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Morphometric Evaluation of Thoracic Pedicles in the Turkish Population: Comparison Between Radiological and Direct Anatomical Measurements

Evaluación Morfométrica de los Pedículos Torácicos en la Población Turca: Comparación Entre Mediciones Radiológicas y Anatómicas Directas

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SUMMARY: The objective of the study was to perform a comprehensive morphometric analysis of thoracic vertebrae in the Turkish population and to evaluate the agreement between CT-based and direct anatomical (dry vertebra) measurements, with a focus on surgical relevance for transpedicular screw placement. A total of 157 thoracic vertebrae were evaluated. Morphometric parameters including vertebral body width, length, height; pedicle width, length, and height; and pedicle transverse and sagittal angles were measured using both CT imaging and direct caliper-based anatomical assessment. Statistical comparisons were performed using the Mann-Whitney U test and Cohen's d effect size. Correlations between vertebral body and pedicle dimensions were assessed using Spearman's correlation analysis. Significant correlations were found between vertebral body dimensions and pedicle morphology, particularly between vertebral body length and pedicle length ($r = 0.812$, $p < 0.001$). Notable differences were observed between CT-based and anatomical measurements, especially in pedicle height, length, and transverse angle ($p < 0.001$). CT-based values tended to be larger than those obtained from direct anatomical measurements. The effect size for some differences (e.g., pedicle width) was small, suggesting limited clinical impact, while others (e.g., pedicle length and height) showed moderate to large discrepancies. This study highlights important morphometric characteristics of thoracic vertebrae in the Turkish population and reveals measurement discrepancies between CT and anatomical methods. These findings emphasize the importance of population-specific morphometric data and suggest caution when relying solely on CT-based measurements—especially in settings where free-hand surgical techniques are used without navigation assistance.

KEY WORDS: Spine; Thoracic vertebrae; Tomography; Anatomy; Cross-sectional; Bone screws.

INTRODUCTION

A vertebra is composed of a vertebral body (corpus vertebrae) and a vertebral arch (arcus vertebrae). The vertebral arch consists of two parts: the pedicle (pediculus arcus vertebrae) and the lamina (lamina arcus vertebrae). The pedicle is located between the vertebral body and the lamina (Standring, 2021). Over the last sixty years, screws inserted into the vertebral body via the pedicles have been widely used in spinal fixation. Pedicle screw fixation is considered a stable and versatile fixation method, even in osteoporotic bone (Roy-Camille *et al*., 1986; Krag *et al*., 1988). Accurate determination of pedicle dimensions is essential for thoracic pedicle fixation. Studies indicate that vertebral pedicle morphometry can exhibit racial differences. Pedicle morphometry measurements are considered essential for creating a comprehensive database. Research on pedicle morphometry is anticipated to help reduce high pedicle perforation rates and enable more accurate preoperative evaluation and planning. Furthermore, morphometric data specific to a particular geographic region will guide clinical diagnosis and management for that population by enhancing the understanding of spinal biomechanics, informing appropriate implant design, and optimizing implant selection (Hou *et al*., 1993; Vaccaro *et al*., 1995; Xu *et al*., 1998; Kim *et al*., 2001; Ugur *et al*., 2001; McLain *et al*., 2002).

This study was conducted to reveal the morphometric measurements of the thoracic vertebrae in the Turkish population and to highlight the potential variations that may be encountered in spinal surgery due to critical adjacency relationships. In addition, this study aimed to investigate

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whether there is a correlation between measurements obtained from CT images on-screen and those performed directly on the vertebrae using physical tools, simulating intraoperative conditions.

MATERIAL AND METHOD

This study was conducted on 157 thoracic vertebrae in the Anatomy Department Laboratory of the Gülhane Faculty of Medicine, Health Sciences University. Vertebrae with compromised integrity were excluded from the study. Definitive information regarding the vertebrae's levels, ages, and sexes was not available. Each vertebra was individually numbered, and morphometric measurements were taken from its anatomical structures.

