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Sex Differentiation from Anthropometric Measurements of Adult Clavicle in Bengalee Population

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ABSTRACT

Clavicle, a modified long bone of human body is itself unique by its position and feature. This is not only the connecting link between axial and appendicular skeleton but also way to identify gender. In the field of observational science every observation adds some more findings to build up knowledge. Hence anthropometric study on wet clavicle specimen in Bengalese to find out significant gender difference is expected to add some more to the sea of information in hand. To differentiate gender from measurements of length of clavicle, diameter and breadth of sternal and acromial ends of clavicle. 60 Male and 40 Female wet specimens of clavicle are obtained from Departments of Anatomy and Forensic and State Medicine of Burdwan and Murshidabad Medical Colleges. They are dried and measured with the help of osteometric board, sliding callipers, graduated scale and copper wire. For statistical analysis SPSS (20.0 version) software has been used. Gender determination could be done correctly in 17% of right male, 7% of left male, 20% of right female and 40% of left female clavicles. The sternal end diameter is found to be statistically highly significant ($p<0.001$) in differentiating the sex of male and female clavicles. Acromial breadth however did not show statistically significant difference among male and female. Clavicle is a medicolegally important and useful tool for gender determination on comparative study.

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Key Words
Anthropometry, clavicle, length of clavicle, sex determination

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INTRODUCTION

Anthropometry is a series of systematized measuring techniques that express quantitatively the dimensions of the human body and skeleton. Anthropometry can be subdivided into (a) Somatometry and (b) Osteometry[1].

Osteometry is an useful tool in forensic science for estimation of stature, age, sex and race. These four parameters are considered as the "big fours" of forensic anthropology. The anthropometry of the body parts like soft tissue and bones show sexual dimorphism, which can be explained by Stanfield's postulation of evolutionary biology (1977)[2]. The body part that takes longest time to get perished is none other than bone. Skeletal remnants are of immense importance for both anatomist and anthropologist to opine regarding gender, age and stature.

Taylor in his book of medical jurisprudence, presented the accuracy of sex determination from different bone[3] (Table 1).

Krogmen[4] has opined that the accuracy of sex identification based on the study of complete skeleton was 100%. Percentages of accuracy of sex determination with other bone in Table 2.

Long bones are especially useful because of ease of defining measurement and often better preserved[5]. Femur, clavicle and humerus are most important bone. Sexual dimorphism in the clavicle from Bengalee population was the aim of observation in this study.

The present morphometric study on the clavicle will also give the common values of the dimensions of the clavicle of the region. The knowledge regarding this will help the orthopedic surgeon to decide the correct size and shapes of plates and nails for the treatment of clavicular fractures by open reduction methods.

Aims and objectives: The aims of this study are to discriminate sex by using following measurements of adult clavicles (right and left) and comparing them:

- Maximum length of the clavicle
- Antero-posterior diameter of sternal end of the clavicle
- Antero-posterior diameter and circumference of mid-shaft of clavicle
- Antero-posterior breadth of acromial end of clavicle

Table 1: Accuracy of sex determination from different bone

Bone	Accuracy (%)
Skull+clavicle	97.35
Coccyx+sacrum	97.18
Pelvis	95.00
Skull alone	91.38
clavicle	39.84
Atlas vertebrae	31.18

Table 2: Percentages of accuracy of sex determination with other bone

Bone	Skull+pelvis (%)	Pelvis alone (%)	Skull (%)	Long bones (%)
Accuracy	98	95	90	80

The hot and humid climate in Bengal accelerate chemical and mechanical taphonamic process. This results in quick decomposition and scattering of flat bones of the skull and less robust portion of the pelvis[6-8]. Long bones such as clavicle may be particularly useful, in such cases, because they are often better preserved. Till date hardly any study has been reported in Bengali community on sex determination using clavicle measurements. Limited studies have been done on other communities of India.

