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Research Article

An Approach to Thorax Morphometry with New Reference Values: A Morphological Study

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Abstract

Aim: Radiological evaluation is frequently used in the evaluation of healthy individuals or patients. When performing radiological evaluations, certain anatomical reference regions and values must be known in order to discover anomalies or variations. In this study, it was aimed to bring new anatomical reference values, which have not been studied before, to the literature and clinical evaluation.
Material and Method: This is a retrospective study that examines the patient archives in the Department of Radiology of Adıyaman University Training and Research Hospital. 57 women, 55 men, a total of 112 cases (age range 0-50 years) were included in the study. By using radiological measurements with Computed Tomography (CT); Manubrio-Sternal Angle (MSA), Manubrio-Vertebral Distance (MVD), Xipho-Vertebral Distance (XVD), Manubrio-Xiphoid Distance (MXD) were measured.
Results: When the measurements were evaluated statistically, there was a significant gender difference in Louis angle (SA) and MVD values of the individuals participating in the study; There was a significant age-related difference in MXD and XVD values.
Conclusion: With this study, some morphometric measurements of the thorax cavity are presented. It will contribute to the literature in determining the normal reference values of the thorax and adjacent structures. Knowing the normal anatomical structure in the clinic will contribute to the physician in the differentiation of pathologies, diagnosis.

Keywords: Chest deformity, computed tomography, sternal reference values, thorax morphometry

INTRODUCTION

Sternum; It is a flat bone that consists of the manubrium, body and xiphoid process sections that form the front part of the rib cage (1). Louis angle (SA) is formed between the manubrium and body of the sternum at the level of this joint facing the back (2-4). Because it points to some anatomical regions, the SA is an important anatomical reference point. The pleura on both sides, just below the level of the SA, is in direct contact, and the brachiocephalic veins converge at this point and form the superior vena cava. Also at this level, the trachea is divided into bronchi and the thoracic duct crosses the vertebral column (5).

The normal shape of the breastbone can vary depending on the age and the structure of the individuals. In studies conducted, sternum measurements can also be used for gender determination (6). Normal reference values were determined by measurements made in various populations (7,8). Differences in the sternum and thorax cause various pathologies in the clinic (6-10).

Pectus excavatum (Shoemaker chest), Pectus carinatum (Pigeon chest), Poland syndrome and sternaldefects are some of these. Chest deformities are common pathologies in the clinic and are frequently the subject of research articles (8-11).

There are important anatomical structures in the area localized behind the thorax and the sternum (9). Therefore, it is important to know the sternum anatomy and its variations and to distinguish it from pathological conditions and for many surgical fields.

The aim of this study is to present the anatomical and radiological approaches to cases frequently encountered in the clinic by making morphological analysis of the sternum. We believe that the data obtained from this study will provide ease of diagnosis and diagnosis to our physicians.

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MATERIAL AND METHOD

This study is a retrospective study that examines the patient archives in the Department of Radiology of Adıyaman University Training and Research Hospital. Ethical approval for the study was granted by the Adıyaman University Medical Faculty Ethics Commitee for Non-ınterventional Procedures (Ethics Number is 2019-5-10). In our study, 57 women, 55 men, a total of 112 cases (age range 0-50 years), who underwent Thorax Computed Tomography (CT) between January 1, 2017 and January 1, 2019, were included. Radiological images were evaluated by a radiologist with over 10 years of experience. Cases with poor CT image quality, history of previous chest or thoracic surgery, with thorax CT examination due to trauma and tumor, with congenital skeletal system deformation (such as marfan syndrom, ankylospospondylitis), and extensive bone degeneration or osteporosis were excluded.

CT Protocol and Visualization Analysis

Figure 1 shows anatomical illustration of chest bones and thorax cavity in a saggital plane. This figure also shows some anatomical reference points snd sternal angle. When deciding on our methodology, we decided on our new reference measurements based on these reference points (sternal joint, xiphoid process etc.). Because these anatomical points are also preferred in indexes used in chest diseases and deformities. However, they are not fully sufficient.

