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Morphometric Measurements on Lumbal Vertebras and Its Importance

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Abstract: Introduction: The skeletal system is examined as upper and lower bones (skeleton appendiculare) and bones from the head to the pelvis (Skeleton axiale). Due to its complex structure and important functions, it is a common area where problems such as instability, pain and dysfunction are caused by both degenerative processes increasing with age and trauma, tumoral and infectious diseases. Materials and Methods: 123 lumbar vertebrae dry bone samples were used for the study. When selecting dry bone samples, care was taken to select those without deformity, fracture, pathology and erosion, regardless of age and sex. All measurements were performed using a digital caliper with a precision of 0.01 millimeter (mm). On dry bone samples, parameters such as anterior height of corpus vertebrae, posterior height of corpus vertebrae, transverse diameter in corpus vertebrae superior, transverse length of foramen vertebrae, sagittal length of foramen vertebrae, length between right and left processus transversus, and length between right and left processus mamillaries were measured. Results: According to the measurement results, the mean anterior height of corpus vertebra was 25.79 mm and the mean posterior height of corpus vertebra was 26.08 mm. Corpus vertebra superior transverse diameter is 45.62 mm, corpus vertebra superior sagittal diameter is 31.99 mm. Conclusion: We believe that the measurements obtained in this study will help surgeons for successful operation and anesthesia. We hope that our study will serve as an example and a reliable source for new studies on lumbar vertebrae.

Key words: Vertebrae, measurement, lumbar.

1. Introduction

The spine plays an important role in countering gravity in everyday life. It also maintains the balance of the body by carrying a large part of the body weight, transferring this weight to the lower extremities along the pelvis [1].

The pelvic skeleton is made up of four bones that are joined to each other by means of less movable joints. The double ones are os coxae and others are os sacrum and os coccygis [2, 3].

Columna vertebralis is composed of 33-34 vertebrae. The first 7 of these are cervical vertebrae (8% of the total body length), 12 thoracic vertebrae (20% of the total body length), 5 lumbar vertebrae (12% of the total body length), 5 sacral vertebrae and the last 3-4 of them are cocsigeal (os sacrum and os coccygis together 8% of total body length) vertebra [4]. This deformity of spinal region after thoracic kyphosis formation in general causes difficulty in standing position to balance, lumbar region, sacroiliac joints, hip and knee joints and increase lumbar lordosis with thoracic kyphosis [5].

The foramen vertebrae of the overlapping vertebrae combine to form the canal vertebralis [6, 7]. The vital spinal cord (medulla spinalis) passes through the canalis vertebralis. Spinal cord injury is one of the most devastating conditions, whose importance has been increasingly recognized [8].

The lumbar region is a part of a spine carrying large loads and moving. Due to its complex structure and important functions, this region is frequently encountered with instability and pain problems due to degenerative processes increasing with age and trauma, tumoral and infectious diseases [9]. Stabilization of vertebral fractures, correction of vertebral deformities

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and rigid immobilization of the vertebrae are vital [10]. In addition, different studies have shown the sex determination of human bones. In anthropology and morphology, lumbar vertebrae are also utilized when sex determination is performed [11, 12]. These measurements will be a reliable source for neurosurgeons, orthopedists, radiologists and anthropologists. Morphometric and clinical aspects of the literature will provide important contributions.

The aim of this study is to know the morphometric measurement of lumbar vertebrae in surgery, lumbar puncture, is very important for epidural anesthesia. We believe that our study will be a reference for other studies in the lumbar region.

2. Material and Method

A total of 123 lumbar vertebra bones used for the study were selected from the bones found in the anatomy laboratories of Department of Anatomy, Faculty of Medicine, Yozgat Bozok University and Department of Anatomy, Faculty of Medicine, Erciyes University. When selecting dry bone samples, care was taken to select those without deformity, fracture, pathology and erosion (without altering the measurement results), regardless of age and sex. Measurements were made by a single person in order to avoid differences related to the measurement person and the results were recorded. All measurements were made with a digital caliper with a precision of 0.01 millimeter (mm) [13, 14]. Measurement parameters include (Fig. 1):

(1) anterior height of the corpus vertebrae;

(2) posterior height of the corpus vertebrae;

(3) transverse diameter of the corpus vertebrae superior;

(4) sagittal diameter of the corpus vertebrae superior;

(5) transverse diameter of the corpus vertebrae inferior;

(6) sagittal diameter of the corpus vertebrae inferior;

