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ORIGINAL ARTICLE

Robustness Index of Clavicle: A Beneficial but Less Explored Parameter for Sex Determination

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ABSTRACT

CONTEXT: Determination of sex in a mutilated or fragmented body eases the dilemma of a Forensic expert to a certain extent. Apart from other long bones, clavicle is one of the bones which is less explored but has drawn considerable interest in this field, particularly in relation to sexual dimorphism.

AIM: The purpose of this research was to evaluate the sexual dimorphism of clavicle, based on Robustness Index in dry bone sample.

MATERIALS AND METHODS: The study was conducted in the mortuary of the Department of Forensic Medicine, Gandhi Medical College, on 100 cases (50 males and 50 females) in which medico-legal postmortem examination was done. Clavicle bone of the deceased in 25 to 60 year age group were collected during autopsy, dried and then examined for the study. Measured Robustness Index is the ratio of Maximum length of clavicle and Mid clavicular circumference. Prior approval of the Institutional Ethics Committee was taken.

RESULTS: Robustness Index was found to be larger in males compared to females in dry clavicle. By discriminant function analysis, sex can be estimated with an accuracy of about 81%. However, these values were found to be more accurate in males with accuracy of 82% for males and 80% for females. **CONCLUSIONS:** Determination of sex by means of Robustness Index of clavicle can be considered a reliable indicator in dried state of the bone and the accuracy rate was high for males than females.

Keywords: Identification, Sexual Dimorphism; Robustness Index; Clavicle; Mid-shaft circumference; Maximum length of clavicle.

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INTRODUCTION

The latin word clavicle means 'a small key', forming the anterior portion of the shoulder girdle placed at the upper and anterior part of the thorax, immediately above the first rib. Clavicle is the less studied element of the shoulder girdle. Of all the long bones, the clavicle is the only membranous bone placed horizontally in the body and it possesses certain gender and age specific traits.[1] Several studies have been conducted on sexual determination from skeletal elements. Robustness Index is the ratio of Mid-shaft circumference with Maximum length of clavicle which indicates the robustness of clavicle as both the parameters make clavicle a strong bone.

The present study was designed to identify these morphological features (predictors) and

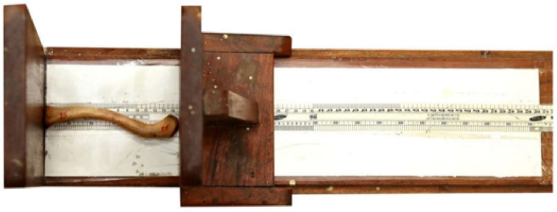
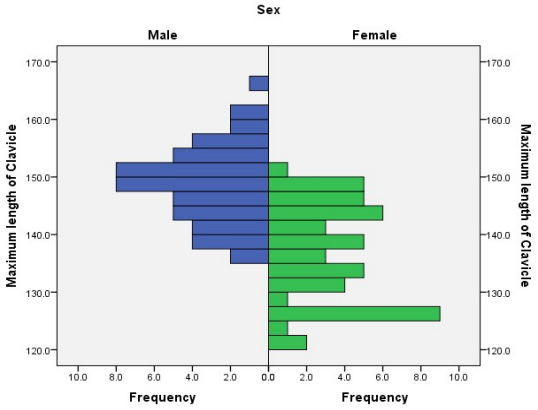
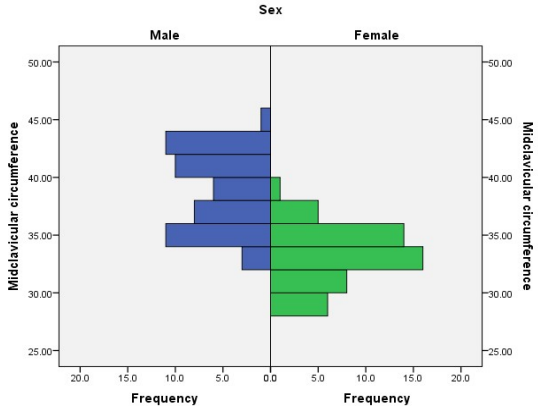