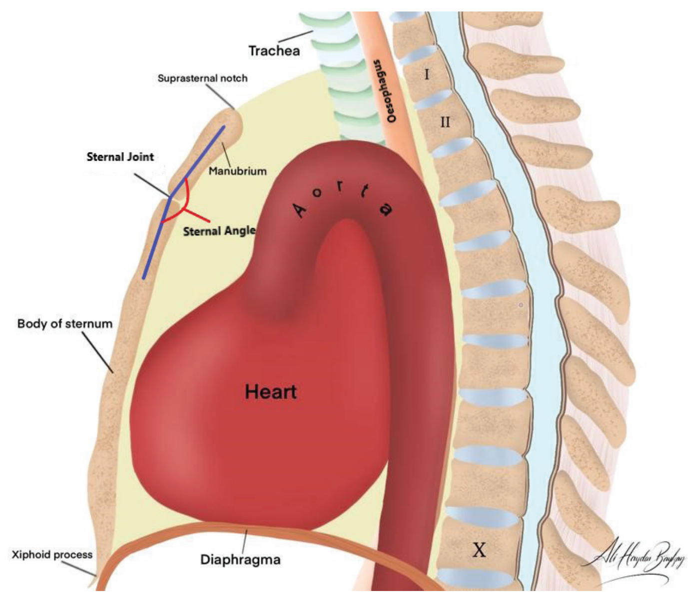

Figure 1. Illustration of the sternum and adjacent anatomical structures on sagittal plane

All cases were performed using a Toshiba Aquilion 64 (Toshiba Medical, Tochigi, Japan) computed tomography device. CT scanning; (FOV: 400mm, thickness: 3mm, kV: 120, mAs: effective mAs: 90). Radiological images were obtained in the supine position. Measurements were evaluated on sagittal reformat images (Figure 2). Measurements were calculated in millimeters and recorded.

Manubrio-Vertebral Distance (MVD): Measured in the midsagittal plane as the vertical distance that connects the upper edge of the sternum with the anterior edge of the vertebral column (Figure 2, a).

Xipho-Vertebral Distance (XVD): It was determined as a vertical distance that connects the lower edge of the xiphoid with the anterior edge of the vertebral column in the midsagittal plane (Figure 2, b).

Manubrio-Xiphoid Distance (MXD): The vertical line connecting the MVD and the XVD (Figure 2, c).

Manubrio-Sternal Angle (MSA): The angle between the horizontal line and the vertical axis parallel to the axis of the manubrio-sternal joint (Figure 2, d).