(7) transverse width from the middle of the corpus vertebrae;

(8) foramen vertebrale transverse length;

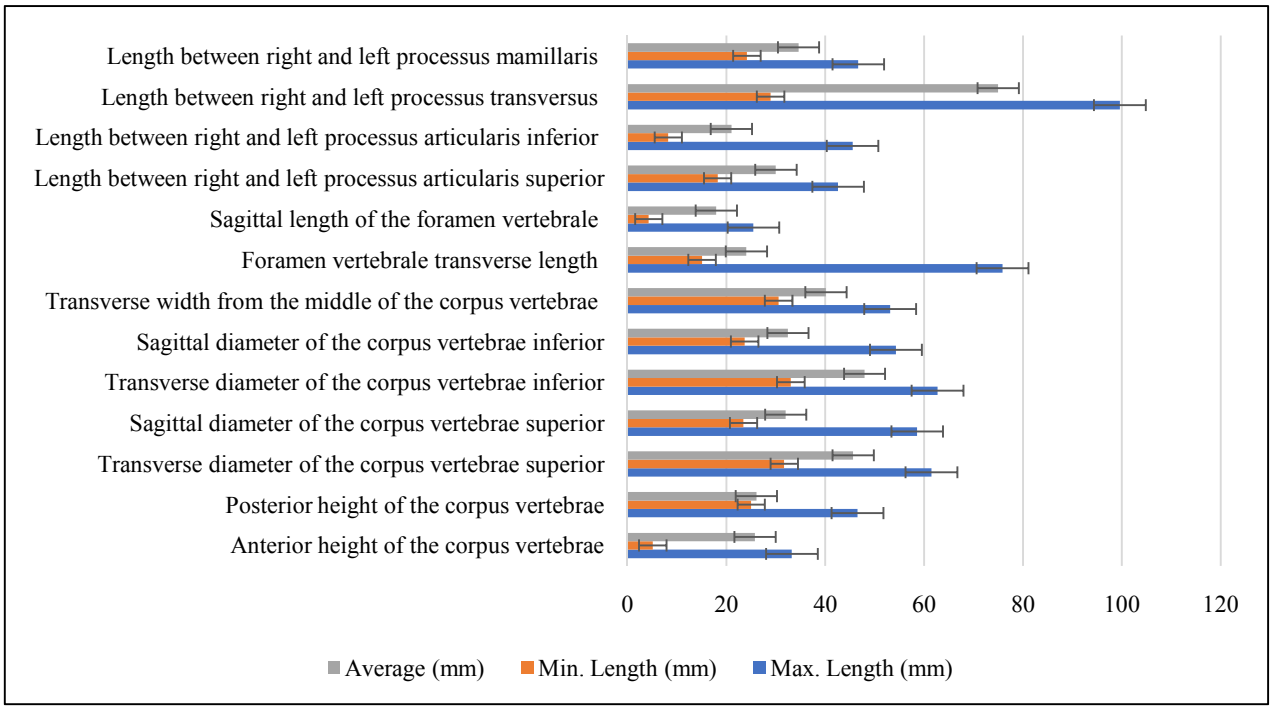

Fig. 1 Measured parameter values.

(9) sagittal length of the foramen vertebrale;

(10) length between right and left processus articularis superior;

(11) length between inferior and right processus articularis inferior;

(12) length between right and left processus transversus;

(13) Length between right and left processus mamillaris (Figs. 2-5).

2.1 Statistical Analysis

SPSS (Statistical Package for the Social Sciences) 15.0 program was used to analyze the data. Summary of data was expressed as mean ± standard deviation.

The morphometric measurements of 123 dry lumbar vertebrae bones that do not discriminate between sex and age are presented in Table 1.

According to the results, the mean anterior height of corpus vertebra was measured as 25.79 mm and the mean posterior height of corpus vertebra was measured as 26.08 mm. Corpus vertebra superior transverse diameter was 45.62 mm, corpus vertebra superior sagittal diameter was 31.99 mm, corpus vertebra inferior transverse diameter was 47.3 mm, corpus vertebra inferior sagittal diameter was 32.45 mm. Corpus vertebra middle transverse average width was 40.13 mm. Foramen vertebrale transverse length avg. was 24.04 mm, and sagittal length of the foramen vertebrale was 17.95 mm. While the distance between right-left processus articularis superior was 30.02 mm, the distance between right-left processus articularis inferior was 21.03 mm. The average distance between right-left processus transversus was 74.99 mm, and the average distance between the right-left processus mamillaris was 34.59 mm.