MATERIALS AND METHODS

In this observational study total 100 wet adult human clavicles of known gender (60 male and 40 female) were collected from the department of Anatomy, and department of Forensic and state medicine, Burdwan Medical College and Murshidabaad Medical College.

Inclusion criteria:

- Ossification completed
- No obvious bony deformity

Exclusion criteria:

- Incomplete ossification/ fusion
- Obvious deformity or disease

Clavicles are cleaned and dried prior to taking measurements. The study population included adult clavicle of male and female above 31 years of age in Bengali population. The present study was done over one year from February 2011 to January 2012. Measurements were taken in millimetre (mm) up to the first decimal place.

Maximum length of clavicle was maximum distance between most extreme ends of the clavicle. Antero-posterior diameter of mid-shaft of clavicle was measured from the anterior to the posterior surface at mid-shaft of the clavicle after determining the mid-point of the diaphysis on osteometric board. Circumferance of mid-shaft of clavicle was measured at the middle of the shaft of the clavicle after determining the mid-point on osteometric board, with a copper wire. With measuring tape the lengths of the copper wire required were measured. Antero-posterior diameter of sternal end of clavicle was the maximum diameter from anterior to posterior surface at sternal end[9]. Antero-posterior breadth of acromial end of clavicle was maximum breadth between anterior to posterior border at acromial end[10,11]. For measurements osteometric board, measuring tape, sliding callipers, flexible copper wire and graduated scale were used.

In order to avoid manual error, sufficient care is taken and all parameters are measured accurately.

Ethical clearance: Obtained from Institutional ethical committee of Burdwan Medical College, registered under memo no. BMC/PG/1218, 28/02/2011.

Statistical analysis: Data collected were compiled and analysed using SPSS software version 20.0. Descriptive statistics such as mean, standard deviation, were calculated for each of the variable for both the sexes. Stepwise discriminate function analysis using measurements was applied to determine the optimal combination of variables for assessing gender. Variables, alone and in combination, were also subjected to direct analysis to develop functions to allow gender

determination from fragmentary remains. Standard descriptive statistics were calculated and then t-test and stepwise analysis were applied.

Discriminant function analysis: Discriminant function analysis is used to determine which variables discriminate between two or more naturally occurring groups. There is similarity among computation of discriminant function analysis and analysis of variance. Whether groups differ with regard to the mean of a variable, and then to use that variable to predict group membership (e.g., of new cases) is the basis of this analysis. In one study multiple variables are usually included to determine which among them is/are contributing towards group discrimination.

RESULTS and DISCUSSIONS

Sex determination can be done even with a part of clavicle with high accuracy by metric measurement and analysis. Even after many similarities with previous studies this study results differs in the finding that the classification depending on length is more accurate than that depending on the midshaft circumference (Fig. 1).

As many studies are available on same data, comparison is done by representing the findings in tabular format (Table 3)**.**

Length of clavicle: In the present study, mean length of masculine clavicle is significantly higher than that of feminine clavicle. Thus, it is clear from table that, similar to studies of Doengen[12] and Jit and Sahni[13] and Padeyappanavar *et al*.[14] and the study observed statistically significant difference between length of clavicles from either gender ($p<0.001$) (Table 4).

The difference is probably suggestive of the fact that the built of American Negroes, Whites and North Indian are stouter than the eastern Indian population (Table 5,6).

Mid-shaft clavicular circumference: It is clear from the table that, statistical significance is high for the parameter mid-shaft circumference ($p<0.001$) in differentiating the gender of clavicle, which is similar to the studies of Doengen[6] and Sahni[7] and Padeyappanavar *et al*.[8]. Though the statistical significance is not available from many previous studies (Table 7-10).

