Determination of Sex From Adult Clavicle – An Autopsy based Regional Study

Levis Vaseem Moorkhan[1], Prajith Thekke Madathil[2]

[1]Assistant Professor, Department of Forensic Medicine, Govt.Medical college Manjeri, Malappuram, Kerala,
[2]Assistant Professor, Department of Forensic Medicine, Govt. Medical college Kozhikode, Kozhikode, Kerala

Abstract

Background: Studies on "identification of the sex from clavicle bone alone" are carried out by various workers all over the world.But, it is well known fact that the racial and geographical differences exist in the metrical measurement of all the bones including clavicles, as the determination of sex is a population specific phenomenon. **Matrials and Methode** : This study was conducted on100 male clavicles and 100 female clavicles collected from identified corpses brought for medicolegal autopsy at Department of Forensic Medicine Govt. Medical College Calicut. Measured the various parameters and compared with previous studies. RESULTS :In the present study, the length , midclavicular circumference and weight of male clavicles weres more than female clavicles. The female clavicle has its length around 86% of male clavicle and mean MCC around 83% of the male clavicles.. Robustness index also calculated, mean robustness index was 23.11, and could identify only 76 % males and 64% females by this. CONCLUSION:In order to establish the anthropometric standards, and for the evaluation of the same from time to time, the continuance of such studies in defined geographical areas over a particular period of time is needed.

Key Words :*clavicle, sex determination, midclavicular circumference, Robustness index and autopsy.*

Background

Identification of an individual is based on various physical features and biological parameters, which are unique to an individual. Question of identification arises in everyday medico legal practice in both civil and criminal cases. The features such as birthmarks, scars, tattoo marks, malformations, assessment of age and sex determination, race, stature, anthropometric measurements, fingerprints etc. are usually taken for the same.

Since bone resist putrefaction and destruction by animals, they contribute to the determination of age, sex, race and stature of an individual. Sex being one of the cardinal features of establishing the identity, its estimation is of greater importance and requires special attention in cases, where bodies are found decomposed, mutilated or only fragmentary remains are discovered.

Determination of sex from the skeletal remains of an individual by the examination of a single bone (except hipbone) is considered to be almost an impossible task. Even in cases where entire human bony pelvis and skull are available, more than 95% of accuracy cannot be achieved (Krogman, 1962)[1].

On the whole, the bones of male skeleton are heavier, larger and markings of muscular attachments are more pronounced than females. Human clavicle is a long bone (Troter&Peterson 1953); it extends horizontally with a double curve across the root of the neck, laterally towards the point of shoulder.

Studies on "identification of the sex from clavicle bone alone" are carried out by various workers all over the world. These studies include that of Peterson in England (1916), Terry in USA(1932) and in India study has been conducted by Jit I &Singh in Amritsar zone(1966),Singh and Gangrade in Varanasi zone(1968), Jit I &SahniD in

Corresponding author :
Prajith Thekke Madathil
Assistant Professor, Dept.of Forensic Medicine
Govt. Medical college Kozhikode. Mob.9895345296
Email. drprajithtm@gmail.com

Chandigarh zone(1983). However major pioneer studies about the subject has been lacking from south Indian zone.

But, it is well known fact that the racial and geographical differences exist in the metrical measurement of all the bones including clavicles, as the determination of sex is a population specific phenomenon.

Objectives

This study attempts to identify the sex of an individual from measurable characteristics of clavicle.

1. To assess the difference in measurements of various parameters and indices such as length, mid clavicular circumference , and Robustness index in male and female clavicles.

2. To compare the results with previous studies.

3. To establish standardised formula for determination of sex from clavicle.

Materials and Method

This is a descriptive study based on 100 clavicles from males and 100 clavicles from females collected from cadavers of Calicut Medical College mortuary, selected from cases in which the consent has been obtained.

Selection Criteria:

1. Left clavicle (for uniformity) of adult humans of known age (>25years) and sex.

Exclusion Criteria:

1. Unidentified bodies, or wherever the exact age and sex could not be determined.

2. Cases showing any deformed, diseased or fractured (including old healed fracture) clavicles, and that showing any pathologic lesion, which may hamper the study

Measurements:

1. Maximum length in millimetres; measured from the sternal end to the acromial end with the help of a Verniercaliper, ignoring the curves of the bone.

2. Circumference of the clavicle at the middle of the bone in millimetres; The middle point of the length of the clavicle is marked and taken as the point where the mid-shaft circumference was measured with the help of a measuring tape and recorded in millimetres.

After the measurements were taken, they were subjected to statistical analysis usingSPSS software for windows .On applying ROC curve, decided the cut off values for each parameters.

Observations

The present study includes a total of 100 adult clavicles from males and 100 clavicles from females of known age and sex.

Length

Table – 1 shows that, the length of male clavicles ranges from 130 to 167.80mm, with a mean of 147.97 and standard deviation 11.61, and the length of female clavicles ranges from 116.22 to 143.20mm, with a mean of 127.4 and standard deviation 6.9.

