e-ISSN: 2319-9865
p-ISSN: 2322-0104
Research and Reviews: Journal of Medical and Health Sciences

The Angle of the First Rib and Its Implication in Forensic Anthropology: A Morphometric Study.

Anne D Souza, Mamatha Hosapatna, Vrinda Hari Ankolekar*, and Antony Sylvan D Souza.

Department of Anatomy, Kasturba Medical College, Manipal University, Manipal- 576104, Karnataka, India.

Research Article

Received: 28/09/2013
Revised: 14/10/2013
Accepted: 22/09/2013

***For Correspondence**

Department of Anatomy,
Kasturba Medical College,
Manipal University, Manipal-
576104, Karnataka, India.
Phone- +91 8762938099
Fax- +91-820-2570061

Keywords: first rib, tubercle, angle, external length, internal length

ABSTRACT

Assessing the sex of an adult human skeleton is fundamental in forensic anthropology. The identification of skeletal remains is important for both legal and humanitarian reasons. Five distinct landmarks are formed on the first rib, head, tubercle, sternal end and groove for subclavian vein and artery. In non-anatomical position, an angle is visible between the head and the tubercle at the inferior portion of the neck. In cases where the pelvis and skull are not available or too damaged for examination, the ribs may provide an alternative method for estimating sex of an individual. The present study included 35 right and 35 left first ribs. The following measurements were taken in non-anatomical position like length from head to tubercle, height from head to surface, external length and internal length. Angle of the rib was determined using an inverse sine function, with measured height over the length. The mean and standard deviation of height and length of right side were 5.51± 3.65mm and 25.20± 4.52mm respectively and on left side 6.28± 2.81mm and 23.70± 3.39mm respectively. Unpaired t-test was used to determine the significance of means between angles of right and left side which was not statistically significant (p=0.17). On right side Pearson's correlation test showed a positive correlation between the angle and the external length and also for the internal length (r=0.8, 0.7). On left side Pearson's correlation test did not show any significant positive correlation between them (r=0.3, 0.2).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.

INTRODUCTION

Assessing the sex of an adult human skeleton is fundamental in forming the biological profile used in forensic anthropology [1]. The identification of skeletal remains, badly decomposed, or otherwise unidentified human remains is important for both legal and humanitarian reasons. Forensic anthropologists apply standard scientific techniques developed in physical anthropology in identifying human remains and assist in medico-legal process. Forensic anthropologists create a biological profile, consisting of sex, age, ancestry, stature and unique features, such as any antemortem pathology or postmortem trauma of decedent from the skeleton [2].

First rib is most acutely curved and usually shortest, with internal and external borders. It slopes obliquely down and forwards to its sternal end. The head of the first rib is small and round. It bears an almost circular facet, and articulates with the body of the first thoracic vertebra. The neck is rounded and ascends posterolaterally. The tubercle is directed up and backwards; articulates with the transverse process of the first thoracic vertebra. The external border is convex, thick posteriorly and thin anteriorly. The internal border is concave and thin, and the scalene tubercle is near its midpoint. The inferior surface is smooth. The anterior end is larger than in any other rib [3]. Five distinct landmarks are formed on the first rib, head, tubercle, sternal end and groove for subclavian vein and artery. In proper anatomical position the head of first rib points downwards and superior surface presents a subclavian groove. In non-anatomical position, an angle is visible between the head and the tubercle at the inferior

e-ISSN: 2319-9865
p-ISSN: 2322-0104

portion of the neck [4]. Estimation of sex via examination of sexually dimorphic features as focused primarily on pelvic girdle, long bones and skull. 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 [5,6].

The aims of the present study were

- To calculate the angle of first rib and to determine the difference in means between right and left sides.
- To correlate the angles on right and left side with the internal and external diameter of the first rib.

MATERIALS AND METHODS

The present analytical study included 35 right and 35 left first ribs of unknown age and sex. The ribs were collected from the department of Anatomy and museum, Kasturba Medical College, Manipal. The measurements were taken using a vernier caliper.

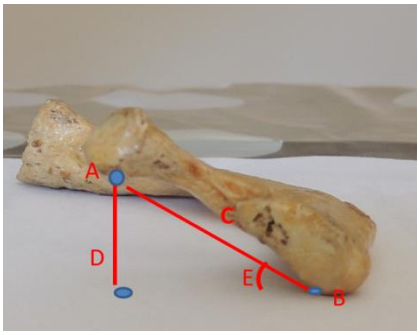
The following points were marked on the rib as shown in figure 1.

