Original Research Article

MORPHOMETRIC ANALYSIS OF TYPICAL THORACIC VERTEBRAE AND ITS CLINICAL RELEVANCE

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ABSTRACT

Background: The frequent surgical interventions of thoracic spine are more common due to a wide array of traumatic, degenerative and neoplastic diseases. For successful surgical management of these conditions, a detailed anatomical knowledge of the thoracic vertebrae is required.

Aim: The aim of this study was to present a morphometric reference database for Pedicle morphometry of typical thoracic vertebrae in Indian population.

Material and methods: The study was conducted on 120 dry human typical (T2-T8) thoracic vertebrae selected from the bone bank of the Department of Anatomy, SGT Medical College Hospital and research institute, Gurugram. Linear measurements of the vertebrae were taken with the help of digital Vernier caliper .Statistical Analysis: Mean and standard deviation of the morphometric parameters taken into account were analyzed. The comparison of morphometric dimensions of the right and left sides was performed using Student's t-test and p-value was calculated.

Results: The morphometric analysis of the thoracic vertebrae demonstrated that the Pedicle height (PH) was 10.35 ± 1.22 mm and Pedicle Width (PW) was 5.65±2.06mm.

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

KEY WORDS: Pedicle width (PW), Pedicle Height (PH), Typical Thoracic vertebrae, Morphometry.

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INTRODUCTION

The human vertebral column is composed of a series of 33 vertebral segments (7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 coccygeal) alternating with intervertebral discs that extend from the cranium to the coccyx. This resilient cylindrical column essentially protects the spinal cord and plays an important role in posture and locomotion [1]. Although their basic structure is similar, vertebrae vary in size

and exhibit regional characteristics. The thoracic vertebrae are easily recognizable by the presence of costal facets in their body and transverse processes. The mid thoracic zone of vertebral column is of utmost importance due to the presence of combination of narrow spinal canal and critical vascular supply that make them prone to a diverse array of traumatic and degenerative conditions [2].

For better management of diseases and mechanical processes, countless researchers have investigated the diverse aspects of human thoracic spine, foremost being the anatomy, kinematics and mechanical properties of thoracic vertebrae as well as intervertebral discs. As spinal ailments are frequently managed by arthrodesis which involves surgical fusion of adjacent degenerated vertebrae with plates and screws, accurate placement of screws is of paramount importance to circumvent damage to the spinal cord or nerve roots. In recent years there have been considerable developments in instrumentation designed to stabilize and correct the thoracic spine instability, as well as for the decompression of neural structures [3]. 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 [4].

Posterior fixation of the thoracic spine has been used successfully to correct deformity and achieve stability in patients who have scoliosis, traumatic injury, or vertebral collapse secondary to infection .[5] A further superior approach of arthrodesis is transpedicular screw fixation wherein pedicles of adjacent vertebrae are held together with screws[6].The advent and general acceptance of pedicle screw fixation of thoracic spine has made the morphometric analysis of the thoracic pedicle a clinical necessity for all the surgeons practicing this procedure. Use of wrong size of screw may result in cortex perforation of pedicle or fracture of pedicle with resultant injury to nerve roots [7, 8].

Differences exist in thoracic spine morphometric values across different study populations and prevents the standardization of measurement. The present study quantifies morphometric characteristics of pedicles of typical thoracic spine (T2-T8) in Indian population and comparing with available literature.

MATERIALS AND METHODS

The study was conducted on dry human typical thoracic vertebrae. The vertebrae were obtained from the bone bank of the department of Anatomy, SGT Medical College Hospital and research institute, Gurugram. Of the total collection of thoracic vertebrae in the department, 120 typical thoracic vertebrae (T2-T8) were selected for the study. Vertebrae that were damaged or those with bony spurs excluded from the study and only intact vertebrae in good conditions were studied and photographed. Anatomical measurements were taken on these specimens using a Digital Vernier caliper (0-150mm with a precision of 0.01 mm. Mean and standard deviation of the mentioned parameters were calculated.

Fig. 1: Illustration showing measurement of pedicle width (PW) at the midpoint of the pedicle.
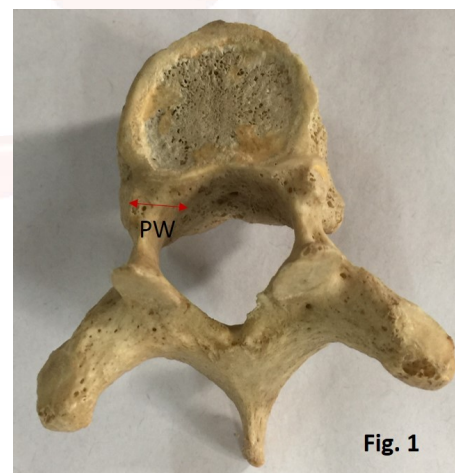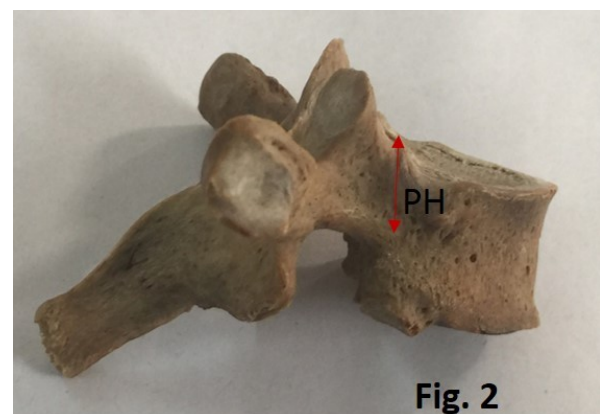

Fig. 2: Illustration showing measurement of pedicle height (PH).