Figure 1: Measurement of Maximum length of clavicle with Osteometric board

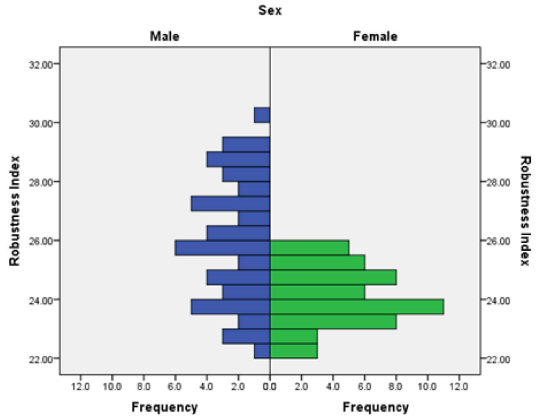
Figure 2: Measurement of midclavicular circumference with thread



Graph 1: Histogram showing frequency-distribution of Maximum length of Clavicle



Graph 2: Histogram showing frequency-distribution of Mid-clavicular circumference



Graph 3: Histogram showing frequency-distribution of Robustness Index

examine the sexual dimorphism of adult clavicle in the population of Central India (Bhopal region), applying linear discriminant function analysis. As the skeletal remains that are usually bought for anthropological examination are in the dried and fragmented state, this study was conducted on dry clavicle.

MATERIALS AND METHOD

The study was conducted on 100 clavicles (50 males, 50 females) recovered from the medicolegal autopsies conducted in the Mortuary of Department of Forensic Medicine and Toxicology, Gandhi Medical College, Bhopal. Cases with known age and sex in between the age group of 25-60 years were taken for the study. Case below 25 years and above 60 years and with any chronic illness, metabolic disorders, congenital anomalies, bony deformities, fracture of clavicle in Road Traffic Accidents or by any other reason were excluded. After obtaining written informed consent, the thorax was opened and clavicle was recovered using routine standard autopsy technique. The gap was packed with cotton and body contour was restored. The clavicle then cleaned to remove maximum soft tissues. It was then tagged with a numbered plastic disc. These bones along with their plastic discs bearing the number were buried in the ground and left over for sufficient time (about 1 month), so that the bones were completely separated

Maximum length of Clavicle (MCL) in Male & Female (in mm)							
Sex	N	Minimum	Maximum	Range	Mean	Std. Deviation	Statistical significance
Male	50	135.9	166.0	30.1	148.71	6.6522	P< 0.05
Female	50	122.2	150.2	28.0	136.88	8.5184	
Total	100	122.2	166.0	43.8	142.80	9.6520	
Midclavicular Cicumference (MCC) for Male & Female (in mm)							
Sex	N	Minimum	Maximum	Range	Mean	Std. Deviation	Statistical significance
Male	50	32.40	45.46	13.06	38.67	3.28199	P< 0.05
Female	50	28.18	38.62	10.44	33.04	2.42797	
Total	100	28.18	45.46	17.28	35.85	4.03253	
Robustness Index (RI) for Male & Female (in mm)							
Sex	N	Minimum	Maximum	Range	Mean	Std. Deviation	Statistical significance
Male	50	22.24	30.15	7.91	26.01	2.06363	P< 0.05
Female	50	22.00	25.92	3.92	24.13	1.00715	
Total	100	22.00	30.15	8.15	25.07	1.86943	

Table 1: Descriptive statistics of MCL, MCC and RI

PARAMETERS	DF SCORE	CLASSIFICATION RESULT	
Maximum clavicle length	DF = 0.131MCL – 18.685	Males- 80% Females- 70%	75% 75%
Midclavicular circumference of clavicle	DF= 0.346MCC – 12.421	Males- 72% Females- 88%	80%
Robustness Index of clavicle	DF= 0.616RI – 15.441	Males- 88% Females 84%	86%
All Three parameters together	DF= 0.245MCL- 0.555MCC + 1.208RI	Males-82% Females -80%	81%

