

Derivation of Regression Equation for Estimation of Height from the Length of Clavicles

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Abstract

Background: The various features of clavicle help to decide the gender and height of the individual. Stature is an important biological parameter in medico-legal forensic examination. The length of clavicle is considered as an important anthropological parameter. The present study was undertaken with the aim of deriving of regression equation for estimation of height from the lengths of clavicle.

Methodology: This cross sectional, observational study was conducted from October 2019 to February 2020 after getting approval from IEC. 489 healthy subjects (290 males and 199 females) were included in the study after getting the informed consent. Length of clavicle and height of individual were measured and mean was calculated. Regression equations were derived after statistical analysis.

Results: The values obtained by statistical analysis were found statistically significant. Equation were derived for estimation of height from right and left clavicles in males as well as females. The mean lengths of right sided clavicles are more than that of left sided clavicles in both the genders.

Discussion: Stature estimation is key parameter in the identification process of unknown individuals in which human remains are found in mutilated form or as skeletal remains. In the present study, we attempted to correlate the lengths of clavicle with stature of individual. The present study also proved that lengths of clavicles are more in males than in females which can be attributed to heavy built in males.

Keywords: Stature; correlation; mutilated; anthropological; decomposing.

Introduction

The clavicle is a modified long bone. It is the only long bone that lies horizontally, and shows variations in its morphometry. The locomotor behavior of superior

extremity relies mostly on clavicle morphometry. The various features of clavicle help to decide the gender and height of the individual.

The length of clavicle is considered as an important anthropological parameter which is described as the distance between the lateral-most point of the clavicle in the acromio-clavicular joint and the medial-most point of the clavicle in the sterno-clavicular joint¹. Black S and Scheuer L¹ have mentioned that most of the adult morphological features of clavicle in humans are developed very early in fetal life well before birth³. Clavicle attains 80% of its total length by 12 years in males and 9 years in females⁴.

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Stature is an important biological parameter in medico-legal forensic examination⁵. The linear measurement of individual body parts plays very important role in the field of forensic, anatomical and anthropological sciences⁶. Out of various criteria for personal identification, stature carries the significant value. Anthropological database can be prepared from four basic parameters- age, race, stature and gender.

Establishment of an identity is very much important in both civil and criminal cases. Sometimes mutilated or decomposed bodies or the fragmentary remains of skeleton are brought for medico-legal examination⁵. This is common in Indian set up where victims are attacked by wild animals in forests. This leads to difficulty in identification of the deceased⁵. Literature shows many studies on stature estimation from percutaneous body measurements. But stature estimation from clavicle length is very rarely done especially in central India region. So, we have attempted to estimate the stature of individual from the clavicle length.

Material and Method

The present cross sectional, observational study was conducted in the department of Anatomy from October 2019 to February 2020 over a period of five months. The protocol was approved by the Institutional Ethics Committee. All the participants were informed about the procedure of the study and informed consent was taken before taking the measurements.

Total of 489 apparently healthy subjects of both the sexes were involved in the study. The age group of the participants was 18 to 30 years. Lower age limit of 18 years was considered because stature at this age is considered as adult height⁷ and multiplication factor remains mostly constant⁸. Apparently healthy subjects without any noticeable deformities (congenital or acquired) of the spine or upper extremities were included in the study.

The length of clavicle was measured with the vernier caliper using palpable landmarks- most medial most point of the clavicle on the sterno-clavicular joint and the lateral most point of the clavicle on the acromio-clavicular joint.

Height of the individual was measured using stadiometer in standing position where he/she was asked to stand barefoot.

All the measurements were taken thrice and mean of it was used for documentation.

Statistical Analysis: All the values were analyzed statistically using SPSS software Version 22. Mean and standard deviations were calculated for both genders. Linear regression and correlation coefficients were calculated separately for males and females. Equations were derived in both genders individually for right and left sided clavicles.



Figure 1: Measurements of height



Figure 2 Measurement of length of clavicle

Results

Out of 489 participants, 290 were male and 199 were females. Demographic distribution of the involved subjects in mentioned in table I for males and table II for females.

