A Study Of Of Body And Pedicle Morphometry Of Typical And Atypical Thoracic Vertebra And It's Clinical And Surgical Applications In Delhi-NCR Region.

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ABSTRACT
Artificial vertebral implants, used widely to stabilize the thoracic spine in incidence of fracture, tumours and various spinal deformities, need a constant modification and improvement in their design for which the detailed morphometric analysis of thoracic vertebra is imperative. Hence, the present study was carried out to provide a comprehensive morphometric data of typical and atypical thoracic vertebrae in Greater Noida, India. Material and Methods: The present study was done on a total of 200 (typical 115 +atypical 85) thoracic vertebrae of unknown age and gender by direct measurements of the vertebral body (right and anterior height, anteroposterior and transverse diameter) and pedicle width and height of right and left sides. The measurements were taken by Digital Vernier Caliper and data collected was statistically analyzed. Results: The mean right side height and anterior height of body in was 15.98mm and 15.65 mm respectively in typical and15.62mm and 15.77 mm in atypical vertebrae correspondingly. The mean transverse diameter of body was noted to be 24,65mm and 25.06 mm in typical and atypical thoracic vertebrae respectively while the mean anteroposterior diameter was 19.39 mm and 17.84 mm in typical and atypical vertebrae respectively. Right side pedicle height was 9.94 mm and 10.83mm in typical and atypical vertebrae respectively, while pedicle height on left side was 9.80 mm and 10.73 mm in typical and atypical vertebrae respectively. The mean pedicle width of right side was found to be 1.88 mm and 2.59 mm in typical and atypical respectively. The mean left pedicle width was 1.81mm and 2.55mm in typical and atypical vertebrae respectively. Discussion and Conclusion: Spine morphometry is of global interest because of its great importance in prosthetics, orthopedics, and biomechanics. The date obtained from this study will serve as a reference for designing of artificial vertebral body implants for the typical and atypical thoracic vertebrae, and thereby enhance preclinical and clinical evaluation of vertebral implants, prosthetics, and management of spine pathology in Indian population.

Key words: typical, Atypical, Thoracic vertebrae, morphometry

Introduction

The human adult vertebral column consists of 33 vertebrae comprising of 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 4 coccygeal vertebrae. The thoracic vertebrae serve to align the the mobile cervical column with a comparatively rigid lumbar region.(1) The identification features of typical thoracic vertebrae (T2 toT8)are the presence of costal facets on the body and transverse processes for forming the costovertebral joints with ribs(2). T11 and T12 do not articulate with rib and so referred to as "floating thoracic vertebrae" (3). A considerable variation in anatomical morphometry is present in thoracic vertebral bodies as compared to the more homogeneous lumbar morphology(4). The various parameters like body height, transverse and anteroposterior diameters differ significantly among the T1 through T12 levels(5).

The various pathologies, notably fractures, malignancies, inflammatory disorders, infections, abnormal curvatures such as kyphosis, scoliosis, spondylolisthesis, involve the vertebrae. The complex kinesiology and interaction of compressive forces of thoracic spine due to spinal curvature call for a continuous and progressive improvement and modification in instrumentation designed to stabilize and correct spinal deformities. Majority of the previous studies have either focused on the pedicle diameters and their angulations or on the vertebral body. Our study aims to quantify the body and pedicle morphometry data of 200 typical and atypical thoracic vertebrae from Indian population which will serve the purpose of authentication and calibration of vertebral implants for spinal stabilization.

Material and methods

The place of study was the department of Anatomy, in School of medical sciences and research, Sharda university, Greater Noida, India. The study involved intact 200 dry thoracic vertebrae consisting of 115 typical (T2-T8) and 85 atypical (T1,and T9-T12), of undetermined age and sex. Any damaged, deformed and vertebra with bony spurs were excluded from the study. The vertebrae were chosen randomly with no particular order. Digital vernier caliper which read from 0-150 mm with a precision of 0.01mm was used to take the following anatomical parameter measurements of body and pedicle as under:

Anterior height of body: Vertical distance between superior and inferior surface in midline (FIG 1)

Figure 1.Anterior height of Body

Right lateral height of body: Vertical distance between superior and inferior surface on right lateral side of body (Fig 2)

Figure 2.Right lateral height of Body

Superior Anteroposterior diameter of body: Midline distance between anterior and posterior border of superior surface of body (Fig 3)

Superior Transverse diameter of body: Maximum transverse diameter of superior surface of body(Fig 4)

Figure 3.Anteroposterior diameter of body

Figure 4.Transvere height of body

Pedicle width (PW): Maximum distance between medial and lateral surfaces of pedicle measured at right angle to long axis of pedicle of right and left side. (Fig 5)
Pedicle height (PH): Maximum vertical distance between superior and inferior border of pedicle at it's midpoint of right and left side (Fig 6)

Figure 5.Pedicle width

Figure 6.pedicle height

Result:
RESULTS The present study examined the morphometric characteristics of both typical and atypical thoracic vertebrae [Table 1].