1. Lowest point on the head.
2. Tubercle where it touches the surface.

The following measurements were taken in non-anatomical position as shown in figure 1 and 2.

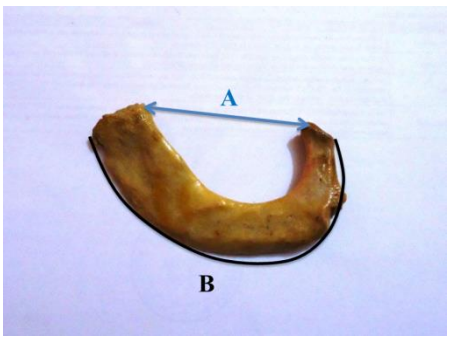
1. Length from head to tubercle.
2. Height from head to surface.
3. Total external length of the rib measured from anterior sternal end to the lateral portion of the head.
4. Inner length from posterior portion of sternal end to the medial portion of the head.

Figure 1: Determination of angle (left rib)



A- Lowest point on the head
B- Tubercle where it touches the surface
C- Length between head and tubercle
D- Height from head to surface
E- Angle of head relative to tubercle

Figure 2: Estimation of external and internal length (left rib)



A- Internal length from posterior sternal end to medial portion of head
B- External length from anterior sternal end to lateral portion of head

e-ISSN: 2319-9865
p-ISSN: 2322-0104

Angle of the rib was determined using an inverse sine function. This sine function was calculated in Microsoft excel, Asin = Height /Length. This was converted into degrees using the same excel function. The ribs with any external damage and ossified costal cartilage were excluded from the study. SPSS version 16 was used for statistical analysis. Means and standard deviation for right and left side were calculated and compared using unpaired t-test. Pearson's correlation test was used to determine the correlation between the angle and internal and external lengths.

RESULTS

In the present study 70 first ribs (35 right side, 35 left side) were taken. The heights, length, internal and external lengths of each were measured. Mean and standard deviation (SD) of height and length were done and are shown in table 1. The mean and SD of height and length of left were higher than that of right but not statistically significant.

Table 1: Mean and standard deviation of height and length in mm.

Descriptive statistics for height and length of first rib.

	HEIGHT (mm)			LENGTH (mm)	
Side	Mean and SD	95% confidence interval	Side	Mean and SD	95% confidence interval
Right N=35	5.51± 3.65	4.25- 6.76	Right N=35	25.20± 4.52	23.64- 26.75
Left N=35	6.28± 2.81	5.23-7.33	Left N=35	23.70± 3.39	22.43- 24.96

Mean and standard deviations of external and internal length of first ribs were done and are shown in table 2.

The mean and SD of angle of first rib on right side was 12.18 ± 7.84. Maximum being 14.87 and minimum was 9.48. On left side it was 15.17 ± 6.38. Maximum being 17.55 and minimum was 12.78. Graph 1 shows the frequency distribution of the angle on right and left sides.

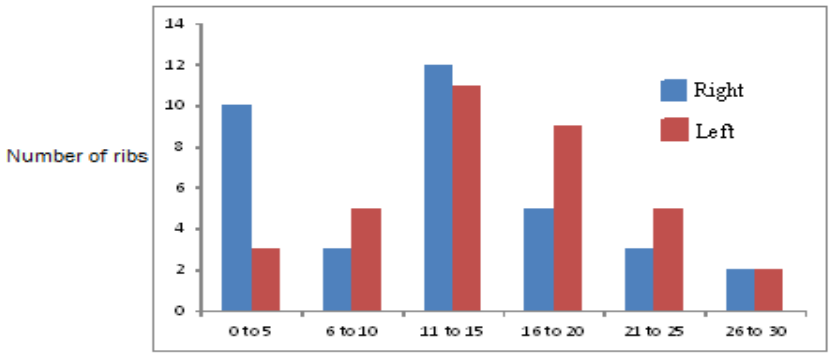
Table 2: Mean and standard deviation of external and internal length in cm.

Descriptive statistics for external and internal length of first rib.

	External length (cm)			Internal length (cm)	
Side	Mean and SD	95% confidence interval	Side	Mean and SD	95% confidence interval
Right N=35	12.13± 1.45	11.63- 12.63	Right N=35	4.98± 0.70	4.74- 5.22
Left N=35	12.19± 1.20	11.73- 12.64	Left N=35	5.27± 0.65	5.02- 5.51

Graph 1: The frequency distribution of angle of first rib shows maximum number of ribs on both right and left side have angle of 11- 15° and minimum number of ribs have angle of 26-30 °

Frequency distribution of angle of first rib



Unpaired t-test was used to determine the significance of means between angles of first rib of right and left side which was not statistically significant (p=0.17). On right side Pearson's correlation test showed a positive correlation between the angle and the external length (r=0.8) and also for the internal length (0.7). On left side

Pearson's correlation test did not show any significant positive correlation between the angle and the external length (r=0.3) and also for the internal length (0.2).