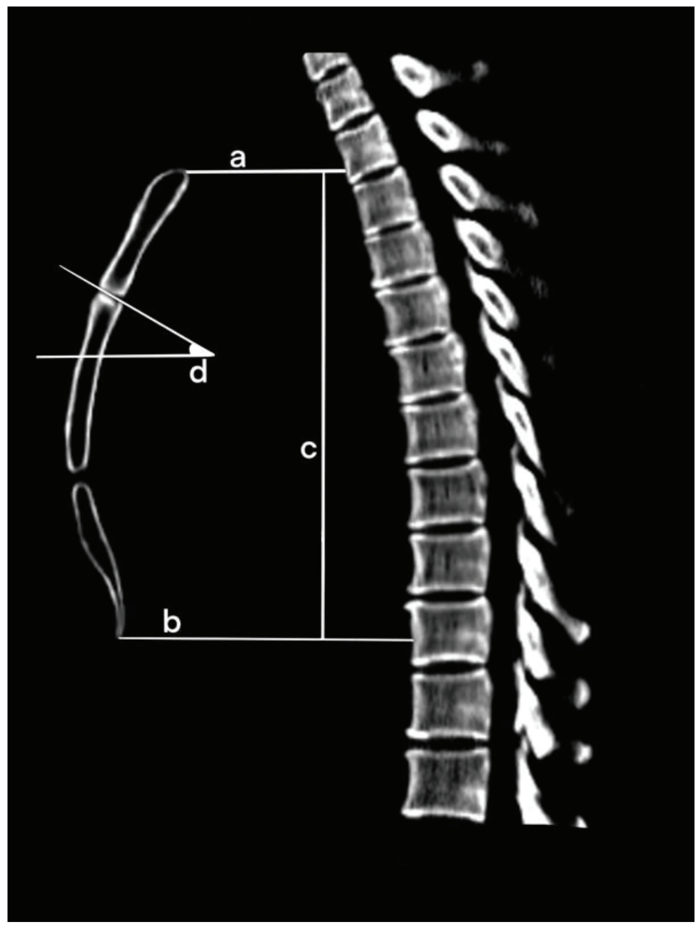

Figure 2. T1 weighted sagittal plane computed tomography image of thorax. Manubrio-vertebral distance (a), Xipho-vertebral distance (b), Manibrio-xiphoid distance (c), Manubrio-sternal angle (d).

Statistical Analysis

All the statistical analysis was performed with SPSS 15.0 for Windows (SPSS Inc.). The one sample Kolmogorov-Smirnov test was used to determine whether the data was distributed normally. Groups were compared using independent two samples t-test in terms of all the characteristics. The results were reported as mean±SD.

The standard normal distribution was used to determine the reference range. The reference interval is given as 95%. $p<0.05$ was considered statistically significant.

RESULTS

When the measurements were evaluated statistically, no significant difference was found in the gender-based measurements of the MSA in the individuals participating in the study (p=0.427), but when this angle was evaluated based on age, a statistically significant difference was found (p<0.001), (Table 1).

When the reference interval for age and gender is determined, the MSA in men is in the range of 25.74-29.84; in women, it was measured as 24.93-28.45. The reference values for the MSA between the ages of 0-30 were 22.07-26.27 degrees while the reference values for the age of 31 and above were 27.70-30.87. The XVD was shorter in males than females, and this difference was not significant (p=0.63). When the same measurement was evaluated as age-dependent, it was seen that the distance between 0-30 years was insignificantly shorter (p=0.347), (Table 1). Gender-based measurements of MVD were found to be statistically significant (p=0.032), (Table 1). The MXD was statistically significant (p=0.028). When age-dependent variables were analyzed, although there was a difference between men and women, this difference was not significant (Table 1).

Table 1. Age and gender based anthropometric measurement values of sternum

	MSA	MVD	XVD	MXD
Sex				
Male n=55	27.79±7.77	52.29±9.37	121.45±22.32	166.45±20.22
Female n=57	26.69±6.77	55.84±7.94	123.19±21.19	174.26±16.70
p value	0.427	0.032	0.673	0.028
Age				
0-30	24.17±7.19	55.42±10.47	119.98±20.01	166.62±22.22
31 and over	29.29±6.61	53.21±7.46	123.93±22.73	172.99±15.85
p value	<0.001	0.194	0.347	0.080

MSA: Manubrio-Sternal Angle, MVD: Manubrio-Vertebral Distance, XVD: Xipho-Vertebral Distance, MXD: Manubrio-Xiphoid Distance

The reference values of the MVD were determined as 49.81-54.77 in men and 53.78-57.90 in women. MVD in the 0-30 age range was 52.36-58.48, while it was between 31.42 and 54.99 at the age of 31 and above (Table 2). The reference values for the XVD are determined as 115.56-127.35 mm in men and 117.69-128.69 mm in woman. Reference values between the ages of 0-30 founded as 114.13-125.82 mm and over the age of 31 was 118.48-129.37 mm (Table 2).

The reference range for the MXD was 161.11-171.80 mm and 169.93-178.60 mm in males and women, respectively. The reference values between the ages of 0-30 founded as 160.13-173.11 mm and over the age of 31 was 169.19-176.78 mm.