Table 3: Comparison of right and left clavicular lengths of both male and female subjects

Subjects	Mean right clavicle length	Standard deviation of right clavicle length	Mean left clavicle length	Standard deviation of left clavicle length	Correlation between right and left clavicular lengths
Male	145.1333	7.95129	146.0667	7.50142	0.973
Female	128.6000	7.13516	129.9000	6.84913	0.951

Table 4: Comparison of right and left mid clavicular circumferences of both male and female subjects

Subjects	Mean right mid clavicle circumference	Standard deviation of RMCC	Mean left mid clavicle circumference	Standard deviation of LMCC	correlation between right and left
Male	37.7667	2.60217	36.40	3.14971	0.656
Female	30.8000	2.05452	29.95	2.91953	0.854

Table 5: Comparison of right and left mid-clavicular diameters of both male and female subjects

Subjects	Mean right mid clavicle diameter	Standard deviation of RMCD	Mean left mid clavicle diameter	Standard deviation of LMCD	Correlation between right and left
Male	13.0733	1.18582	12.6233	1.13310	0.794
Female	10.8000	1.33180	10.3000	1.55089	0.840

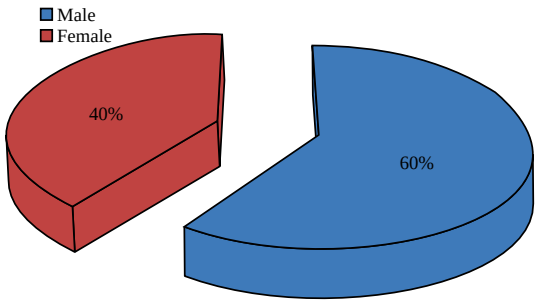

Fig. 1: Gender distribution of study population

Table 6: comparison of right and left sternal end diameters of both male and female subjects

Subjects	Mean right sternal end of clavicle diameter	Standard deviation of RSD	Mean left sternal end of clavicle diameter	Standard deviation of LSD	Correlation between right and left
Male	21.1233	2.84747	21.6	2.49966	0.946
Female	18.05	1.74642	18.7	1.88065	0.83

Table 7: Comparison of right and left acromial breadth of both male and female subjects

Subjects	Mean right clavicle acromial end breadth	Standard deviation of RAB	Mean left acromial end of clavicle breadth	Standard deviation of lab	correlation between right and left
Male	19.1167	2.02435	19.8833	2.09549	0.82
Female	17.75	0.93892	18.725	1.72043	0.346

Table 8: Results of unpaired t-test of different parameters of male and female subjects.

Comparison of male and female parameters	t-score	Standard error of difference	p-value	Significance
Length of right clavicle	7.4978	2.2050	<0.0001	High
Length of left clavicle	11.1280	1.4528	<0.0001	High
Mid clavicular circumference of right clavicle	14.9080	0.4673	<0.0001	High
Mid clavicular circumference of left clavicle	10.4849	0.6152	<0.0001	High
Sternal end diameter of right clavicle	6.6845	0.4598	<0.0001	High
Sternal end diameter of left clavicle	6.6087	0.4388	<0.0001	High
Right clavicle acromial end breadth	4.5471	0.3006	<0.0001	High
Left clavicle acromial end breadth	3.0192	0.3836	0.0051	

Table 9: Comparison of length of male and female clavicles in different studies

				Male		Female		
Years	Authors	Regions	Side	Mean	Range	Mean	Range	p-value
1932	Terry[15]	USA Negroes	Right	153.3	-	140.98	-	
			Left	155.86	-	141.78	-	
1932	Terry[15]	USA Whites	Right	152.9	-	138.60	-	
			Left	154.1	-	140.40	-	
1963	Doengen[12]	Australia	Right	139.5	-	125.10	-	<0.001
			Left	139.5	-	125.1	-	
1966	Jit and Singh[16]	Amritsar Zone	Right	145.58	119.8-171.4	130.36	103.0-157.7	<0.001
			Left	147.59	119.84-175.3	129.8	103.5-151.1	
1968	Singh and Gangrade[17]	Varanasi Zone	Right	141.19	116.8-166.2	125.78	103.3-148.3	
			Left	144.18	120.2-168.2	127.77	103.5-146.4	
1972	Singh[18]	American Negroes	Right	155.72	-	137.6	-	
			Left	157.32	-	140.8	-	
1972	Singh[18]	American Whites	Right	151.4	-	133.68	-	
			Left	153.37	-	134.84	-	
1983	Jit and Sahni[13]	Chandigarh Zone	Right	148.0	127-175	132.4	116-160	<0.001
			Left	149.8	127-176	134.0	117-149	
1992	Sayee *et al*.[19]	Bangalore zone	Right	137.0	-	123.9	-	
			Left	141.5	-	128.2	-	
2009	Padeyappanavar *et al*.[14]	North Interior Karnataka	Right	141.9	120-167	125.4	100-145	<0.001
			Left	143.5	121-170	129.7	105-145	
2012	Present study	Bengali population	Right	145.13	133-160	128.60	118-142	<0.001
			Left	146.06	135.50 -161.50	129.90	120-144.50	

