

GENDER IDENTIFICATION IN A CROSS-SECTIONAL STUDY USING THE LINEAR HORIZONTAL LENGTH AND MID-LENGTH DIAMETER OF CLAVICLE IN INDIAN POPULATION

K. Sangeeta¹, Vimal Modi², Pawan kumar Mahato³

¹Ph.D Scholar, Mawanchal University, Indore, Madhya Pradesh, India

²Professor, Department of Anatomy, Index Medical College, Indore, Madhya Pradesh, India

³Associate Professor, Department of Anatomy, Index Medical College, Indore, Madhya Pradesh, India

Received : 30/07/2022
Received in revised form : 17/09/2022
Accepted : 28/09/2022

Keywords:

Clavicle, Linear horizontal length, Mid-length diameter, Indian population, Vernier calipers.

Corresponding Author:

Dr. Pawan Kumar Mahato,
Email: pawanmahato12@gmail.com
ORCID: 0000-0002-5243-0374

DOI: 10.47009/jamp.2022.4.4.116

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2022; 4 (4); 596-599



Abstract

Background: The purpose of this study is to predict the sex of an individual by taking into account of linear horizontal length (LHL) and mid-length diameter (MLD) from the clavicle dimensions in the population of India. **Materials and 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. **Result:** In all the parameters, the mean \pm 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 \pm 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.

INTRODUCTION

An accurate identification of previously unidentified human skeletal elements requires first establishing the gender of the individual whose remains are being studied.^[1] According to findings from earlier studies, the pelvic bones display the greatest degree of sexual dimorphism among all bones, whereas the clavicle displays the least amount of sexual dimorphism.^[2,3] Forensic scientists and anthropologists have been fascinated with the challenge of determining the age and gender of human skeletal remains for a very long time.^[4] It is obvious that reliable methods are required in cases of commingled, eroded, and/or missing remains in order to differentiate males and females based on various skeletal elements.^[5] This is because the remains may have been commingled or eroded.

The clavicle is a long bone that can be found on the human body. It has two ends and a shaft.^[6] 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.^[7] 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.^[8] 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.^[2,3] It will also provide a database of anthropometric clavicle dimensions to aid in the surgical management of patients involving the clavicle by orthopaedic surgeons.^[9] This study will be relevant to Biological Anthropologist for population studies. The purpose of this study is to predict the sex of an individual by taking into account of linear horizontal length (LHL) and mid-length diameter (MLD) from the clavicle dimensions in the population of India.

MATERIALS AND METHODS

After receiving approval from the Institutional Ethics Committee at the Department of Anatomy, Index Medical College & Hospital, Indore, this cross-sectional study was conducted. According to the department's data registry, 150 dry clavicles were collected (75 male and 75 female). The lengths of 150 adult human clavicles of known sex were

measured using a Vernier caliper. Pathologically affected clavicles were excluded. Using an osteometric board, the maximum length will be measured in millimeters. Using a digital caliper, the following parameters were measured, Linear horizontal length (LHL): The horizontal distance between parallel lines drawn at the most medial part of the Sternal end and most lateral part of the acromial end of the clavicle. Mid-length diameter (MLD): The vertical distance between the highest point and the lowest point of the middle of the linear horizontal length of the clavicle.

Statistical Analysis

The raw data was analyzed with IBM SPSS. T-tests for independent and paired samples were used to examine the differences in mean differences between males and females, as well as between the right and left sides. To determine the strength of the relationship between the right and left sides, Pearson's correlation was used. It has also been determined how accurate each sex determination factor is through a discriminant function analysis. There was a 0.05 p-value threshold for statistical significance in this study.

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 \pm SD in males were statistically significantly higher than those in females on both sides: $p < 0.05$ each for LHL and MLD on the left; LHL and MLD on the right.

Table 3 shows paired samples t-test of the combined data of all parameters studied between the right and left sides. In MLD, the mean \pm SD were significantly higher on the left than the right side ($p=0.003$). However, there were no significant side differences in LHL ($p=0.674$).

Discriminant analyses showed in Table 4, was significant for the Linear horizontal length; Sternal diameter; Mid-length diameter and combined data ($p < 0.05$) 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, with the LHL on the right.