Table 2. Reference interval values of the sternum based on age and gender

	MSA	MVD	XVD	MXD
Sex				
Male	(25.74-29.84)	(49.81-54.77)	(115.56-127.35)	(161.11-171.80)
Female	(24.93-28.45)	(53.78-57.90)	(117.69-128.69)	(169.93-178.60)
Age				
0-30	(22.07-26.27)	(52.36-58.48)	(114.13-125.82)	(160.13-173.11)
31 and over	(27.70-30.87)	(51.42-54.99)	(118.48-129.37)	(169.19-176.78)

MSA: Manubrio-Sternal Angle, MVD: Manubrio-Vertebral Distance, XVD: Xipho-Vertebral Distance, MXD: Manubrio-Xiphoid Distance

DISCUSSION

Sternum, which forms the front wall of the skeleton of thorax, is of a great importance in the clinic for surgical fields (12). Although various anatomical differences have been defined and standardized in morphometric studies conducted on many organs and systems, sufficient information about sternum morphology has not been found (13). Our study is radiology based and includes various morphological measurements of the sternum. We believe that these findings will be of great importance for anthropological and morphological researches.

Selthofer R. et al. reported that the general structure of the sternum has some basic differences although it is equal for both genders (13). In our study, when we examined the various measurements of the stenum, we found that some female morphometric measurements were different compared to men. We determined that the MVD was longer in women compared to the men and this measurement was statistically significant.

Measurements of the sternum are frequently used in gender determination (6,14,15). Despite this, the information that MVD is used for gender determination has not been found in the literature. With this aspect, our study is a first in the literature in terms of MVD in the use of the sternum for gender determination and offers a different perspective. We think that this measurement will be useful in gender determination in forensic medicine.

Yet another data obtained from this study; MXD is longer in females than in males. In the study of Ateşoğlu et al., they stated that body length of sternum is a very useful parameter in determining gender, and the total sternum length is more reliable than the manubrium or the body of sterni length (16). Our data reveal that the MXD is between 161-171 in males and 169-178 in females. These statistically significant findings present a different approach to the data in the literature (16).

In our study; for MSA, age and sex-dependent reference value ranges that would contribute to the literature and to determine the surgical line were also determined. Hong-MingXu and his team emphasized that sternal angle values show a gender difference (17). In our measurements about MSA supports his study. We think that these important anatomically reference values will contribute to the physicians to determining the appropriate surgical intervention methods.

Measurements obtained directly from skeletal remains or radiological methods are very important in the formation of anthropological data in forensic medicine and to define surgical procedures. It has been reported in the literature that morphometric pelvic studies, morphometric parameters of the craniofacial region, morphometric analysis of the maxillary sinuses are the basic anatomical data for gender prediction (18). Also it's known that the sternum used as another anatomical structure to is gender determination, nowadays (6,16-18). Although the data of this study are compatible with the literature, the fact that it includes sternum measurements that have not been used in previous studies makes the study unique. At the same time, the new measurements mentioned in the study are also determinative in terms of gender determination.

Morphometric data belonging to the sternum have been fixed with the studies conducted to determine the differences between the populations (18). When the population-specific study datas are examined; average sternum measurements in South African, Indian, European, US and Canadian populations were determined (18-24). We believe that our study data will also be of great importance for the sternal measurements of the Turkish population.

CONCLUSION

In this study, anatomical and radiological approaches to pathologies frequently encountered in the clinic are presented by obtaining anatomical and morphometric measurements of the sternum. These data, which indicate that the MVD can be used for gender determination, may be useful in forensic medicine. In addition, the data obtained from our research will assist surgeons in determining the appropriate surgical intervention before surgery. Our study data will also contribute to the literature in determining the normal reference values of the sternal measurements.

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Conflict of interest: *The authors have no conflicts of interest to declare.*

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