Research Article

Morphological and morphometrical analysis of variations of the first rib with reference to its angle of curvature and its clinical implications

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ABSTRACT

Introduction: Although many bones of the human skeleton show the sex-, age-, and race-related differences, the distinctive morphology of the human rib bone makes it of utmost interest from anatomical, anthropological, and forensic point of view. The human first rib bone is one of the most informative bones in the human body. Morphometry of the rib bone is important for the anatomist as well as for the anthropologist for population studies. Moreover, specimen identification and sex determination from skeletal remains have great importance in many forensic medicine and related investigations. **Materials and Methods:** In the present study, a total of 20 dry rib bones of unknown sex and without any gross abnormality were collected from the Department of Anatomy, Saveetha Dental College, Chennai, for evaluation. With the help of Vernier caliper, the measurements such as the length, breadth, and diameter of rib bone were measured. The results obtained were analyzed, tabulated, and represented graphically. **Results:** In male, the average total length of the first rib on the right side was found to be 67.28 ± 2.34 and on the left side, it was 66.43 ± 3.42. In female, on the right side, it was 61.32 ± 1.6 and on the left side, it was 63.85 ± 1.56. In male, the average of ventrodorsal breadth of the first rib on the right side was found to be 21.57 ± 2.93 and on the left side, it was 20.4 ± 1.62. In female, on the right side, it was 18.5 ± 2.84 and on the left side, it was 17.43 ± 1.79. The mean angle of curvature of the right and left rib in male was 45.5° and 46.2°. In female, it was 41.5° and 42.8° on the right and left side. **Conclusion:** There are no much studies in literature for comparing the angle of the first rib between the right and left sides for Indian population. The present study was an initial step in estimation of the angle which can be used for estimating sexual dimorphism. Further researches on the first rib can add to the information and help the forensic anthropologists to identify the sex of an individual.

KEY WORDS: Anthropology, Forensic investigation, Morphometry, Rib bone, Sexual differences

INTRODUCTION

Evaluating the sex of a grown-up human skeleton is principal in shaping the natural profile utilized in criminological sciences.[1] The recognition of skeletal remnants, defectively decaying or any unknown human remains is vital for legal reasons.[2] Anthropologists apply standard logical strategies created in physical anthropology in distinguishing human remains and in medicolegal procedures.[3] Such anthropologists make a natural profile, comprising sex, age, heritage, stature, and special highlights, for example, any antemortem pathology or after death injury of decedent from the skeleton.[4]

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Website: jprsolutions.info	ISSN: 0975-7619

The first rib is most intensely bended and typically briefest, with inside and outside fringes. The first rib is most acutely curved and usually shortest, with internal and external borders. It slopes obliquely down and forward to its sternal end.[5] The vertebral end or the head of the first rib is diminutive and spherical. It bears an almost circular facet and articulates with the body of the first thoracic vertebra.[6] The neck is rounded and ascends posterolaterally. The tubercle is directed up and backward, articulates with the transverse process of the first thoracic vertebra.[7] The external border is convex, thick posteriorly, and thin anteriorly.[8] The inner border is thin and curved inward and at the midpoint of two ends of the first rib is the situation of scalene tubercle. The inferior surface is smooth. The anterior end is larger than in any other rib.[9] Five distinct landmarks are formed on

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Received on: 23-04-2019; Revised on: 26-06-2019; Accepted on: 28-07-2019

the first rib such as the head, tubercle, sternal end, and groove for subclavian vein and artery.[10]

In exact anatomical position, the head of the first rib usually directs inferiorly and the upper surface of the rib contains a small faint groove formed by the overlying subclavian artery. In non-anatomical position, an angle is visible between the head and the tubercle at the inferior portion of the neck.[11] Estimation of sex through examination of sexually dimorphic features as focused primarily on pelvic girdle, long bones, and skull.[12] Numerous areas of skull and pelvis are used in determining the sex. However, in cases where the pelvis and skull are not available for study or too damaged for examination, the ribs may provide an alternative method for estimating an individual sex.[13]

