



A Morphometric Study of the Vertebral Body in Dry Human Typical Thoracic Vertebrae

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Abstract:

Background: Majority of studies in the past about morphometry of thoracic vertebrae mainly focused on pedicle diameters and their angulations. The vertebral body were not studied or only little importance was given to them. Taking into account the complex nature of thoracic spine, the present study has given importance to the morphometry of vertebral body.

Objective: To measure the various dimensions of vertebral body in typical thoracic vertebrae.

Material and methods: Two hundred dry human typical thoracic vertebrae of undetermined gender and age were selected for the study. The various parameters of vertebral body were measured.

Results: The anteroposterior distance of the vertebral body in typical thoracic vertebrae ranged from 12.36 - 31.26 mm with a mean of 20.78 ± 3.36 mm. The transverse diameter of the vertebral body ranged from 22.16 - 35.52 mm with a mean of 27.02 ± 2.06 mm. The vertebral body width ranged from 20.36 - 47.76 mm with a mean of 25.49 ± 2.59 mm. The anterior height of the body ranged from 12.16 - 24.72 mm with a mean of 17.17 ± 1.65 mm. The posterior height of the body ranged from 14.04 - 26.28 mm with a mean of 18.27 ± 1.64 mm.

Conclusion: The results provide a comprehensive database for more accurate modelling and design of vertebral body implants and instrumentations for Indian population.

Key Words: Anterior height, Posterior height, Vertebral body width, Typical thoracic vertebra

Introduction:

The adult vertebral column (also called the spine or spinal column) usually consists of 33 vertebral segments- 7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal. The linkages between the vertebrae include cartilaginous interbody joints and paired synovial facet (zygapophysial) joints, together with a complex of ligaments and overlying muscles and fasciae. The functions of the column are to support the trunk, to protect the spinal cord

and nerves, and to provide attachments for muscles. It is also an important site of haematopoiesis throughout life.¹The vertebrae can be involved in various conditions. These include fractures, infections, malignancies and inflammatory disorders. Abnormal curvatures of the vertebral column in the thoracic region such as kyphosis and scoliosis may result from developmental anomalies or pathological processes involving vertebrae.²The vertebral bodies and the intervertebral discs form an important column in transmission of weight of the

body. In the upper thoracic region, due to the anterior curvature, the main part of the compressive force is transmitted through the anterior column formed vertebral body and intervertebral disc, with resulting increased stress.³ The compressive force in the lower thoracic region is transmitted through two parallel columns, one anterior and one posterior formed by successive articulations of laminae with each other.⁴In recent years, there have been considerable developments in instrumentation designed to stabilize and correct the thoracic spine.⁵Anterior interbody fusion, in association with a variety of methods to stabilize both the implant and motion segment, has increased in popularity. Also, expandable vertebral body replacement material is being used to provide solid anterior column constructs with restoration of height and sagittal alignment. The anterior route provides direct access to most spine diseases and allows optimal neural decompression and the possibility of adequate realignment and strong reconstruction/fixation. Stability of the vertebral column is achieved, resolution of clinical pain is rapid and almost complete, and the rate of surgical complications is very low. Hence, the present study measured the various dimensions of vertebral body.

Material and Methods:

The study was conducted on dry human typical thoracic vertebrae. The vertebrae were obtained from the bone collection of the department of Anatomy of a tertiary care hospital. Of the total collection of thoracic vertebrae in the department, 200 undamaged typical thoracic vertebrae were selected for the study. The vertebrae were of undetermined gender and age. Each vertebra was assigned a serial number. Anatomical measurements were taken on these specimens using a verniercaliper (0-150mm with a precision of 0.02 mm)(Fig. 1-5). The following parameters were recorded in a proforma:

1. Anteroposterior distance of the vertebral body- It is the distance between anterior border and posterior border of the superior surface of vertebral body in midline. (Fig. 3)
2. Transverse diameter of the vertebral body- It is the maximum transverse diameter of the vertebral body at the superior surface.
3. Vertebral body width- It is the minimum transverse distance across the sides of vertebra in anterior view of the body. (Fig. 4)
4. Anterior height of the body- It is the vertical distance between superior and inferior surface of body in the midline anteriorly. (Fig. 5)
5. Posterior height of the body- It is the vertical distance between superior and inferior surface of body in the midline posteriorly.



Fig.1- Illustration showing measurement of the anteroposterior distance and transverse diameter in typical thoracic vertebra.



Fig.2- Illustration showing measurement of anterior and posterior height of the body in typical thoracic vertebra.



Fig. 3- Illustration showing measurement of anteroposterior distance of the vertebral body



Fig. 4- Illustration showing measurement of vertebral body width



Fig. 5- Illustration showing measurement of anterior height of the body

Results:

1. The anteroposterior distance of the vertebral body in typical thoracic vertebrae ranged from 12.36 - 31.26 mm with a mean of 20.78 ± 3.36 mm.
2. The transverse diameter of the vertebral body in typical thoracic vertebrae ranged from 22.16 - 35.52 mm with a mean of 27.02 ± 2.06 mm.