Discriminant analyses for sex determination using clavicular dimensions is shown in Table 5. The overall accuracy of correct classification was higher in LHL on the right and combined data on both sides (82.1 %).

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

Side	Parameter	Sex	N	Range	Mean \pm SD	t	df	p-value
Left	LHL (mm)	F	75	88.1-166.4	139 \pm 11.46	6.223	148	<0.05
		M	75	129.1-172.7	149 \pm 12.1			
	MLD (mm)	F	75	12.4-28.3	14.9 \pm 3.1	5.337	148	<0.05
		M	75	14.3.1-29.7	17.5 \pm 3.1			

LHL= Linear horizontal length; MLD= Mid-length 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 \pm SD	t	df	p-value
Right	LHL (mm)	F	75	88.1-166.4	139 \pm 11.46	6.223	148	<0.05
		M	75	129.1-172.7	149 \pm 12.1			
	MLD (mm)	F	75	12.4-28.3	14.9 \pm 3.1	5.337	148	<0.05
		M	75	14.3.1-29.7	17.5 \pm 3.1			

LHL= Linear horizontal length; MLD= Mid-length 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 \pm SD	t	df	p-value
Pair-1	Linear horizontal length on right side -Linear horizontal length of left side (mm)	0.21 \pm 7.92	0.449	149	0.674
Pair-2	Mid-length diameter on right side – Mid-length diameter on the left side (mm)	-0.88 \pm 2.01	-0.98	149	< 0.05

Table 4: Coefficients of right-to-left correlations in paired samples (n=150)

Pair	Parameter	r	p-value
Pair-1	Linear horizontal length on right side -Linear horizontal length of left side (mm)	0.789	<0.05
Pair-2	Mid-length diameter on right side – Mid-length diameter on the left side (mm)	0.744	< 0.05

Table 5: Discriminant analyses for sex determination using clavicular dimensions

Side	Parameter	Correlation	Model	Accuracy (Males)	Accuracy (Females)	Overall accuracy
Rt	LHL	0.58	S = -9.213 + 0.08 (LHL)	82.5%	76%	82.1%

	MLD	0.29	$S = -6.921 + 0.521$ (MLD)	58.3%	72.1%	69%
	LHL+MLD	0.60	$S = -11.23 + 0.048$ (LHL) + 0.21 (MLD)	82.1%	74%	86%
Lt	LHL	0.48	$S = -4.621 + 0.564$ (LHL)	72.1%	70.1%	76%
	MLD	0.36	$S = -5.989 + 0.434$ (MLD)	54.5%	62.4%	64%
	LHL+MLD	0.66	$S = -15.794 + 0.068$ (LHL) + 0.71 (MLD)	88.1%	78%	84%

DISCUSSION

Since the length of the clavicle contributes to the width of the shoulder, the wider shoulder than hip in males after puberty, but the wider hip than shoulder in females, could explain the higher mean value of linear horizontal length in males than in females in the current study. This is because the shoulder is wider than the hip in males after puberty, but the hip is wider than the shoulder in females.^[10] According to studies,^[11,12,13,14,15] it takes men about four years longer than it does women to grow to the point where their clavicles are four-fifths of their total length. It's possible that the gender gap was so pronounced because males had to wait a certain amount of time before their clavicles could fully develop. Studies have shown that males have clavicles that are noticeably longer than those of females.^[5,15] Even though some studies discovered that men's clavicles were, on average, longer than those of women, the researchers who conducted those studies did not conduct statistical tests to determine whether or not this was actually the case.^[5,15] Several recent studies have found results that are consistent with the findings of the current study.^[16,17,18,19,20,21] The current study found that men have a statistically significant higher mean linear horizontal length than women. As was mentioned earlier, the shoulder width of post-pubertal males is greater than their hip width, and the development of the clavicle takes significantly longer in men than it does in women.

According to previous research,^[12,17,18,21] the linear horizontal length of the clavicle did not significantly differ on either side in their studies. It is not clear why this result was found in the study that is being discussed. Previous research has shown that the mean clavicle length measured in this study is longer than what was reported in those studies.^[13,14,19,20] The observed variations might be explained by differences in the genetic make-up of the population, in addition to environmental factors like diet and geography.