We volumetrically scanned 157 thoracic vertebrae at a slice thickness of 0.75 mm via a "Siemens Somatom Scope 16-slice CT" scanner. We then reconstructed the images on a workstation to create MPR (multiplanar reconstruction) and 3D reformatted views, and we performed all the measurements using these reconstructed images. All measurements were performed bilaterally. To minimize measurement error, the same researcher conducted all measurements, and a total of 13 parameters were evaluated for each vertebra (Fig. 1).

To evaluate whether intraoperative measurements of the vertebrae would differ from radiological measurements obtained on-screen, additional direct measurements were performed using physical tools. A digital caliper was used for linear measurements, and a digital angle gauge (goniometer) was employed to assess angular parameters. These anatomical measurements were then compared with CT-based measurements to investigate the degree of agreement between radiological planning and actual conditions.

All procedures in the study were performed in accordance with national research committee standards and ethical guidelines for the 1964 Helsinki Declaration and later amendments. The Health Sciences University Gülhane Faculty of Medicine Non-invasive Investigation Ethics Committee approved this study (date: 2025/02, number: 2025-93).

Technique

The measurements in this study were conducted based on the following parameters:

- Transverse (medio-lateral) diameter of the vertebral body (X)
- Sagittal (anterior-posterior) diameter of the vertebral body (Y)
- Height of the vertebral body (H)
- Pedicle width (PW)
- Pedicle height (PH)
- Pedicle length (PL)
- Pedicle sagittal angle (PSA)
- Pedicle transverse angle (PTA)

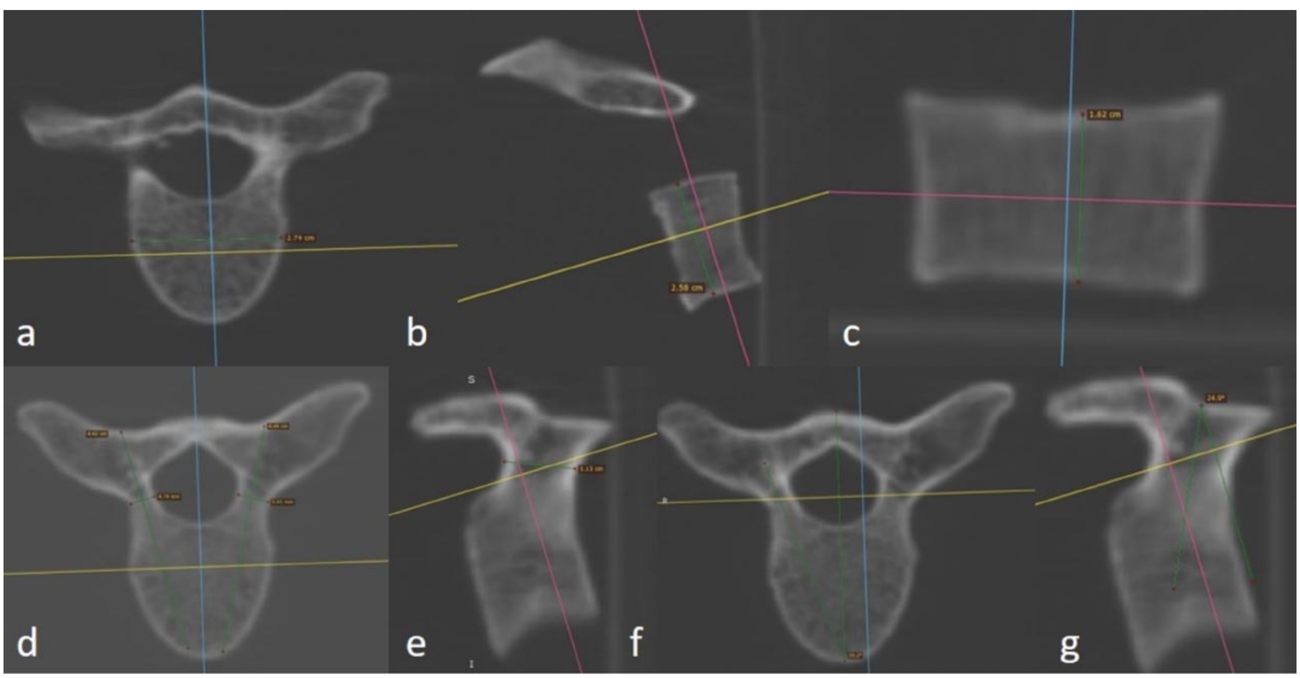

Fig.1. Representative example demonstrating how (a) vertebral body width, (b) length, and (c) height; (d) pedicle width, (d) length, and (e) height; as well as (f) pedicle transverse angle (PTA) and (g) pedicle sagittal angle (PSA) were measured on multiplanar reformatted (MPR) CT images.

