Cross-sectional study to identify the gender of an individual by sternal end diameter and acromial-end diameter of Clavicle

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Abstract:

Aim: The purpose of this study is to predict the sex of an individual by taking into account of Sternal end diameter (SED) and Acromial end diameter (AED) from the clavicle dimensions in the population of India. **Materials & Methods:** This cross-sectional study was initiated after receiving approval from the Institutional Ethics Committee at the Department of Anatomy, Index Medical College & Hospital, Indore. According to the data registry of the department, 150 dry clavicles (75 male and 75 female) were collected. **Results:** In all the parameters, the mean ± SD in males were statistically significantly higher than those in females on both sides: $p < 0.05$ for SED on the left; SED and AED on the right; while $p= 0.010$ for left AED. In SED, the mean ± SD were significantly higher on the left than the right side ($p < 0.05$). However, there were no significant side differences AED ($p=0.792$). Correlation of all the predictor variables were significant. **Conclusion:** The present study concluded that there is a significant and strong positive correlation between the right and left sternal end diameter and acromial end diameter. This correlation was found to be significant because it was found to be positively correlated with all of the variables.

Keywords: Clavicle; Sternal end diameter; Acromial end diameter; Indian population; Vernier calipers.

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Introduction:

The population of the world is highly variable as far as biological variability is concerned [1]. Indian population is no exception, rather Indian population compromises various ethnic and racial groups leading to even greater variability in biological characteristics [2].

The skull, pelvis, and long bones of the upper and lower limbs, including the clavicle, humerus, and femur, have been used to identify unidentified individuals [3]. The clavicle ossifies first, around the fifth or sixth week of intrauterine life, and last, around the 25th year of life [4]. Males possess a clavicle that is more curved, thicker, less smooth, and longer than females [5]. As a bone, the clavicle is a durable anatomical structure that can withstand taphonomic degradation after death, even after the soft tissues have decomposed, making it suitable for human identification and even sex determination [6].

The clavicle is a long bone that can be found on the human body. It has two ends and a shaft [7]. At the lateral end of the clavicle, it will form a joint called the acromio-clavicular joint by articulating with the acromion process of the scapula [8]. The only connection that exists between the scapula and the trunk is the acromio-clavicular joint; other than that, only the muscles are responsible for keeping it in place [9,10]. Both the clavicle and the scapula play an important role in the motions of the upper extremity and the thoracic cage. When a person reaches the age of 29, the ossification of the clavicle is finished [10,11]. It will also provide a database of anthropometric clavicle dimensions to aid in the surgical management of patients involving the clavicle by orthopaedic surgeons [10]. The purpose of this

study is to predict the sex of an individual by taking into account of Sternal end diameter (SED) and Acromial end diameter (AED) from the clavicle dimensions in the population of India.

Materials & Methods:

This cross-sectional study was initiated after receiving approval from the Institutional Ethics Committee at the Department of Anatomy, Index Medical College & Hospital, Indore. According to the data registry of the department, 150 dry clavicles (75 male and 75 female) were collected. Using a Vernier caliper, the lengths of 150 adult human clavicles of known sex were measured. Clavicles exhibiting pathology were excluded. Using an osteo-metric board, the maximum length in millimeters will be determined. Using a digital caliper, the following parameters were measured, Sternal end diameter (SED): The vertical distance between the highest point and the lowest point of the medial border of Sternal end of the clavicle. Acromial end diameter (AED): The vertical distance between the highest point and the lowest point of the lateral border of acromial end of the clavicle.

Statistical analysis:

Utilizing IBM SPSS, the raw data were analyzed. The independent samples t-test was used to examine the mean difference between males and females, while the paired samples t-test was utilized to examine the mean difference between the right and left sides. In addition, Pearson's correlation was used to determine the strength of the relationship between the right and left sides. In addition, a discriminant function analysis was performed to determine the accuracy of each sex determination parameter. The p-value threshold for statistical significance was fixed at 0.05.

Results:

Demographic data of subjects revealed 50 % (n=75) and 50 % (n=75) of all study subjects were males and females respectively. Table 1 & 2 shows the comparison of clavicular parameters studied on the left and right side between males and females. In all the parameters, the mean ± SD in males were statistically significantly higher than those in females on both sides: $p < 0.05$ for SED on the left; SED and AED on the right; while $p= 0.010$ for left AED.

Table 3 shows paired samples t-test of the combined data of all parameters studied between the right and left sides. In SED, the mean ± SD were significantly higher on the left than the right side ($p < 0.05$). However, there were no significant side differences AED ($p=0.792$).

Discriminant analyses showed in Table 3, was significant for the Sternal diameter on both sides, and Acromial diameter ($p < 0.05$ on the right and < 0.05 on the left). Correlation of all the predictor variables were significant. Discriminant analyses for sex determination using clavicular dimensions is shown in Table 4.