3. The vertebral body width in typical thoracic vertebrae ranged from 20.36 - 47.76 mm with a mean of 25.49 ± 2.59 mm.
4. The anterior height of the body in typical thoracic vertebrae ranged from 12.16 - 24.72 mm with a mean of 17.17 ± 1.65 mm.
5. The posterior height of the body in typical thoracic vertebrae ranged from 14.04 - 26.28 mm with a mean of 18.27 ± 1.64 mm.

Discussion:

Several quantitative anatomical studies have been carried out for thoracic vertebrae in different countries. Many authors have studied the vertebrae using different methods such as plain radiographs, direct specimen measurements and quantitative 3-dimensional anatomic techniques. These include Panjabi MM et al⁶, Tan et al⁷, Roop Singh et al⁸, Gupta R et al⁹ and Kunkel ME et al¹⁰. However, Berry JL et al¹¹ studied only second and seventh thoracic vertebrae. The following tables present the comparison of means of the various parameters obtained from previous studies with that of the present study.

Table 1: Comparison of mean anteroposterior distance of the vertebral body in typical thoracic vertebrae with other studies.

Study	Year	Country	Material for study	Mean (in mm)
Panjabi MM et al ⁶	1991	USA	Dry bones	24.26
Tan et al ⁷	2004	Singapore	Dry bones	20.21
Present study	2014	Indian	Dry bones	20.78

When compared, the mean anteroposterior distance of the vertebral body in the present study is lesser than the value found by Panjabi MM et al⁶ but is in agreement with the finding of Tan et al⁷.

Table 2: Comparison of mean transverse diameter of the vertebral body in typical thoracic vertebrae with other studies.

Study	Year	Country	Material for study	Mean (in mm)
Panjabi MM et al ⁶	1991	USA	Dry bones	26.06
Tan et al ⁷	2004	Singapore	Dry bones	23.84
Singh R et al ⁸	2011	India	Dry bones	25.9
Present study	2014	India	Dry bones	27.02

The mean transverse diameter of the vertebral body in the present study is slightly greater than that of the earlier studies.

Table 3: Comparison of mean vertebral body width in typical thoracic vertebrae with other studies.

Study	Year	Country	Material for study	Mean (in mm)
Berry JL et al ¹¹	1987	USA	Dry bones	28.05
Gupta R et al ⁹	2011	India	Dry bones	27.62
Singh R et al ⁸	2011	India	Dry bones	24.88
Present study	2014	India	Dry bones	25.49

According to Table 3, the value of mean vertebral body width in the present study is similar to that of Singh R et al⁸ but lesser than that of the other studies.

Gupta R et al⁹ mention that the vertebral body width ranged between 19.06-39.39 mm for typical thoracic vertebrae as compared to 20.36-47.76 mm in the present study.

Table 4: Comparison of mean anterior height of the body in typical thoracic vertebrae with other studies.

Study	Year	Country	Material for study	Mean (in mm)
Tan et al ⁷	2004	Singapore	Dry bones	15.04
Singh R et al ⁸	2011	India	Dry bones	17.39
Kunkel ME et al ¹⁰	2011	Germany	Cadaveric, Radiographic	15.84
Present study	2014	India	Dry bones	17.17

The mean anterior height of the body in the present study is in agreement with the results of study by Singh R et al⁸ and is greater than the values reported by Tan et al⁷ and Kunkel ME et al¹⁰.

Table 5: Comparison of mean posterior height of the body in typical thoracic vertebrae with other studies.

Study	Year	Country	Material for study	Mean (in mm)
Berry JL et al ¹¹	1987	USA	Dry bones	17.8
Panjabi MM et al ⁶	1991	USA	Dry bones	16.86
Tan et al ⁷	2004	Singapore	Dry bones	16.41
Singh R et al ⁸	2011	India	Dry bones	18.19
Kunkel ME et al ¹⁰	2011	Germany	Cadaveric, Radiographic	17.99
Present study	2014	India	Dry bones	18.27

The finding in the present study is nearly equal to that of Singh R et al⁸, Kunkel ME et al¹⁰ and Berry JL et al¹¹ but is slightly greater than Panjabi MM et al⁶ and Tan et al⁷.

Singh R et al⁸ found that the anterior height was less as compared to posterior height of body at all levels of thoracic spine. They noted this as an explanation for the normal physiological kyphosis present in the thoracic region. The present study found a similar observation.

Conclusion:

Thus, a comprehensive data set has been presented which provides quantitative anatomy of vertebral body of typical thoracic vertebrae. The differences in the results of the present study and those of the previous studies with respect to some of the parameters may be due to differences in race, ethnicity, environmental factors as well as methods used for the studies. These findings strengthen the recommendations by Roop Singh et al⁸ for modification in spinal surgery instrumentations in accordance with the morphometric data obtained from Indian population. In the future, the scope of the study can be further extended to study the vertebral column with respect to individual vertebral levels.

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