of stature when applicable to skeleton or cadaver. To calculate the living stature of an individual using the anatomical method, correction factors that compensate for soft tissue also need to be added. However, when mutilated remains and skeletal parts are referred for personal identification in forensic examinations, the forensic experts have to

rely upon mathematical methods for stature estimation.

Mathematical methods utilize the measurements of one or more bones or body parts to estimate stature. Thus, a distinct advantage of mathematical methods is that a single body part can be used to estimate the living stature of an individual. Standard error of estimate needs to be considered giving a possible range of stature from a given bone/body part. Moreover, different formulae are required for different population groups, different bones or body parts. Mathematical methods employed in stature estimation include multiplication factor and regression analysis. Forensic significance of these mathematical methods is based on the principle that there is a high linear correlation between an individual's stature and the body part or bone length [8]. Trotter [9] states that the most accurate estimates of stature can be obtained when the equation applied to the unknown has been derived from a representative sample of population of same sex, race, age and geographical area to which the unknown is believed to belong. The present study was aimed at and concentrated on finding the co-relation between supine length and anthropometric measurements of both side's arm of both male and female in cosmopolitan population of Delhi for subsequent determination of supine length.

Supine Length

In the present study mean supine length for males was 166.23 cm and for females was 154.32 cm. Table 3, gives the comparison of mean supine length of the study group among different authors.

Table 3: Comparison of mean supine lengths of study group among different authors

Authors	Supine length			
	Mean		Std deviation	
	Males	Females	Males	Females
Agnihotri et al [3]	173.99	159.96	6.13	6.25
Ilayperuma et al [10]	170.14	157.55	5.22	5.75
Chikhalkar et al [4]	167.25		8.49	
Present study	166.23	154.32	4.75	5.30

Arm length in Males and Females

Gender difference in estimation of supine length from arm length was studied in the present study. It was observed (table 4) that arm length exhibited statistically significant bilateral differences in both males and females ($p< 0.01$).

Table 4: Gender difference in estimation of Supine length from Arm length

Variable	Males				Females			
	Mean difference	Std deviation	t- value	p – value	Mean difference	Std deviation	t- value	p – value
Arm length	0.290	0.891	3.255	< 0.01	0.570	0.769	7.414	0.434

Akhlagi et al [2] studied 100 Iranian students (50 males and 50 females) in the age group of 21 to 26 years and formulated the correlation coefficient in males and females to be 0.602 and 0.669 respectively and the value of 'r' was 0.759 when both the genders were combined. Only the left upper limb was chosen because of insignificant bilateral variation in both genders.

The study by Kaur et al [5] comprised of 400 students (200 males and 200 females) between 17 – 25 years of age. All the measurements were taken from the left side. The correlation coefficient in males and females was found to be 0.660 and 0.474 respectively.

Difference in estimation of supine length from right and left Arm length

Correlation coefficient of right arm length for estimation of supine length was 0.114 in case of males and 0.769 in females. Correlation coefficient of left arm length was 0.217 in case of males and 0.786 in case of females. For the combined population the correlation coefficient for right arm was 0.812 and for left arm was 0.829.

Table 5: Differences in estimation of supine length from right and left arm length

Variable	Supine length	Right arm length	Left arm length
t – value	16.710	15.067	15.357
p – value	< 0.01	< 0.01	< 0.01

Table 5 depicts t- value and p- value of supine length and arm lengths of both sides. Estimation of supine length from arm length showed statistically significant ($p<0.01$) differences between right and left sides.

Conclusions

Arm length showed statistically positive correlation with supine length. Left arm length gives better prediction of supine length with high correlation coefficient and lower standard error of prediction.

Hence arm length can be used for estimation of supine length in cases of mutilated bodies and amputated body fragments.

Source of funding: Self.

Ethical Clearance: Taken from Institutional Ethical committee, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi.

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