Table 2: Discriminant function analysis of all variable

Studies by various experts	Sample size	Age Group	Year of Study	Male (mm)	Female (mm)	Region	Accuracy
Sehrawat et al[22]	263	17-94	2016	25.99 ± 2.36 6	24.20 ± 1.98	Chandigarh (India)	M-61.5 F-72.1
Akhlagi et al[14]	120	–	2012	29.9	29.4	Iran	–
Kralik et al[9]	200		2014	26.87	25.91	Greece	–
Benwoke et al[8]	40	25-70	2019	25.54	22.64	Nigeria	–
Jit and Singh et al[10]			1966	24.8	22.8	Chandigarh	–
Present study	100	25-60	2017	26.01±2.1	24.13±1.0	Bhopal (India)	M- 88% F-84%

Table 3: Studies on Robustness Index (RI) associated with Sex

from the soft tissue. It was then cleaned and dried at room temperature. Measurements were taken in the dry state.

Maximum length of clavicle (MCL):

The straight maximum distance between the sternal and acromial end measured by placing the clavicle in horizontal plane on the Osteometric board, taking precaution that sternal end and concavity of acromial half of clavicle are placed in the same line, the maximum length of clavicle is noted. Three readings were taken and the average was recorded. (Fig. 1)

Midclavicular Circumfenrence (MCC):

It is measured at Midclavicular point, determined with the help of osteometric board. The circumference was measured with the help of non-stretchable white colour twine thread. The twine thread was applied two rounds

encircling the midclavicular point taking precaution that the thread is neither stretched nor overlaps on each other. Then a straight line was drawn over all the three threads completing two circles around the midpoint. Now the thread is removed from the bone and placed as a straight line and the distance between two farthest marks was measured in mms on Osteometric board and was divided by two which gave the Midclavicular circumference. (Fig. 2)

Robustness Index:

Mean of Robustness Index is significantly higher in males as compared to females. For RI (In males, Mean = 26.01, S.D = 2.1, In females, Mean =24.13, S.D = 1.0), t (95) = 5.8, $p < 0.01$ (Table 1), shows that variable has significant mean difference. The Robustness Index of male clavicles is found between 22.24 mm to 30.15 mm. and forfemale clavicle is found between 22.00 mm to 25.92 mm. The following discriminant function is obtained from discriminant coefficient: DF= 0.616RI – 15.441. It is observed that 44 among 50 males (88%) and 42 females from 50 (84%) were correctly classified by this DF score. It implies that criteria for Robustness Index of clavicle can be used with 86% accuracy for sex discrimination.

If all the three parameters Maximum length of clavicle, Midclavicular circumference and Robustness Index taken together for sexual dimorphism, It is observed with the help of Discriminant function, DF= 0.245MCL- 0.555MCC + 1.208RI – 45.387, 41among 50 males (82%) and 40 females from 50 (80%) were correctly classified. It implies that all three parameters if combined together can be used with 86% accuracy for sex discrimination. (Table no. 3)

DISCUSSION

Based on the observations and results of the clavicle measurements, it can be concluded that Robustness Index of clavicle is higher among males as compared to the females in Bhopal. Also, male clavicle can be sexed with a higher accuracy rate; when only clavicle is received for examination. DF score was calculated as DF= 0.245MCL- 0.555MCC + 1.208RI – 45.387 where by merely placing the values of MCL, MCC, and Robustness index measurements in the discriminant function analysis equation helps us to determine sex with an accuracy of 81% in Bhopal (Central region). Robustness Index can be a reliable indicator for sex determination in dried state of the bone.

The overall observation suggests that even in a single country, variations are seen with regard to estimation of sex with the help of Clavicle. The causes for this can be Environmental, socioeconomic, geographical, heredity and growth patterns. The worldwide variation also comes in both extremes. As India is heterogeneous population, studies in different region should be conducted for correlation and comparison. IJFMP

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Conflict of Interest:

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