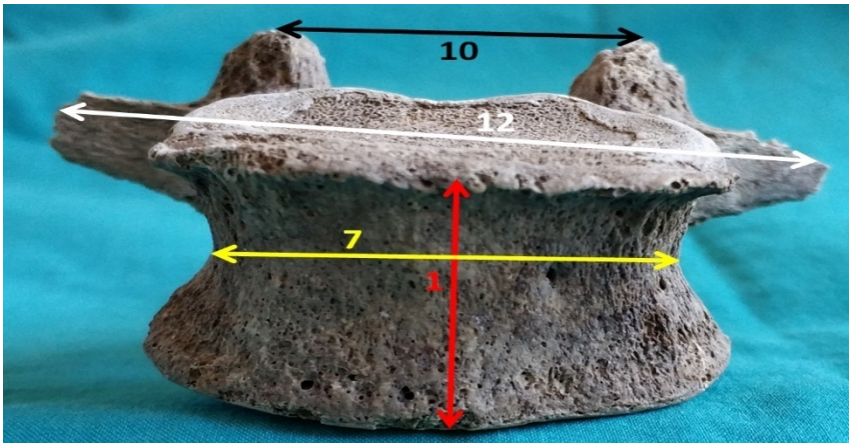

Fig. 2 Front view of lumbar vertebra.

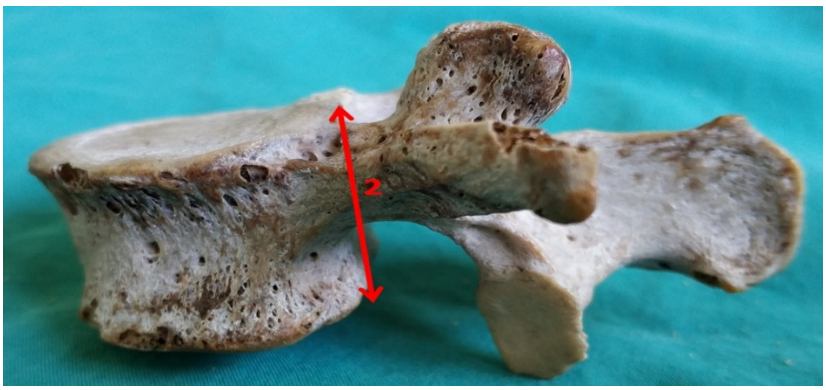

Fig. 3 Lumbar vertebra in left side view.