Table 1: Statistical analysis of the male and female clavicles of both sexes in relation to length

Sex	Range(mm)	Mean(mm)	SD
Male	130-167.80	147.97	11.61
Female	116.22-143.20	127.4	6.9

Table 2: Probable Sex determination using cut off values for clavicular length

Sex	> Cut off	<Cut off
Male	88%	12%
Female	16%	84%

Table - 2 shows that, for the male clavicles, the length > 88 % of them lies above the cut-off, that is 132mm(on applying ROC curve), and only 12 % of the length of male clavicles, falls below the cut-off.In the

case of length of female clavicles, only 16 % of them falls above the cut-off and > 84% of the length of female clavicles falls below the cut-off point 132mm.

Midclavicularcircumference

Table 3: Statistical analysis of the male and female clavicles of both sexes in relation to MCC

Sex	Range(mm)	Mean(mm)	SD
Male	30.8-45.8	36.37	4.3
Female	24.8-33.8	29.23	2.39

Table – 3 shows that, the MCC of male clavicles ranges from 30.8 to 45.8mm, with a mean of 36.37mm and standard deviation 4.13, and the MCC of female clavicles ranges from 24.8 to 33.8mm, with a mean of 29.23mm and standard deviation 2.39.

Table 4: Probable Sex determination using cut off values for the clavicles with MCC

sex	>Cut off	<Cut off
male	84%	16%
female	8%	92%

Table – 4 shows that, for the male clavicles, the MCC > 84 % of them lies above the cut-off value(on applying ROC curve), that is 32, and only 16 % of the male clavicular MCC falls below the cut-off. In the case of female clavicular MCC, only 8 % of them falls above the cut-off and > 92% of the female clavicular MCC falls below the cut-off point.

Table 5: Probable Sex determination using cut off values for the clavicles with Robustness index

sex	>Cut off	<Cut off
male	76%	24%
female	36%	64%

Robustness Index

Robustness (Circumference: Length) index of clavicle is calculated as

RI = X 100

Table – 5 shows that cut off value of robustness index for sex determination of clavicles as 23.11 (on applying ROC curve). Thus table – 11, shows that for the male clavicles, the robustness index > 76 % of them lies above the cut-off, that is 23.11, and only 24 % of the male clavicular index falls below the cut-off. In the case of female clavicular index, only 36 % of them falls above the cut-off and > 64% falls below the cut-off point 23.11mm.

Discussion

In the present study, the clavicle has been compared in relation to its morphometric parameters with the studies in the past.

1. LENGTH OF CLAVICLE

In the present study, mean length of male clavicle is significantly higher than that of female clavicle. It is clear from table that, present study similar to studies of Padeyappanavar et al[2] (2009), and Jit I and Sahni D[3];thus the present study observed statistically significant difference between length of male and female clavicles ($p<0.001$). In the present study, mean length of male clavicle (147.97mm)is comparable with the studies of Jit I & Singh S[4] (157.59), Singh and Gangrade[5](144.18mm) and Padeyappanavar KV et al[2] (143.5mm),and Jit I &Sahni D[3]. But it is lower than the studies of Terry RJ6 for USA white (154.10mm) and Negroes(155.86mm) and Singh S7 for USA white (153.7mm) and Negroes (157.32mm).

The mean length of female clavicle in present study (127.4mm) is comparablewith most of the studies except Jit I and Sahni D[3] (134mm), Terry RJ[6] for USA Negroes(141.8mm) and Singh S[7] for USA Negroes (140.80mm) which are higher than the meanvalue of present study.

The fact that American Negroes and Whites and North Indians are taller and well-built than South Indian population, this difference in length is appreciated.

Sexual difference: According to Olivier (1951)[8], the length of the female clavicle is 89.7% of that in a male clavicle, and other authors give the proportion varying from 88.2% to 93%. In the present study, the average North Malabar female clavicle is 86% of male clavicle. This is similar to the study results of Arvinder PalSingh Batra, Anupama Mahajan, Seema12 (2010), and Jit I and Singh S (1966)[4]. As there is overlap between the length measurements of male and female clavicles, the sex of the clavicle could not be determined in every case, 88% of male and 84% of female clavicle could only be sexed correctly. This result is also similarto the results of study done by Frutos and Rios L[9] (2002), Kaur K, Sindhu SS, KaushalS, Kaur B[10] (1997). The prediction of correct sex can still be increased by including length in multivariate analysis along with mid shaft circumference, weight and volume of the clavicle.

2. Mid-Shaft Circumference:

The mid-shaft circumference of the clavicle had been calculated in several races by different workers and this is the most popular clavicular parameter used for sex

identification. Oliver G[8] has provided a table giving finding of various workers in this regard.

Mid-shaft circumference in the present study is statistically highly significant ($p<0.001$) in differentiating the sex of male and female clavicles, which is similar to the studies of Padeyappanavaret al[2], Jit I and Sahni D[3].

Mean mid-shaft circumference in male (36.37mm) and in female (29.23mm) ofpresent study is comparable with all the studies except with Terry RJ[6], Singh S[7].