In this particular study, the male participants had a greater value for their mid-length diameter than the female participants did. According to the statistics, there was a large gap in achievement levels between the two groups. Since the length of the clavicle is less sensitive to the effect of loading than the breadth of the shaft, it is possible that the differences observed are the result of greater mechanical stress being placed on the male clavicle

as a result of more strenuous work. According to additional research,^[16,18] there is a statistically significant difference between males and females in terms of the diameter at the midpoint of the length.

Because of the strong positive correlations that exist between right and left clavicles in corresponding samples, it is possible that the clavicles were influenced in the same way by a variety of factors, including nutrition, hormones, and others. Alternately, it could imply that both of them were subject to the same level of influence from anthropometric factors.

In a related study that was conducted in Maharashtra, India,^[18] researchers found a similarly high overall accuracy rate of 87.0 percent using the entire length of the clavicle. They also found similar results for males (87.0) and males (87.8) and females (87.0). Overall, the accuracy rate was similar across all three genders (85.6 percent). It was discovered that the mid-length had an equally impressive degree of accuracy.

In North Karnataka, India, an earlier study,^[10] used dried clavicle to determine sex more accurately (right: 62 percent male; 63 percent female; left: 76 percent male; 67.5 percent female) than the values in the present study, which used discriminant analysis of clavicle length. In the present study, the values were as follows: right: 62 percent male; 63 percent female; left: 76 percent male; some researchers looked into the possibility of determining sex based on the presence or absence of dried clavicles in South African and Turkish populations.^[21,22,23,24] Even though they used a Logistic regression analysis, they reported that the accuracy of the sex prediction for the full length was 89 percent. This is despite the fact that they used the analysis. According to the findings of this other piece of research, the percentage accuracy of sex prediction using the full length of the clavicle is 80.7 percent on both sides, which is comparable to the findings of the current study.

CONCLUSION

In addition, it has been established that there is a significant and strong positive correlation between the right and left linear horizontal length and clavicle mid-length diameter. This correlation was found to be significant because it was found to be positively correlated with all of the variables. On the right, 82.1 percent according to LHL, 66 percent and 69 percent according to MLD, and 88 percent

according to combined parameters; on the left, 76 percent according to LHL, 72 percent and 64 percent according to MLD, and 89 percent according to combined parameters (combined parameters).