Table 10: Comparison of mid-clavicular circumference of male & female clavicles in different studies

				Male		Female		
Years	Authors	Regions	Side	Mean	Range	Mean	Range	p-value
1932	Terry[15]	USA Negroes	Right	40.02	-	35.26	-	<0.001
			Left	38.58	-	32.42	-	
1932	Terry[15]	USA Whites	Right	40.02	-	35.16	-	
			Left	40.06	-	38.42	-	
1951	Oliver[20]	French (France)	Right	38.4	-	31.06		
			Left	38.4	-	31.6		
1963	Doengen[12]	Australia	Right	36.2	-	29.5	-	<0.001
			Left	36.2	-	29.5	-	
1966	Jit Singh[16]	Amritsar Zone	Right	36.17	27.11-45.23	29.69	24.47-34.91	<0.001
			Left	35.7	26.22-45.18	29.51	23.60-35.42	
1968	Singh Gangrade[17]	Varanasi Zone	Right	35.09	25-48	28.52	21-41	
			Left	34.64	25.12-44.16	28.0	21.32-34.68	
1972	Singh[18]	American Negroes	Right	39.96	-	33.06	-	
			Left	39.08	-	32.66	-	
1972	Singh[18]	American Whites	Right	38.47	-	31.61	-	
			Left	37.61	-	30.72	-	
1983	Jit Sahni[13]	Chandigarh Zone	Right	36.2	31-45	30.4	24.0-35.0	<0.001
			Left	35.9	27.8-45	30.0	21.6-38.0	
1992	Sayee *et al*.[19]	Bangalore zone	Right	37.0	-	32.0	-	
			Left	37.0	-	35.0	-	
2009	Padeyappanavar *et al*.[14]	North Interior Karnataka	Right	38.34	30.0-54.0	31.76	24.0-37.0	<0.001
			Left	37.96	28.0-45.0	32.44	25.0-39.0	
2012	Present study	Bengali population	Right	37.77	33 - 42	30.80	28 - 35	<0.001
			Left	36.40	30 - 43	29.95	25.50 - 35	

Mid-shaft clavicular diameter, sternal end diameter and breadth of acromial end: It is clear from the table 3 that, clavicular diameter at the middle of the shaft in this study is statistically highly significant ($p<0.001$) in differentiating the gender of male and female clavicles. 17% of right male, 7% of left male, 20% of right female and 40% of left female clavicles could be sexed correctly from mid shaft diameter. The diameter of sternal end of clavicle was also found to be statistically significant for gender determination.

The above Table 8 clearly states that, acromial breadth in this study is statistically not significant. It was seen that lengths of right clavicle and left clavicle were significantly positively correlated [$r = 0.973$, $p<0.01$]. The mid- shaft clavicular circumference of right clavicle was significantly positively correlated [$r = 0.630$, $p<0.01$] to mid-shaft clavicular circumference of left clavicle. The same stands true for the mid- shaft clavicular diameter of right and left clavicle (Table 7 and 8).

It was seen that sternal diameter of right clavicle was significantly positively correlated [$r = 0.946$, $p<0.01$] to sternal diameter of left clavicle i.e. increased the sternal diameter of right clavicle the sternal diameter of left clavicle increased (Table 9 and 10).