TABLE 1: Body and Pedicle Dimensions of Typical and Atypical Thoracic Vertebrae

Group		Right side height	Anterior . Height	Transverse diameter	Anteroposterio Diameter	Pedicle height (right)	Pedicle height (left)	Pedicle width (right)	pedicle width (left)
ATY	N	85	85	85	85	85	85	85	85
		0	0	0	0	0	0	0	0
	Mean	15.6224	15.7718	25.0647	17.8412	10.8318	10.7329	2.5918	2.5506
	Std. Deviation	2.63599	2.38670	3.83107	4.57077	2.32390	2.30942	.94708	.92320
	Range	13.00	10.90	17.10	18.10	8.80	8.80	5.80	5.70
	Minimum	9.80	10.90	16.00	9.90	6.40	6.20	1.10	1.10
	Maximum	22.80	21.80	33.10	28.00	15.20	15.00	6.90	6.80
TY	N	115	115	115	115	115	115	115	115
		0	0	0	0	0	0	0	0
	Mean	15.9843	15.6565	24.6574	19.3991	9.9496	9.8096	1.8835	1.8165
	Std. Deviation	1.61129	1.61137	2.80254	4.92381	1.71435	1.65953	.60798	.57795
	Range	7.80	8.70	15.10	48.00	12.40	12.10	2.70	2.60
	Minimum	11.90	11.10	16.70	12.00	1.80	1.80	.80	.70
	Maximum	19.70	19.80	31.80	21.00	14.20	13.90	3.50	3.30

The mean right side height and anterior height of body in was 15.98mm and 15.65 mm respectively in typical and15.62mm and 15.77 mm in atypical vertebrae correspondingly. The mean transverse diameter of body was noted to be 24,65mm and 25.06 mm in typical and atypical thoracic vertebrae respectively while the mean anteroposterior diameter was 19.39 mm and 17.84 mm in typical and atypical vertebrae respectively. Right side pedicle height was 9.94 mm and 10.83mm in typical and atypical vertebrae respectively, while pedicle height on left side was 9.80 mm and 10.73 mm in typical and atypical vertebrae respectively. The mean pedicle

width of right side was found to be 1.88 mm and 2.59 mm in typical and atypical respectively. The mean left pedicle width was 1.81mm and 2.55mm in typical and atypical vertebrae respectively.
The measurements were taken for both the right and left sides. The average pedicle height was found to be 10.35 ± 1.22 mm, with a slightly greater value on the left side compared to the right side. Similarly, the average pedicle width was 5.65 ± 2.06 mm, also larger on the left side than the right. The p-value was calculated, and the difference was not statistically significant.
Statistical Analysis: The mean and standard deviation for the morphometric parameters were calculated. The comparison of the measurements between the right and left sides was performed using an independent Student's t-test, and the p-value was determined. All statistical analyses were conducted using SPSS for Windows (Statistical Package for the Social Sciences), version 29.

Table 2: Coefficient of Variation of Thoracic Vertebrae Parameters

	Std. Deviation	COV	Mean	Std. Deviation	COV
Right side Height	2.63599	17%	15.9843	1.61129	10%
Anterior height	2.38670	15%	15.6565	1.61137	10%
Transverse diameter	3.83107	15%	24.6574	2.80254	11%
Anteroposterior diameter	4.57077	26%	19.3991	4.92381	25%
Pedicle height (right)	2.32390	21%	9.9496	1.71435	17%
Pedicle height(left)	2.30942	22%	9.8096	1.65953	17%
Pedicle width (right)	.94708	37%	1.8835	.60798	32%
Pedicle width(left)	.92320	36%	1.8165	.57795	32%

Table 3 Group Statistics of typical and atypical thoracic vertebrae.

Group		N	Mean	Std. Deviation	Std. Error Mean
Right side height	ATY	85	15.6224	2.63599	.28591
	TY	115	15.9843	1.61129	.15025
Anterior height	ATY	85	15.7718	2.38670	.25887
	TY	115	15.6565	1.61137	.15026
Transverse diameter	ATY	85	25.0647	3.83107	.41554
	TY	115	24.6574	2.80254	.26134
Anteroposterior diameter	ATY	85	17.8412	4.57077	.49577
	TY	115	19.3991	4.92381	.45915
Pedicle height (right)	ATY	85	10.8318	2.32390	.25206
	TY	115	9.9496	1.71435	.15986
Pedicle height (left(	ATY	85	10.7329	2.30942	.25049
	TY	115	9.8096	1.65953	.15475
Pedicle width(right)	ATY	85	2.5918	.94708	.10272
	TY	115	1.8835	.60798	.05669

Pedicle width (left)	ATY	85	2.5506	.92320	.10013
	TY	115	1.8165	.57795	.05389

DISCUSSION

The present study attempts to comprehensively assess the various parameters of vertebral body and pedicle in both typical and atypical thoracic vertebrae which is the novel feature of this study. The knowledge of accurate dimensions of thoracic vertebrae is crucial for surgery and instrumentation of the spine and to augment preclinical evaluation of the implants for reliability and safety of the procedures.

The current study was conducted to provide a comprehensive understanding of the vertebral pedicle morphology in typical thoracic vertebrae within the Indian population. A progressive increase in pedicle width was observed as one moves caudally in typical thoracic vertebrae (6). The average pedicle width was measured at 5.65±2.06 mm, which aligns with studies by Datir SP et al. (8) and Pai BS et al[7]. in India but is smaller compared to the findings by Zindrick MR et al. (9) based on data from Western populations. The average pedicle height was found to be 10.35±1.22 mm, which is similar to the results of Singh R et al. (10), Panjabi et al. (11), and Berry et al. (12), but smaller than the measurements reported by Zindrick MR et al. (9) and Datir SP et al. (8). Several studies from both India and abroad have consistently shown that pedicle height is greater than pedicle width, which was also confirmed in the present study.

CONCLUSION

Various morphometric studies on vertebrae have been reported in medical literature as early as nineteenth century. The results of the present study aims to provide a comprehensive data of morphometry of typical and atypical thoracic vertebrae and hereby influence the design of implants used for surgical approaches in spinal fractures and pathology in Indian population.

Conflict of interest: Nil

Funding: Nil

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