

## **Determination of the Sternal Angle Reference Values with Radiological Method According to Gender**

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### **Abstract**

**Objectives:** The sternal angle is formed by junction of the manubrium to the body of the sternum on the anterior surface of the sternum and defines the second rib level. The sternal angle known as the angle of Louis, is an important anatomical and clinical landmark point. So, it is aimed to investigate the sternal angle values of healthy individuals in our population by using computed tomography in our study.

**Material and Methods:** In accordance with this purpose, the morphometric measurements of 127 healthy individuals (56 males; 71 females) were taken from thorax region sagittal images using Computed Tomography. “The Statistical Package for Social Science (SPSS) 21.0 program” was used for statistical analysis of the measurement results. From these measurements, means, standard deviations (SD), minimum and maximum values were calculated and in

all statistical analyses; p value under 0.05 was considered statistically significant.

**Results:** The means and standard deviations of the sternal angle were found as 163.11±6.35 degree (147.60 degree in minimum; 178.00 degree in maximum) in males, 163.34±5.21 degree (151.00 degree in minimum; 176.00 degree in maximum) in females, respectively and when analyzed the values, there were no significant difference between genders.

**Conclusion:** The precise knowledge of the sternal angle value is essential for many clinical applications such as accurately counting ribs as well as being used as a reference point in the evaluation of venous pressure and helping in evaluation of the size of organs. Therefore, we think that the sternal angle values of our population presented in this study will help the clinicians as reference values.

**Keywords:** Louis Angle, Reference values, Sternal angle

### **Introduction**

Sternum is known rib cage bone that around 17 cm (15-20) in adult people that taller than woman in man [1]. Sternum is a flat bone consisting of three parts from top to bottom in thorax, extending vertically in the middle of its anterior wall. The bone is analyzed three part which manubrium sterni, corpus sterni and processus xiphoideus [2]. At the upper part it's attached clavículas on lateral side and edges articulate with the first seven rib cartilages [3,4]. The manubrium sternum, the upper part of the sternum, is located in front of the third and fourth thoracic vertebrae and it's look like triangular in shape. Corpus sterni, middle part of the sternum, is located in front of the fifth and ninth thoracic vertebrae. it's more thinner, more taller and more narrower than manubrium sterni however its width varies due to the scalloping of its lateral edges by the rib notch.

Sternal angle (Louis angle, Ludovici angle, angulus sterni) is the obtuse angle whose opening faces posteriorly where the manubrium sterni articulates with the corpus sterni. These two bones articulate with synchondrosis type and their junctions are provided by fibrocartilage type cartilage [2]. In addition to being named sternal angle for many years, also there are many different eponymous nomenclatures. Because the names of the researchers working on this subject are given, in the literature; Different naming variations are available such as Louis, Ludovici, Ludovicus, Ludwick and Ludwig. It is named after the French surgeon Antoine Louis (1723-1792) [5,6,7,8]. This angle is an important anatomical and clinical reference point, and the horizontal plane passed through it passes posteriorly through the discus intervertebralis between the T4 and

T5 vertebrae. In addition, the 2nd rib attached to this angle level is of great importance in terms of determining the number of other ribs. Because of the first rib is not palpable, during the physical examination by the clinician, the rib count starts from the second rib, which is located under the skin and adjacent to the sternal angle which can be easily felt with palpation [9,10]. This anatomical formation is the palpable connection of the manubrium with the body of the sternum and is described as the best guide for counting ribs correctly. Counting the ribs gives clinicians important clues about the size of the organs. And it is also used as a reference point in the evaluation of venous pressure [2,5]. In addition, the transverse plane from the sternal angle is separates the upper and lower mediastinum [1].

The sternal angle is defined as approximately 140 degrees at the junction of the manubrium sterni and the corpus sterni, and plays an important role in clinical practice. The trachea which right next to it; at the level of bifurcatio trachea, it is divided into two main bronchi: bronchus principalis dexter and bronchus principalis sinister. It is also important as the starting point of the aortic arch [3,4]. In addition, it is assumed that the right atrium is approximately 5 cm above [11,12].