DISCUSSION

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. Many other skeletal elements have proven valuable in sexing individuals; yet, little focus has been placed on the ribs. The fourth rib is commonly used as an example of age determination, but the fourth rib easily can be confused with the surrounding ribs if not all ribs are present. For this reason, the first rib has the potential to be valuable as both an aging and sexing method [7]. A study was done to estimate sexual dimorphism using first rib by Elrod P showed a mean height of 8.8 mm, length 23.3 mm and angle 22.5^0 for females. In males mean height were 11.2 mm, length 25.4 mm and angle 26.4^0. The data support that the angle of the first rib, head to tubercle, is indicative of sex of the individual. This study has shown with 60% probability that we can determine the sex of an individual using the angle of the first rib, head to tubercle. This 60% probability determination lies below 22.02^0 for females and above 31.44^0 for males. Adding the total length and exterior length, to the process of determining sex can increase the probability of correctly sexing individual unknown ribs to at least 70%. Using the data obtained from the logistic regression, several calculations for determination of sex were derived and can be used to identify the probability of an angle being male. If the entire rib is present, a greater accuracy can be obtained using the combined angle and total length of the first rib, a more statistically significant prediction of sex than angle alone. If the sternal end is damaged, then the calculation for angle alone can be used to predict the sex of the individual [8]. The present study was done to estimate the angle of first rib and to compare between right and left sides. On the right side mean height were 5.51 mm, mean length was 25.2 mm and angle was 13.5^0. On the left side mean height were 6.28 mm, mean length was 23.7 mm and angle was 15.1^0. Compared to the study done by Elrod, the values were less and this could be attributed to racial difference. Wiredu et al. compared the means of various rib measurements in their study with mean measurements in Iscan's study and found that rib sizes were much larger for both sexes in Iscan's study population. This is an area for future research, taking into consideration such elements as ancestry, environment, nutrition, and the generation of the population being used [9,10]. It is found that males as a whole are larger in several chest dimensions than females [11,12]. Research could also be done to determine whether the same angle, formed in the articulation points of the vertebrae, produces similar results. The ability to use the vertebral articulation points to identify sex would be useful [8].

CONCLUSION

There are no other studies in the literature for comparing the angle of the first rib between the right and left side 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.

REFERENCES

1. Patil KR, RN Mody. Determination of Sex by Discriminant Function Analysis and Stature Regression Analysis: a Lateral Cephalometric Study. Forensic Sci Int 2005;147:175-180.
2. ABFA. 1996. ABFA Home Page. In: Murad TA, editor.
3. S Standring, Ed., Gray's Anatomy: The Anatomical Basis of Clinical Practice, Churchill Livingstone-Elsevier, Philadelphia, Pa, USA, 40th edition, 2008. pg. 920-921
4. Bass WM. Human Osteology: A Laboratory and Field Manual 4th Edition. Columbia, Mo: Missouri Archaeological Society. 1995.
5. Krogman W. 1962. The Human Skeleton in Forensic Medicine. Springfield: Charles C. Thomas.
6. Giles E, Elliot O. Sex Determination by Discriminant Function Analysis of Crania. Am J Phys Anthropol. 1963;21(1):53-68.
7. İşcan MY. The Aging Process in the Rib: An Analysis of Sex and Race Related Morphological Variation. American J Human Biol. 1991;3:617-623.
8. http://etd.lsu.edu/docs/available/etd-04112012-121135/unrestricted/PaigeElrod_thesis.pdf
9. Wiredu EK, Kumoji R, Seshadri R, and Biritwum RB. Osteometric analysis of sexual dimorphism in the sternal end of the rib in a west African population. J Forensic Sci. 1999;44(5):921-925.
10. İşcan MY. Osteometric Analysis of Sexual Dimorphism in the Sternal End of the Rib. J Forensic Sci. 1985;30(4): 1090-9
11. Semine AA, Damon A. Costochondral ossification and aging in five populations. Hum Biol. 1975;47(1):101-116.
12. Di Gangi EA, JD Bethard, EH Kimmerle, LW Konigsberg. A New Method for Estimating Age-At-Death from the First Rib. American J Phy Anthropol. 2009;138:164-176.