1. **Vertebral body width (X):** The widest transverse distance on the superior surface of the vertebral body.
2. **Vertebral body length (Y):** The widest sagittal distance on the superior surface of the vertebral body.
3. **Vertebral body height (H):** The greatest vertical distance measured on the anterior, posterior, right, and left surfaces of the vertebral body.
4. **Pedicle width (PW):** The narrowest external transverse diameter of the pedicle.
5. **Pedicle height (PH):** The narrowest external sagittal diameter of the pedicle.
6. **Pedicle length (PL):** The distance from the posterior cortex of the pedicle, along the pedicle axis, to the anterior vertebral cortex.
7. **Pedicle sagittal angle (PSA):** The angle formed by the pedicle in the sagittal plane, measured between the pedicle axis and the superior margin of the vertebral body in the sagittal plane.
8. **Pedicle transverse angle (PTA):** The angle formed by the pedicle in the transverse plane, measured between the pedicle axis and the presumed midline of the vertebra.

Statistical Analysis

To summarize the study's findings, descriptive statistics for numerical variables were presented in tables based on their distribution, including both mean and median values. Categorical variables were reported as counts and percentages. The normality of numerical variables was assessed using appropriate tests, confirming that the data met the assumptions for parametric analysis. As a result, Spearman correlation test was applied to examine the relationships among vertebral body width, length, and height; pedicle width, length, and height; as well as PTA and PSA.

Following the morphometric analysis, CT-based measurements were compared with direct anatomical measurements to evaluate whether data obtained from cross-sectional imaging accurately reflect the actual anatomical dimensions.

Statistical analyses were performed via ChatGPT 4o and ChatGPT o1 analysis assistants. A p value of <0.05 was considered to indicate statistical significance. Artificial intelligence (AI) tools were used in this study solely to facilitate the application of statistical tests to datasets organized in Microsoft Excel. These tools functioned in a supportive capacity, similar to conventional software such as SPSS or Python, by executing standard statistical analyses upon user request. AI was not involved in the study design, data interpretation, or decision-making processes. All the statistical methods applied adhere to established scientific guidelines and remain fully reproducible when traditional statistical software is used.

RESULTS

A total of 157 thoracic vertebrae from individuals representing the Turkish population were analyzed in this study. The mean vertebral body width (X) was 27.14 ± 3.56 mm, the body length (Y) was 22.64 ± 3.98 mm, and the body height (H) was 17.76 ± 2.54 mm. Pedicle morphometry demonstrated that the right pedicle width, length, and height were 5.0 ± 1.16 mm, 35.51 ± 5.12 mm, and 10.75 ± 1.75 mm, respectively. Corresponding values for the left pedicle were 4.93 ± 1.16 mm (width), 35.23 ± 5.61 mm (length), and 10.83 ± 1.70 mm (height), indicating symmetrical dimensions between sides. Regarding pedicle angulations, the mean transverse angles were 21.26 ± 4.29° on the right and 20.68 ± 4.25° on the left, while sagittal angles were 21.35 ± 2.97° (right) and 21.25 ± 2.84° (left). These findings are summarized in Table I and provide a comprehensive morphometric baseline for thoracic vertebrae in the Turkish population.

Table I. Descriptive statistics of thoracic vertebral measurements in the Turkish population.