MATERIALS AND METHODS

In the present study, a total of 20 dry rib bones of unknown sex and without any gross abnormality were collected from the Department of Anatomy, Saveetha Dental College, Chennai, for evaluation. Rib bones containing cartilaginous ossification in its chondral part are excluded from selection. With the help of Vernier caliper, the measurements such as the length, breadth, and diameter of rib bone were measured. Three important bony measurements were taken [Figure 1]. They are as follows:

- Total length (TL) of the rib was measured from anterior sternal end to the lateral portion to the vertebral end of the head
- Ventrodorsal breadth (VB) taken at the scalene tubercle
- The dorsal curvature or angle of curvature (AC) taken from sternal end to the start of the rib head. A flexible measuring tape was used by warping the tape to the contour of curvature of the rib.

An overall mean for the measured three parameters was calculated using the data obtained. The raw data obtained were analyzed for its mean and standard deviation for each parameter. The results obtained were analyzed, tabulated, and represented graphically. All the values are represented as mean ± SD.

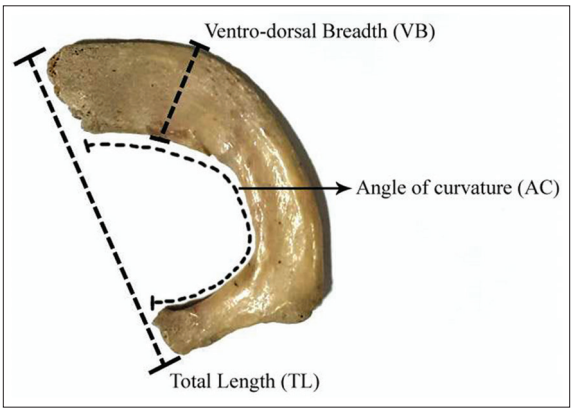

Figure 1: First rib depicting measurements of total length and ventrodorsal breadth and the angle of curvature

RESULTS

The first rib depicting measurements of TL and VB and the AC are shown in Figure 1. In male, the average TL of the first rib on the right side was found to be 67.28 ± 2.34 and on the left side, it was 66.43 ± 3.42. In female, the average TL of the first rib on the right side was 61.32 ± 1.6 and on the left side, it was 63.85 ± 1.56. In male, the average of VB of the first rib on the right side was found to be 21.57 ± 2.93 and on the left side, it was 20.4 ± 1.62. In female, the average VB of the first rib on the right side was 18.5 ± 2.84 and on the left side, it was 17.43 ± 1.79. Measurement of various parameters of the first rib in male and female is depicted in Figure 2. The mean AC of the right and left rib in male was 45.5° and 46.2°. The mean AC of the right and left rib in female was 41.5° and 42.8°. The mean AC of the right and left rib in male and female is shown in Figure 3.

DISCUSSION

Remarkable differences were found between male and female rib bone morphology and morphometry. The overall goal of this study was to generate data that would be useful to the orthopedicians for geometric modeling. The study would also help the forensic experts in specimen identification and sex determination from skeleton remains. It would also be valuable for the anthropologists in their racial and population studies.[14]

Few studies have been conducted on the ribs, and none has focused on using the angle formed by the head and tubercles at the points where the rib attaches to the first thoracic vertebra.[15] Many other skeletal elements have proven valuable in sexing individuals; yet, little focus has been placed on the ribs. The fourth rib is generally analyzed for age determination, but this rib can be easily baffled with the nearby ribs if not all the ribs are obtained.[16] For this reason, the first rib has the potential to be valuable as both an aging and sexing method.

In this study, we can see that the AC in male is greater than the AC in female. The left first rib bone of the male is more in length when compared to the right first rib bone of the male. In female, the left first rib bone is more in length than the right first rib bone.[17]

It is found that males as a whole are larger in several chest dimensions than females. Research could also be done to determine whether the same angle, formed in the articulation points of the vertebrae, produces similar results.