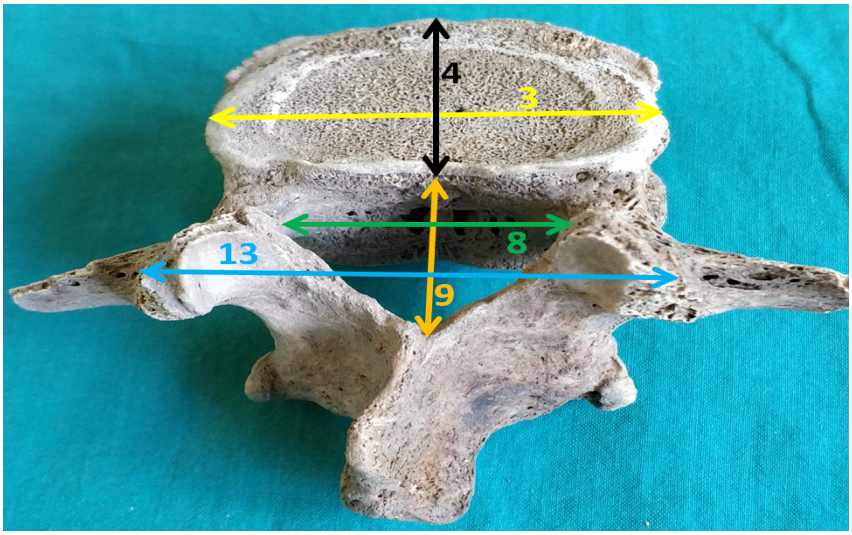

Fig. 4 **Lumbar vertebra, top view.**

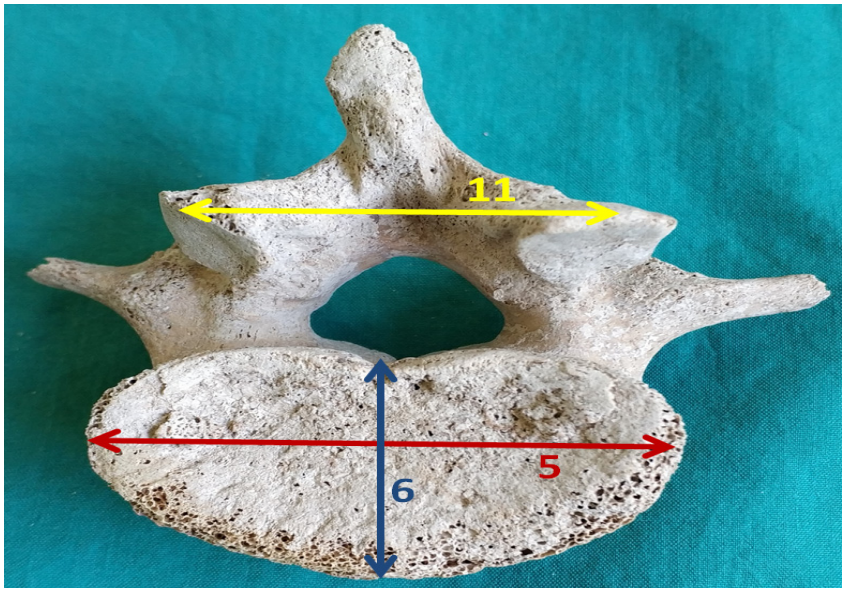

Fig. 5 **Lumbar vertebra in bottom view.**

Table 1 **Morphometric measurements of parameters on dry lumbar vertebra bones.**

	Parameters	Max. length (mm)	Min. length (mm)	Average (mm)
1	Anterior height of the corpus vertebrae	33.27	5.1	25.79
2	Posterior height of the corpus vertebrae	46.52	25.01	26.08
3	Transverse diameter of the corpus vertebrae superior	61.48	31.68	45.62
4	Sagittal diameter of the corpus vertebrae superior	58.6	23.47	31.99
5	Transverse diameter of the corpus vertebrae inferior	62.71	33.03	47.93
6	Sagittal diameter of the corpus vertebrae inferior	54.28	23.7	32.45
7	Transverse width from the middle of the corpus vertebrae	53.12	30.57	40.13
8	Foramen vertebrale transverse length	75.87	15.07	24.04
9	Sagittal length of the foramen vertebrale	25.47	4.29	17.95
10	Length between right and left processus articularis superior	42.59	18.24	30.02
11	Length between right and left processus articularis inferior	45.52	8.22	21.03
12	Length between right and left processus transversus	99.59	28.94	74.99
13	Length between right and left processus mamillaris	46.68	24.15	34.59

4. Discussion

The lumbar vertebrae are in a very important position due to the transfer of the weight of the head, trunk and upper extremity to the lower extremities and the passage of the medulla spinalis through the canalis vertebralis. Defects in lumbar vertebrae cause gait disturbance and imbalances. Surgical interventions in the lumbar region are inevitable in most cases. We believe that these measurements will provide convenience in order to minimize the risk of errors in surgical interventions and to anticipate possible variations and to intervene correctly.

Basaloglu et al. [15] in the study conducted by Department of Anatomy, Faculty of Medicine, Adnan Menderes University in the bone archive of 71 females and 29 males, measured a total of 100 bones. In addition, transverse and sagittal diameter measurements of canalis vertebralis in lumbar vertebrae were measured in computed tomography (CT) of 102 lumbar vertebrae in 18 men (54 lumbar vertebrae) and 16 women (48 lumbar vertebrae). As a result of the measurements, the mean transverse diameter measurements of the canal vertebralis in women were 22.98 ± 2.44 mm, and the mean sagittal diameter was 16.09 ± 1.61 mm. It was reported that the mean transverse diameter measurements in men were 23.02 ± 1.94 mm and the mean sagittal diameter was 16.27 ± 2.7 mm. The results of CT measurements are reported as follows: mean diameter measurement for women was 17.08 ± 2.50 mm, sagittal diameter was 25.03 ± 3.42 mm and for men transverse diameter was 17.52 ± 2.86 mm and sagittal diameter was 25.81 ± 3.15 mm.