Parameter	n	Mean ± SD	Median (min - max)
Vertebral body width (X)	157	27.14 ± 3.56	26.9 (20.6 – 37.1)
Vertebral body length (Y)	157	22.64 ± 3.98	22.6 (12.8 – 32.1)
Vertebral body height (H)	157	17.76 ± 2.54	17.6 (12.2 – 28.3)
Right pedicle width (PW)	157	5.0 ± 1.16	4.97 (2.4 – 9.03)
Right pedicle length (PL)	157	35.51 ± 5.12	36.2 (19.3 – 44.8)
Right pedicle height (PH)	157	10.75 ± 1.75	10.5 (5.05 -16.4)
Left pedicle width (PW)	157	4.93 ± 1.16	4.71 (2.45 – 9.88)
Left pedicle length (PL)	157	35.23 ± 5.61	35.6 (19.2 – 46.7)
Left pedicle height (PH)	157	10.83 ± 1.7	10.6 (5.77 – 15.7)
Right pedicle transverse angle (PTA)	157	21.26 ± 4.29	20.1 (15.9 – 39.5)
Left pedicle transverse angle (PTA)	157	20.68 ± 4.25	19.7 (13.7 – 38.5)
Right pedicle sagittal angle (PSA)	157	21.35 ± 2.97	21.5 (12.7 – 33.1)
Left pedicle sagittal angle (PSA)	157	21.25 ± 2.84	21.05 (12.8 – 29.3)

To assess whether there were statistically significant differences between right and left thoracic pedicle measurements, the Wilcoxon Signed-Rank test was applied. This non-parametric test is particularly useful for comparing paired data that may not follow a normal distribution, making it an appropriate choice for morphometric evaluations where biological variability is common. According to the results, no statistically significant differences were found between the right and left pedicle width, pedicle height, and pedicle sagittal angle (PSA) ($p = 0.1916$, $p = 0.0721$, and $p = 0.6112$, respectively). However, statistically significant differences were observed in pedicle length and pedicle transverse angle (PTA) ($p = 0.0272$ and $p < 0.0001$, respectively). Despite this, the mean difference in pedicle length was only 0.29 mm (±1.86), and the mean difference in PTA was merely 0.58 degrees (±1.02), suggesting that these differences may not be clinically relevant. Overall, it can be concluded that right and left thoracic pedicle measurements are largely symmetrical, and the minimal differences observed are unlikely to have a significant clinical impact (Table II).

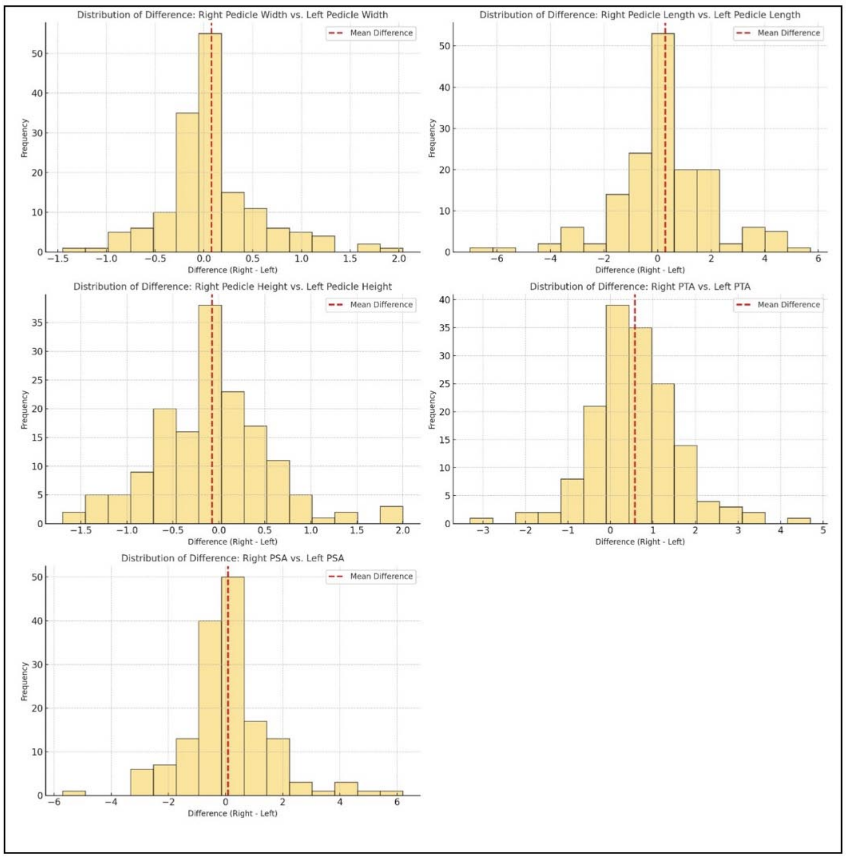

Table II. Comparison of right and left side measurements of thoracic vertebrae using Wilcoxon Signed-Rank Test.