Discussion:

The present study on both sides, males had statistically significantly higher means SDs than females for all parameters: $p < 0.05$ for SED on the left; SED and AED on the right; and $p = 0.010$ for left AED. Males have a higher clavicle height than females because they have to continue growing for a longer period of time [12,13]. This is due to the fact that females reach puberty about two years earlier than males do [12]. According to Kaur et al., 2002, and Mohammed., 2006 [14,15] suggested that both height and diet have an effect on clavicle length. In addition, it has been hypothesized that the proportion of the skeleton that is present in females is approximately twenty percent smaller than it is in males. According to previous research [16-24], male skeletons are anticipated to be more robust and longer than those of female skeletons. The fact that males have statistically significantly higher values for sternal end diameter and acromial end diameter than females on both sides may reflect differences in skeletal growth and maturity time, the timing of puberty, hormones, and the higher stress loadings on the male clavicle due to more laborious tasks. It may also reflect differences in the biomechanical loadings on a bone and activity. Studies [23,24] used both clavicles in their studies and found statistically significant higher mean SED and AED values in males than in females [20]. Yang et al. (2017) [20] used only the right clavicle in their study. The studies [23,24] used both clavicles in their studies In a study with the same design but using only the left clavicle, men had a mean SED that was statistically significantly higher than the average, but the difference in mean AED between the sexes was not statistically significant. In contrast, a study that used both clavicles 8 found statistically significant differences in the mean gender difference for both sides. These differences were found for both

sides. It is possible that differences in results were caused by both genetic and environmental factors [21-23]; these studies were conducted independently of one another.

Conclusion:

The present study concluded that there is a significant and strong positive correlation between the right and left sternal end diameter and acromial end diameter. This correlation was found to be significant because it was found to be positively correlated with all of the variables. On the right, 66 percent according to SED, 62 percent according to AED and 68 percent according to combined parameters; on the left, 72 percent according to SED and 58 percent according to AED, and 74 percent according to combined parameters (combined parameters).

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Table 1: Left-side comparison of male and female study variables

Side	Parameter	Sex	N	Range	Mean ± SD	t	df	p-value
Left	SED (mm)	F	75	15.6-33.5	24.4±3.4	4.332	148	<0.05
		M	75	20.1-31.4	26.4±3.1			
	AED (mm)	F	75	8.1-21.3	13.8±1.9	3.667	148	<0.05
		M	75	10.1-21.9	15.3±1.8			

SED= Sternal end diameter; AED= Acromial end diameter; F=female; M=male; df= degree of freedom.

Table 2: Right-side comparison of male and female study variables

Side	Parameter	Sex	N	Range	Mean ± SD	t	df	p-value
Right	SED (mm)	F	75	15.6-33.5	24.4±3.4	4.332	148	<0.05
		M	75	20.1-31.4	26.4±3.1			
	AED mm)	F	75	8.1-21.3	13.8±1.9	3.667	148	<0.05
		M	75	10.1-21.9	15.3±1.8			

SED= Sternal end diameter; AED= Acromial end diameter; F=female; M=male; df= degree of freedom.

Table 3: Paired samples t-test between right and left clavicles (n=150)

Pair	Parameter	Mean ± SD	t	df	p-value
Pair-1	Sternal end diameter on right side – Sternal end diameter on the left side (mm)	-0.59±2.39	-2.998	149	0.004
Pair-2	Acromial end on right side - Acromial end on left side (mm)	0.07±2.18	0.502	149	0.792

Table 3: Coefficients of right-to-left correlations in paired samples (n=150)

Pair	Parameter	r	p-value
Pair-1	Sternal end diameter on right side – Sternal end diameter on the left side (mm)	0.799	<0.05
Pair-2	Acromial end on right side -Acromial end on left side (mm)	0.698	<0.05

Table 4: Discriminant analyses for sex determination using clavicular dimensions

Side	Parameter	Correlation	Model	Accuracy (Males)	Accuracy (Females)	Overall accuracy
	SED	**0.30**	**S = - 6.823 + 0.421 (SED)**	**60.1%**	**66.2%**	**66%**
	AED	**0.33**	**S = -3.783 + 0.32 (AED)**	**58.3%**	**67.3%**	**62%**
	SED+AED	**0.60**	**S = -11.23 + 0.068 (SED) + 0.08 (AED)**	**82.1%**	**74%**	**86%**
	SED	**0.36**	**S = - 8.311 + 0.424 (SED)**	**63.2%**	**69.9%**	**72%**
	AED	**0.24**	**S = - 6.051 + 0.281 (LHL)**	**52.3%**	**60%**	**58%**
	SED+AED	**0.66**	**S = -15.794 + 0.078 (SED) - 0.09 (AED)**	**88.1%**	**78%**	**84%**