Statistical Analysis: Mean and standard deviation of the morphometric parameters taken into account were analyzed. The comparison of morphometric dimensions of the right and left sides was performed using independent Student's t-test and p-value was calculated. All the statistical calculations were performed using the software SPSS for windows (Statistical Presentation System Software, SPSS) version 16.0.

RESULTS

Parameters

1. Pedicle width (PW): It is the maximum distance between medial and lateral surfaces of pedicle measured at right angles to the long axis of the pedicle. (Fig.1)

2. Pedicle height (PH): It is the maximum vertical distance between superior and inferior border of pedicle at its midpoint.(Fig.2)

Table 1: Observations of Pedicle morphometry of typical thoracic vertebrae.

S.No.	Parameters	Range (mm)		mean ±SD (mm)		mean ±SD (mm)	P Value
	Measurements	Right	Left	right	Left	Total	
1	Pedicle height (PH)	10.02 - 11.38	10.25 - 11.28	10.16 ± 1.28	10.38 ± 1.26	10.35 ± 1.22	0.15
2	Pedicle Width (PW)	5.06 - 6.72	5.09 - 6.13	5.18 ± 1.28	5.71 ± 1.22	5.65 ± 2.06	0.76

The morphometric analysis of the typical thoracic vertebrae from (T2-T8) were examined in the present study [Table 1]. The vertebrae were analyzed for the above mentioned parameter both on right and left sides. The mean height of pedicle was noted to be 10.35 ± 1.22 mm, more on left side as compared to right side and mean pedicle width was 5.65± 2.06 mm, more on left side as compared to right side. P value was calculated and difference was not statistically significant.

DISCUSSION

The present study was done to obtain the morphometric data of typical thoracic vertebrae and analyze it in reference to musculoskeletal anatomy. Thoracic vertebrae morphometry is essential for prosthesis designing for a particular population as there is difference in various parameters regarding race, ethnicity, environmental factors and bias in methods used for the studies. Variability in vertebral dimensions prevents the standardization of measurements. The present study was undertaken to give a detailed knowledge of the vertebral pedicle morphology of typical thoracic vertebrae in Indian population and the observations from the present study was compared with the previous published studies from India and other western countries [Table 2]. The pedicles are short cylindrical processes projecting backwards from the vertebral body. The dimensions and angle of thoracic pedicle changes progressively from upper thoracic spine distally. There is progressively caudal increase in thickness [1]. In case of disparity between pedicle and screw length the pedicle may be breached during instrumentation along with damage to vertebral canal space and neuronal structures. Considering the small size of pedicles in thoracic spine some authors proposed extrapedicular fixation with in the pedicle unit to avoid medial wall violation [5]. One should preoperatively determine the size of pedicles using imaging techniques. Mean pedicle width was found to be 5.65±2.06 which is comparable to study done in India by Datir SP etal [9] and Pai BS etal [8]and lesser than studies by Zindrick MR etal [10]and Mc Lain RFetal[11] based on western population. Mean pedicle height was found to be10.35±1.22 mm which is comparable to the results of Singh .R etal [2], Panjabi etal [12] and Berry etal [13] but lesser than Zindrick MR etal[10] and Datir SP etal[9].

According to studies done in different countries it has been established that pedicle height is always greater than pedicle width. The present study also agrees with this finding. Thus from a practical point of view, pedicle width carries more importance in selection of pedicle screw diameter in comparison to pedicle height during spinal surgeries.

Table 2: Comparison of Pedicle dimensions from previous studies (P.H=Pedicle height, PW=Pedicle width).

S.No.	Observer	Year	Country	P.W (mean) mm	P.H (mean) mm
1	Berry JL etal [13]	1987	USA	5.6(T2,T7)	11.9(T2,T7)
2	ZindrickMR.et al [10]	1987	U.S.A	5.46	12.21
3	Panjabi. et al [12]	1991	U.S.A	Left:6.43 Right:6.61	Left:11.93 Right:11.76
4	McLain R Fet al [11]	2002	USA	5.87	11.61(T2-T6)
5	Datir.SP et al [9]	2004	India	5.26	12.16
6	Tan et al [14]	2004	Singapore	Left:4.54 Right:4.56	Left:9.41 Right:9.53
7	Pai BS et al [8]	2010	India	5.09	10.37
8	Singh. R et al [2]	2011	India	4.88	11.12
9	Patil DK et al [4]	2014	India	Left: 4.33 Right:4.29	Left: 10.54 Right:10.62
10	Present Study	2019	India	Left: 5.71±1.22 Right:5.18±1.28	Left: 10.38 ±1.26 Right:10.16±1.28

CONCLUSION

Thus a comprehensive data set has been presented which provides quantitative anatomy of pedicles of typical thoracic vertebrae. These findings strengthen the need for the modifications in various procedures of spinal surgery and instrumentation in accordance with the morphometric data obtained from Indian population.

Conflicts of Interests: None

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