In our study, it is aimed to assist the clinician by obtaining sternal angle values of healthy individuals in our population and creating reference values.

### **Materials and Methods**

In the present paper study, morphometric measurements were taken from thoracic computed tomography sagittal sections retrospectively. Measurements were taken from 127 (56 males; 71 females) healthy individuals aged 20-45 years, who applied to Adana Medline Hospital

Radiology Department for various reasons in a 12-month period from June 2020 to June 2021.

Adult patients without congenital or acquired thorax deformities were included in this study. Measurements were made by one person in order to increase reliability.

While measuring the sternal angle, the sternum was fixed in the lateral position from the left angle. A line was drawn parallel to the manubrium sternum, passing through the midpoint of the jugular notch. A line parallel to the corpus sterni was drawn, intersecting this line, passing through the midpoint of the corpus sterni. The sternal angle was determined by measuring the angle between these two lines (Figure 1).

### Statistical Analysis

“Statistics Package Program for Social Sciences 21.0” was used for the statistical analysis of the measurement results. The mean, standard deviation, minimum and maximum values were calculated from these measurements.  $p < 0.05$  value was accepted as statistically significant in statistical analysis.

### Result & Discussion

In the statistical analysis; The sternal angle ranges from 147.6 to 178.0 degrees. It is  $163.34 \pm 5.21^\circ$  in women and  $163.10 \pm 6.35$  degrees in men and it is not statistically significant between genders. ( $p > 0.05$ ) (Table 1).

The sternal angle was determined by a French clinician named Pierre Charles Alexandre Louis [3,13]. It is defined approximately 140 degrees at the junction of the manubrium sterni and the corpus sterni and plays an important role in the clinic. Right next to it, after bifurcatio trachea, it divides into two main bronchi: bronchus principalis dexter and bronchus principalis sinister. It is also important as the starting point of the aortic arch. It is considered as the reference point for palpation of the 2nd costal cartilages. However, the

sternal angle corresponds to the T4-T5 intervertebral disc level [3,4].

In the literature, since the sternal angle can be palpated when we descend from the incisura jugularis; It is used to find the second rib and to evaluate organomegaly to determine the level of the arcus aorta to find the level of the bifurcatio trachea to find the deep carina to detect the penetration of the superior vena cava into the pericardium at this level and as a reference indicator in clinical approaches [14,15,16,17,18,19,20].

In a study conducted by Kirum et al. in Uganda with dry bones that included the morphometric analysis of the sternum, they found that the sternal angle varied from 149.0 degrees to 177.0 degrees, with an average of 163.4 degrees in men and 165.0 degrees in women [21]. In our study, the sternal angle values ranged from 147.6 degrees to 178.0 degrees with an average of 163.3 degrees in women and 163.1 degrees in men. When we compare the results of our study with this study, it was observed that our measurements in men were approximately similar while our measurements in women were lower.

According to a study conducted in Croatia, it was reported that the mean sternal angle value was 166.4 degrees in men and 165.3 degrees in women [22]. When we evaluate with our study we see that these values are slightly higher.

Furthermore, in a study conducted in another region of Africa it was stated that the sternum angle was on average 161.7 degrees in men and 159.9 degrees in women [23].

In the light of all this information, it was observed that there were some differences between the results we obtained and the values of other populations. We think that these differences may be caused by race, gender,

age, genetic, individual differences and measurement method differences.

### Conclusion

In conclusion, we think that the sternal angle values of healthy individuals in our society which we obtained in our study will contribute to the literature and will guide clinicians in evaluating the size of organs and evaluating the locations of anatomical formations during approaches to this region. In addition, we believe that it will help clinicians in determining the correct diagnosis and appropriate treatment and as a reference value in the prevention of unwanted complications.

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**Legend Table and Figure**

Table 1: (n=127; 56 males; 71 females) Distribution of sternal angle measurements by gender (°)

Gender	Mean	Standard deviation	Minimum	Maximum
Men	163,10	6,35	147,60	178,00
Women	163,34	5,21	151,00	176,00
>0,005				

Figure 1: Evaluation of the sternal angle with Computed Tomography Arrowhead: Sternal angle