Sexual difference: It is agreed by most of the previous workers that femaleclavicle has a smaller circumference than male and this difference is statistically highlysignificant and varies from 3.7 to 7.8mm.Shamer Singh &InderJit[11] found difference to be 8mm for males and 6mm for females. In the study by Terry RJ[6] (1932), the circumference of Negro female bone was about 5mm shorter than that of Negro male.

Oliver G[8] (1951) found the difference to be 6.8mm in French bones. Jit and Singh S[4] (1966) found the difference to be 6mm - 7mm. In the present study, the difference is about 6.42–7.14mm. This shows that, mid-shaft circumference is an extremely useful data by which a fairly large number of clavicles can be sexed without any difficulty. The probable prediction of sex by mid-shaft circumference alone is 84% in male and 92% in female clavicles. These results are similar to results of Jit and Singh S (1966)4 and Padeyappanavar KV et.al[2] (2009).

3. ROBUSTNESS INDEX:

In the present study, mean robustness index of male clavicle is more than that of female clavicle. This is in accordance with all other workers who agree that the robustness index is greater in males than in females. But their reliance to be put on this index as a parameter useful to identify the sex of clavicle has not been worked out. The figures in this study prove that this index is significantly greater in male compared to female and this difference is statistically greater in male compared to female and this difference is statistically significant ($p<0.001$). This is similar to the studies of Jit I and Singh S(1966)[4] who also found that RI values are statistically significant for sex differentiation.

In the present study, mean RI of male clavicle(24.65mm) is comparable with the results of Terry RJ[6], Oliver G[8], Jit and Singh S[4] and mean RI of female clavicle (23.03mm) is also comparable with other studies.

Sexual difference: Robustness index of male and female clavicles as given by other authors vary from 0.4 to 2.8mm, but in the present study, it is 1.62mm . As the values of robustness index of clavicle in both sexes show significant overlapping, the robustness index of clavicle alone is not sufficient to sex each clavicle. Thus, the prediction of sex of clavicles by robustness index alone is 76% male and 64% female , which is having much less prediction of sex as compared to taking individual characteristics like length, weight or mid-shaft circumference for sex estimation.

Conclusion

Present study on determination of sex of adult human clavicle by metric parameters showed some difference with respect to the same results of the studies done by various workers in the past.

In the present study, the length of male clavicles was more than female clavicles. The female clavicle has its

length around 86% of male clavicle. On applying ROC curve, in case of length, the clavicle could be sexed, with some probable predictions. For males could be sexed in 88% of the cases and females in 84 %, also the same prediction is applied with some overlapping.

The mean mid-shaft circumference of male clavicles was more than that in females, and the female clavicle has its mean MCC around 83% of the male clavicles. The probability of prediction of sex of clavicles by mid-shaft circumference alone was 84% for males and 92% for females, with some overlapping.

Robustness index also calculated, mean robustness index was 23.11, and could identify only 76 % males and 64% females by this.There was considerable overlap between male and female clavicular measurements and their indices. This overlap may be due to genetic, nutritional and socio economic difference in the individual or may be due to hypo-muscularity in the male clavicles and hyper- muscularity in the female clavicles. Hence it is not possible to determine the sex of each and every clavicle by any of the parameter alone.

The present study helps to know the changing trends in the metric measurements if any. In order to establish the anthropometric standards, and for the evaluation of the same from time to time, the continuance of such studies in defined geographical areas over a particular period of time is needed.

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References

1. 1..Krogman WM. The human skeleton in forensic medicine: Sexing skeletal remains. 2ndedition. Charles C Thomas publishers, Springfield, 1973: pp143-151.
2. Padeyappanavar KV, Kazi AM, Bhusareddy PS, Kulkarni UK. Sexual dimorphism in adult human clavicles of North interior Karnataka. J Karnataka Medico-legal Soc, 2009 June;18(1):3-13.
3. Jit I, Sahni D. Sexing the North Indian clavicles. J AnatSoc India, 1983;32(2):61-72.
4. Jit I, Singh S. The sexing of the adult clavicles. Indian J Med Research, 1966 June;54(6):551-571.
5. 5 Singh S, Gangrade KC. Sexing of adult clavicles-demarking points for Varanasi zone.JAnatSoc India, 1968 (b);17:89-100.
6. Terry RJ. The clavicle of American Negro. Am J Phys Anthropology, 1932;16:351-380
7. Singh S. Sexing of American clavicles. Proceedings of the Anatomical Society of India,1969;18:25.
8. Oliver G. Anthropologic de la clavicule 111, La Clavicule du Francais. Bull SocAnthrop, 1951;2:121-157.
9. Frutos, Rios L. Determination of sex from the clavicle and scapula in a Guatemalan contemporary Rural Indegenous population. American J Forensic Med Pathol, 2002 Sept ; 23 (3) :284-288.
10. Kaur K, Sindhu SS, Kaushal S, Kaur B. Sexing Northwest Indian adult clavicles of Patiala zone. J Anat Society of India, 1997; 46(2): 121-130.
11. IndarJit, Shamer Singh. The sexing of the adult clavicles. Ind. Jour. Med. Res, 1966june; 54(6): 551-571.