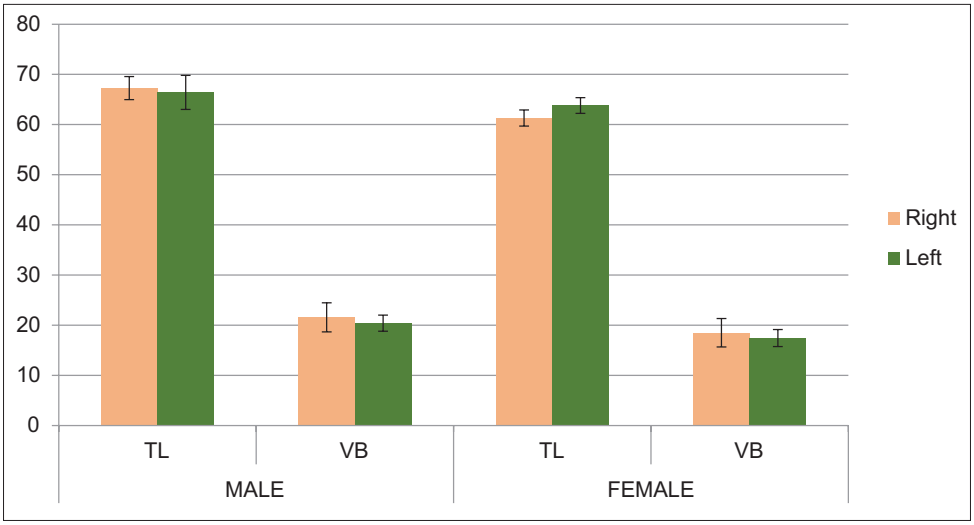

Figure 2: Measurement of various parameters of the first rib showing total length and ventrodorsal breadth in male and female rib bones

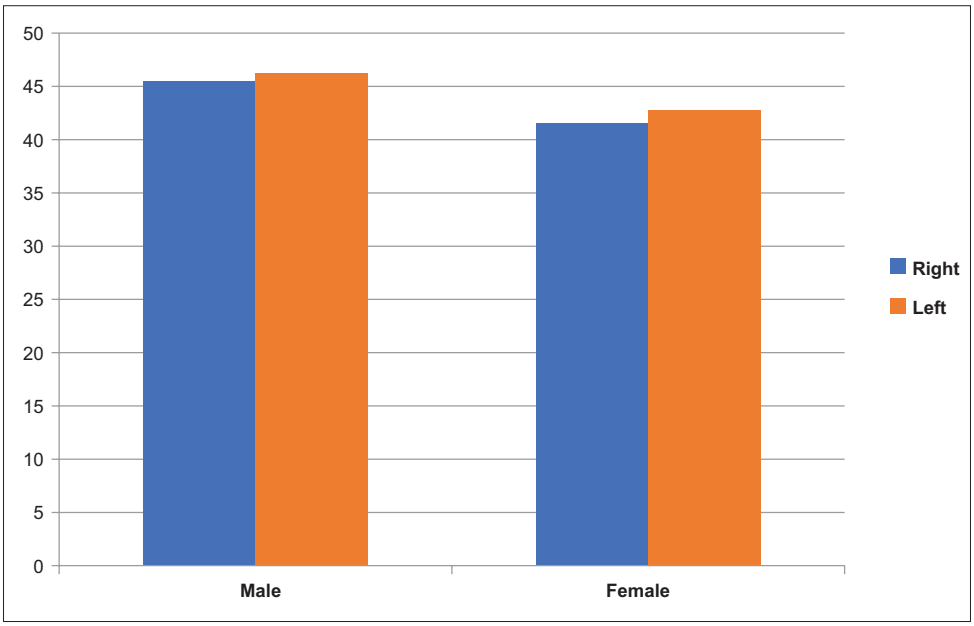

Figure 3: Mean angle of curvature of the right and left rib in male and female

CONCLUSION

There are no different examinations in the writing for looking at the point of the main rib between the right and left sides for Indian population. The present examination was a primary preliminary study in the estimation of the point which can be utilized for assessing sexual dimorphism using ribs, especially the first rib. Further studies on the first rib can add to the available data and help the forensic anthropologists to recognize the sex of a person.

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Source of support: Nil; Conflict of interest: None Declared