Parameter Comparison	Test Statistic	p-value
Right pedicle width *vs*. Left pedicle width	5314.0	0.1916
Right pedicle lenght *vs*. Left pedicle lenght	4422.5	**0.0272**
Right pedicle height *vs*. Left pedicle height	4445.0	0.0721
Right PTA *vs*. Left PTA	1922.0	**<0.0001**
Right PSA *vs*. Left PSA	5464.5	0.6112

In line with previous findings, right and left pedicle measurements were found to be highly correlated and yielded similar results. In clinical practice, surgeons often rely on one side—typically the right—for preoperative planning. Therefore, in this study, only right-sided pedicle morphometric parameters and angulations were analyzed in relation to vertebral body dimensions (X: width, Y: length, H: height).

Spearman correlation analysis was conducted to assess the relationships between vertebral body and pedicle measurements. Spearman correlation analysis revealed that vertebral body width (X) was moderately correlated with pedicle width ($r = 0.466$, $p < 0.0001$), pedicle length ($r = 0.530$, $p < 0.0001$), and pedicle height ($r = 0.605$, $p < 0.0001$). Vertebral body length (Y) demonstrated a strong positive correlation with pedicle length ($r = 0.812$, $p < 0.0001$) and a moderate correlation with pedicle height ($r = 0.652$, $p < 0.0001$), while its correlation with pedicle width was weak and not statistically significant ($r = 0.120$, $p = 0.1341$). Vertebral body height (H) showed a weak but statistically significant correlation with pedicle width ($r = 0.218$, $p = 0.0062$), and moderate positive correlations with pedicle length ($r = 0.573$, $p < 0.0001$) and pedicle height ($r = 0.704$, $p < 0.0001$). These findings suggest that as vertebral body dimensions increase, corresponding pedicle dimensions—particularly length and height—tend to increase as well (Table III).