Table I: Demographic parameters in males

	Minimum	Maximum	Mean	Std. Deviation
Age (Years)	18.00	30.00	26.7800	1.10627
MH	158.40	182.80	172.6780	5.79212
MRTC	13.80	17.50	15.8470	0.93002
MLTC	14.00	17.60	15.6970	0.89932

MH= Height in male (cm) MRTC= length of right clavicle in male (cm) MLTC= length of left clavicle in male (cm)

Table II: Demographic parameters in females

	Minimum	Maximum	Mean	Std. Deviation
Age (Years)	18.00	28.00	25.6900	0.07205
FH	151.00	179.60	161.3170	0.53973
FRTC	12.80	16.10	14.1710	0.10049
FLTC	12.60	16.10	14.0420	0.09911

FH= Height in female (cm) FRTC= length of right clavicle in female (cm) FLTC= length of left clavicle in female (cm)

Table III: Correlations for height in males (MH) with length of right clavicle in males (MRTC) and length of left clavicle in males (MLTC)

Correlations of MH with MRTC				Correlations of MH with MLTC			
		MH	MRTC			MH	MLTC
MH	Pearson Correlation	1	0.829**	MH	Pearson Correlation	1	0.823**
	Sig. (2-tailed)		0.000		Sig. (2-tailed)		0.000
	N	100	100		N	100	100
MRTC	Pearson Correlation	0.829**	1	MLTC	Pearson Correlation	0.823**	1
	Sig. (2-tailed)	0.000			Sig. (2-tailed)	0.000	
	N	100	100		N	100	100

** . Correlation is significant at the 0.01 level (2-tailed).

Equation for height and right clavicle in males (MRTC): Height = 5.160 x MRTC + 90.908

Equation for height and left clavicle in males (MLTC): Height = 5.302 x MLTC + 89.453

Table IV: Correlations for height in females (FH) with length of right clavicle in females (FRTC) and length of left clavicle in females (FLTC)

Correlations of FH with FRTC				Correlations of FH with FLTC			
		FH	FRTC			FH	FLTC
FH	Pearson Correlation	1	0.830**	FH	Pearson Correlation	1	0.835**
	Sig. (2-tailed)		0.000		Sig. (2-tailed)		0.000
	N	100	100		N	100	100
FRTC	Pearson Correlation	0.830**	1	FLTC	Pearson Correlation	0.835**	1
	Sig. (2-tailed)	0.000			Sig. (2-tailed)	0.000	
	N	100	100		N	100	100

Equation for height and right clavicle in females (FRTC): Height = 4.456 x FRTC + 98.178

Equation for height and left clavicle in females (FLTC): Height = 4.549 x FLTC + 97.445

Discussion

Stature estimation is key parameter in the identification process of unknown individuals in which human remains are found in mutilated form or as skeletal remains. Stature calculation from decomposing and incomplete skeletal remains is gold standard in establishing the identity of individual in anthropological studies and forensic examinations^{6, 7}. Literature shows various studies undertaken on the stature determination from dry clavicle bones but very few studies are available where height is determined from the clavicle when the soft tissues are intact around it. It is easier to measure the length of dry clavicle as compared when it's covered with soft tissues i.e. percutaneous measurements. In the present study, we attempted to correlate the lengths of clavicle with stature of individual.

The major conclusion in the present study is that the mean lengths of right sided clavicles are more than that of left sided clavicles in both the genders. Sehrawat JS and Pathak RK³ (2016) also observed bilateral asymmetry in all parameters like length, weight, mid-clavicular circumference etc. They further advocated that right clavicle is more robust due to its greater sagittal diameter and higher development of most of the ligaments and muscles than the left clavicles³. Another differentiating factor might be physical activity pattern of right and side. King PR et al⁸ (2014) found longer left clavicle than the right clavicle in 65% male (4.55 mm) and 67% female (3.14 mm) cases. Cunningham et al⁹ (2013), found 28% clavicles were length-wise asymmetric (with up to 5 mm side differences)³. The different effects of genetic changes, mechanical loadings

and the muscular attachments might be responsible for such asymmetries of the clavicle^{3, 10, 11, 12}. The various factors that may affect the lengths of clavicles are genetic, nutrition, geographical location, physical activity, and different races^{6, 13}. The study carried out by Yashoda et al¹⁴ (2011) in New Delhi population postulated that mean length of the left clavicle was higher than the mean length of the right clavicle for both sexes. Similar results were observed by Ukoha UU et al¹ (2019) in North Eastern Nigerian population.

The present study also proved that lengths of clavicles are more in males than in females which can be attributed to heavy built in males. Other possible factors might be higher skeletal size and body mass^{1,13}. The study conducted by Pande V et al¹⁴ (2020) for correlation between stature and length of clavicle in female population in central India concluded with positive correlation and the linear relationship between the living stature and length of clavicle of either side. But the sample size was just 50.

Conclusion

We derived regression equations for height calculation from length of right and left clavicles in both males and females. These regression equations will be very helpful for calculating height of an individual from the length of clavicle.

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