CONCLUSION

Determination of gender from adult human clavicle from the results of present study by morphometric parameters showed some difference with respect to the results of the same type of studies done by various workers in the past. The length, mid-shaft clavicular circumference, mid-shaft clavicular diameter and diameter of sternal end of the clavicle were found to be better parameters to differentiate gender from clavicle. In this study, majority of male and female clavicles showed overlapping in their measurable parameters between the sexes. This may be due to genetic, nutritional and socio- economic differences in the individuals or may be due to male clavicles with more amount of muscular attachment than in female. Thus, single parameter if taken alone could not differentiate sex of each clavicle properly.

REFERENCES

1. Stewart, T.D., 1948. Medico-legal aspects of the skeleton. i. age, sex, race and stature. Am. J. Phys. Anthropol., 6: 315-322
2. Kumar, K.R., S. Sonali, D.N. Mishra and C. Mohapatra, 2022. Sexual dimorphism of femur in the population of odisha: An anthropometric observational study. IJPSR., 13: 478-483.
3. Mant, A.K., 1984. Taylor's Principles and Practice of Medical Jurisprudence. Thirteenth Edn., Churchill Livingstone,, UK, ISBN-10: 0443014817, Pages: 272.
4. Krogman, W.M., 1973. The human skeleton in forensic medicine: Sexing skeletal remains. 2nd Edn., Springfield: Charles C. Thomas Publishers, Pages: 143.
5. Baker, P.T. and R.W. Newman, 1957. The use of bone weight for human identification. Am. J. Phys. Anthropol., 15: 601-618.
6. Krishan, K., 2007. Anthropometry in forensic medicine and forensic science: Forensic anthropometry. Int. J. Forensic. Sci., Vol. 1.
7. Iscan, M., 2001. Global forensic anthropology in the 21st century. J. Forensic. Sci. Int., 117: 1-6.
8. Iscan, M.Y., 2005. Forensic anthropology of sex and body size. Forensic Sci. Int., 147: 107-112.
9. Standring, S., 2009. The Anatomical Basis of Clinical Practice. 40th Edn., Elsevier Churchill Livingstone, London, Pages: 791.
10. Mitra, S., 2002. Anatomy, osteology. Academic Publishers, Kolkata, Pages: 991.
11. Hollinshead, W.H. and C. Rosse, 2006. Text Book of Anatomy: Pectoral Region, Axilla, Shoulder and Arm. 4th Edn., Philadelphia: Herper Publishers, Pages: 165.
12. Doengen, R., 1963. The shoulder girdle and humerus of the australian aborigine. Am. J. Phys. Anthropol., 21: 469-488.
13. Jit, I. and D. Sahni, 1983. Sexing the North Indian clavicles. J. Anat. Soc. India., 32: 61-72.
14. Padeyappanavar, K.V., A.M. Kazi, P.S. Bhusareddy and U.K. Kulkarni, 2009. Sexual dimorphism in adult human clavicles of North interior Karnataka. J. Karnataka. Medico. egal. Soc., 18: 3-13.
15. Terry, R., 1932. The clavicle of American Negro. Am. J. Phys. Anthropol., 16: 351-380.
16. Jit, I. and S. Singh, 1966. The sexing of the adult clavicles. Indian. J. Med. Res., 54: 551-571.
17. Singh, S. and K. Gangrade, 1968. Sexing of adult clavicles: Demarking points for varanasi zone. J. Anat. Soc. India. 17: 89-100.
18. Singh, S., 1969. Sexing of American clavicles. J. Anat. Soc. India., Vol. 18.
19. Sayee, R., S. Janakiram, R. Rajangam and I. Thomas, 1992. Clavicle: A metrical study. J. Indian. Academy. Forensic. Sci., 31: 24-29.
20. Oliver, G., 1951. Anthropologic de la clavicule III, La clavicule du Francais. Bull. Soc. Anthrop., 2: 121-157.