REFERENCES

- Alonso-Llamazares C, Pablos A. Sex estimation from the calcaneus and talus using discriminant function analysis and its possible application in fossil remains. *Archaeol Anthropol Sci.* 2019;11(9):4927-46.
- Sarkar NR, Mukhopadhyay PP. Determination of Age from the Length of Clavicle using Digital X-Ray in Adolescent Subjects: a Preliminary Study in Indian Bengali. *Forensic Med Toxicol.* 2015;9(1):165.
- Cunha E, Lopez-Capp TT, Inojosa R, Marques SR, Moraes LOC, Liberti E, et al. The Brazilian identified human osteological collections. *Forensic Sci Int.* 2018;289:449.e1-449.e6. doi: 10.1016/j.forsciint.2018.05.040.
- Mann RW, Koel-Abt K, Dhody A, Mahakkanukrauh P, Mann VJ, Techataweewan N, et al. The importance of human osteological collections: Our past, present, and future. *Forensic Sci Int.* 2021;325:110895. doi: 10.1016/j.forsciint.2021.110895.
- Alpaslan-Roodenberg S, Anthony D, Babiker H, Bánffy E, Booth T, Capone P, et al. Ethics of DNA research on human remains: five globally applicable guidelines. *Nature.* 2021;599(7883):41-46. doi: 10.1038/s41586-021-04008-x.
- Dakshayani K, Shivanal U. Morphological study of nutrient foramen in adult human clavicles. *Int J Anat Res.* 2021;9(1.1):7886-9.
- Keche HA, Thute PP, Fulmali DG, Keche AS. Morphometric Study of Nutrient Foramina in Dry Human Clavicles in Central India. *J Evol Med Dent Sci.* 2021;10(28):2099-104.
- Holm S. The privacy of Tutankhamen--utilising the genetic information in stored tissue samples. *Theor Med Bioeth.* 2001;22(5):437-49. doi: 10.1023/a:1013010918460.
- DeBaun MR, Lai C, Schultz BJ, Oquendo YA, Campbell ST, Goodnough LH, et al. White-Light Body Scanning Captures Three-Dimensional Shoulder Deformity After Displaced Diaphyseal Clavicle Fracture. *J Orthop Trauma.* 2021;35(4):e142-e147. doi: 10.1097/BOT.0000000000001957.
- Math S, Math SC, Jatti VB, Murthy CV. Identification of sex of human clavicles from North Karnataka Zone. *Anthropol.* 2014;17(3):917-20.
- Akhlaghi M, Moradi B, Hajibeygi M. Sex determination using anthropometric dimensions of the clavicle in Iranian population. *J Forensic Leg Med.* 2012;19(7):381-5. doi: 10.1016/j.jflm.2012.02.016.
- Mediavilla ER, Pérez BP, González EL, Sánchez JA, Fernández ED, Sáez AS. Determining sex with the clavicle in a contemporary Spanish reference collection: A study on 3D images. *Forensic Sci Int.* 2016;261:163.e1-10. doi: 10.1016/j.forsciint.2016.01.029.
- Moorkhan LV, Madathil PT. Determination of Sex From Adult Clavicle--An Autopsy based Regional Study. *Indian J Forensic Med Toxicol.* 2020;14(3):800-804.
- Samala N, Manasa B. Sex Determination using Anthropometric Dimensions of Clavicle-An Observational Study. *Int J Anat Radiol Surg.* 2019;8(1):24-6.
- Benwoke WI, Aigbogun EO, Bienonwu E, Johnbull TO. The clavicle as a forensic tool: sex-discriminatory characteristics in cadaveric samples of Nigeria origin. *Int J Anat Res.* 2019;7(2.1):6336-40b.
- Udoaka AI, Nwokediuko AU. Radiologic evaluation of clavicular morphology in southern Nigerians. *Int. J. Morphol.* 2013;31(1):94-96.
- El Morsi DA, Al Hawary AA. Sex determination by the length of metacarpals and phalanges: X-ray study on Egyptian population. *J Forensic Leg Med.* 2013;20(1):6-13. doi: 10.1016/j.jflm.2012.04.020.
- Wankhede KP, Bardale RV, Chaudhari GR, Kamdi NY. Determination of sex by discriminant function analysis of mandibles from a Central Indian population. *J Forensic Dent Sci.* 2015;7(1):37-43. doi: 10.4103/0975-1475.150304.
- More CB, Vijayvargiya R, Saha N. Morphometric analysis of mandibular ramus for sex determination on digital orthopantomogram. *J Forensic Dent Sci.* 2017;9(1):1-5. doi: 10.4103/jfo.jfds_25_15.
- Dehiya A, Agnihotri G, Sharma RK. Morphometric Variation of Adult Human Clavicle-A Tool for Gender Determination. *Int J Med Dent Sci.* 2019:1793-9.
- Singh G, Das S, Shamal S, Patra M. Gender variation of Clavicle in Eastern Odisha. *Int J Anat Res.* 2020;8(1.3):7386-89.
- García-Donas JG, Ors S, Inci E, Kranioti EF, Ekizoglu O, Moghaddam N, et al. Sex estimation in a Turkish population using Purkait's triangle: a virtual approach by 3-dimensional computed tomography (3D-CT). *Forensic Sci Res.* 2021;7(2):97-105. doi: 10.1080/20961790.2021.1905203.
- Ishwarkumar S, Pillay P, Haffajee MR, Rennie C. Sex determination using morphometric and morphological dimensions of the clavicle within the KwaZulu-Natal population. *Int J Morphol.* 2016;34(1):244-51.
- Scott S, Peckmann TR, Alblas M. The influence of biological affinity and sex on morphometric parameters of the clavicle in a South African sample. *Am J Hum Biol.* 2018;30(5):e23144.