In the study by Us et al. [16], morphological measurements were made on 225 undamaged lumbar vertebrae found in Department of Anatomy, Faculty of Medicine, Ankara University. When selecting lumbar vertebrae used in the evaluation, this information was excluded because of age and gender discrimination. Pedinculus arcus vertebra width was reported to be 8.2 mm (range 10.6 to 5.5 mm) and height 17.6 mm (range 20.4 to 14.5 mm). The mean distance between the peduncles was 27.6 mm, the width of the arcus vertebra was 6.7 mm and the average height of the arcus vertebra was 20.4 mm. In angular measurements, the angle between the pedinculus arcus vertebra and the transverse axis of the corpus vertebra in the frontal plane is 138 degrees, and between the transverse axis of the corpus vertebra in the frontal plane angle of 47.6 degrees, the horizantal axis of the corpus vertebra in the sagittal plane and the axis between the spine of the processus spine and pedinculus arcus vertebra was determined to be 66.2 degrees.

In the study of Tuncer [17] conducted by Department of Anatomy, Meram Medical Faculty, Necmettin Erbakan University, it was reported that after vertebral deformations and fractures were separated to vary the measurement results, morophological measurements were performed on 103 thoracic and 53 lumbar vertebrae. It was stated that these criteria were excluded from the evaluation because age and sex determination of bones was not possible. Measurements have been reported with a caliper with a precision of 0.01 mm. The mean posterior elevation of corpus vertebra in lumbar vertebrae is 25.33 ± 2.60 mm, the average of anterior elevation of corpus vertebra is 25.24 ± 2.50 mm, the average height of pedinculus vertebra is 13.54 ± 2.08 mm, the width of pedinculus vertebra is 31.84 ± 4.19 mm, mean sagittal diameter of copus vertebra is 15.08 ± 2.212 mm, mean transverse diameter of copus vertebra is 48.53 ± 6.86 mm, mean sagittal diameter of foramen vertebra is 11.86 ± 5.00 mm, mean transverse diameter of foramen vertebra was reported to be 23.13 ± 2.50 mm. Significant statistical differences were found between these measurements ($p > 0.05$).

According to the study conducted by Ross et al. [18], the race according to the size of the vertebras was compared. The Caucasus has been reported to have dimensions of 1-2 mm larger than the vertebral measurements of the Japanese and American breeds.

Çopuroğlu et al. [19] in a retrospective study of 75 patients (25 females, 50 males) in the clinical archive reported that the distance between the peduncles in the L1 vertebrae and the distance between the facet joints and the anterior cortex were measured on lateral radiographs. On the anteroposterior radiograph, the mean distance between the pedunculus was 18.7 mm, and the distance between the facet joints and the anterior cortex of the spine was 31.27 mm.

The specimens used in the sex determination study from the bones made by Ünlütürk et al. [11] were composed of complete colna vertebralis of 144 people (37 white males, 36 white females, 35 black males, 36 black females). These specimens have been reported from the well-preserved skeleton of the Pretoria bone collection of over 1,000 people from the Anatomy Department of the University of Pretoria, South Africa. For gender determination, 7 different measurements were taken by using caliper with 0.01 mm accuracy from each of the bones C7, T1, T11, T12 and L5. Particularly, these bones were chosen because of their anatomical ease in recognizing their position in the colna vertebralis. As a result of the analysis, it has reached 89% accuracy in white and 85% accuracy in black. The most commonly selected measures are posterior and inferior transverse diameters and superior anteroposterior dimensions. Accuracy rate is 89% in white and 84% in black in T1. The lowest dimorfizm is seen in L5 as 80% in white and 64% in black. It has a dimorphic structure like the other long bones in the vertebrae. This makes the vertebrae more advantageous over other bones. In this study, over 70% success was achieved by using all measurements, and the gender success rate was increased to 89% by using the 12th thoracic anterior transverse diameter and 11th thoracic anteroposterior diameter selected using the stepwise method.

5. Conclusion

In this study, corpus vertebra, foramen vertebrae, proc. transversus, proc. mamillaris measurements were obtained. These data are given in the table above and compared with other studies in the literature, and the results were found to be supportive of each other. The parameters that will work in surgical operations have been defined and the data are given in the table above. We believe that the measurements obtained in this study will help surgeons for successful operation and anesthesia. In addition, it will be a reference resource for other studies in the fields of anthropometry and morphometry. We hope that our study will serve as an example and a reliable source for new studies on lumbar vertebrae.

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Conflict of Interest

The authors have no conflicts of interest relevant for this article.

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