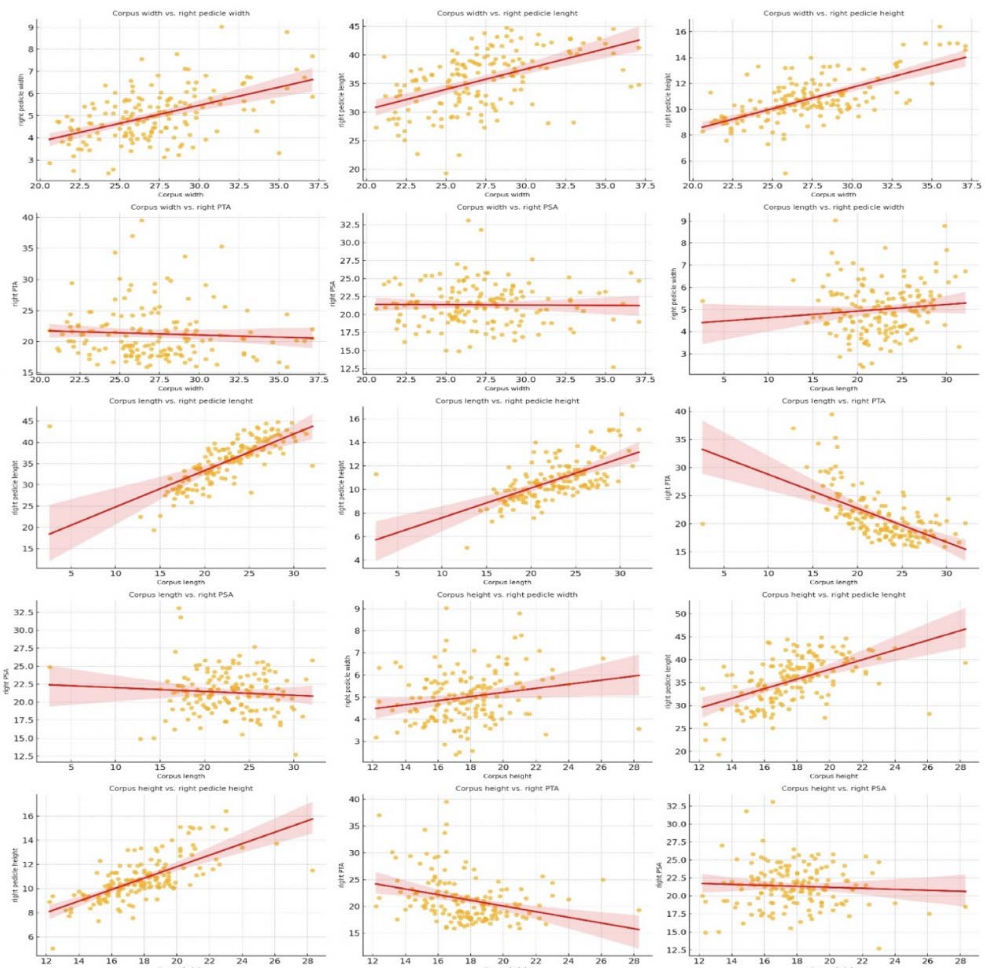

Table III. Spearman correlation between vertebral body and pedicle morphometric measurements.

	Pedicle Width (PW)	Pedicle Length (PL)	Pedicle Height (PH)
Body width (X)	0.466	0.53	0.605
p-value	**<0.0001**	**<0.0001**	**<0.0001**
Body length (Y)	0.12	0.812	0.652
p-value	0.1341	**<0.0001**	**<0.0001**
Body height (H)	0.218	0.573	0.704
p-value	**0.0062**	**<0.0001**	**<0.0001**

r: Spearman correlation coefficient.

Table IV. Spearman correlation between vertebral body dimensions and pedicle angles.

	Pedicle transverse angle (PTA)	**Pedicle sagittal angle (PSA)**
Body width (X)	-0.093	0.014
p-value	0.2477	0.8623
Body length (Y)	-0.661	-0.045
p-value	**<0.0001**	0.5778
Body height (H)	-0.345	-0.014
p-value	**<0.0001**	0.86

r: Spearman correlation coefficient.

Spearman correlation analysis revealed that vertebral body length (Y) was moderately and negatively correlated with pedicle transverse angle (PTA) ($r = -0.661$, $p < 0.0001$), indicating that as vertebral body length increases, the transverse angle tends to decrease. Vertebral body height (H) also showed a weak but statistically significant negative correlation with PTA ($r = -0.345$, $p < 0.0001$). In contrast, vertebral body width (X) demonstrated no significant correlation with either PTA ($r = -0.093$, $p = 0.2477$) or pedicle sagittal angle (PSA) ($r = 0.014$, $p = 0.8623$). Similarly, no statistically significant correlations were observed between vertebral body length or height and PSA ($r = -0.045$ and $r = -0.014$, respectively; $p > 0.05$). These findings suggest that increases in vertebral body length and height may be associated with a narrowing of the pedicle transverse angle, while sagittal angulation appears to remain relatively constant regardless of body dimensions (Table IV).

Finally, thoracic vertebral measurements obtained from CT imaging were compared with direct anatomical measurements using a digital caliper. Statistical comparison using the Mann-Whitney U test revealed no significant difference in corpus width ($p = 0.736$, $d = 0.061$, 95% CI: -0.157 to 0.285) or corpus length ($p = 0.524$, $d = 0.076$, 95% CI: -0.160 to 0.308), indicating excellent agreement between dry vertebra and CT-based measurements. Although corpus height showed a statistically significant difference ($p = 0.021$), the effect size was small ($d = 0.186$, 95% CI: -0.043 to 0.434), suggesting that the practical discrepancy may be limited. More pronounced differences were observed in pedicle-related parameters, especially pedicle length ($p < 0.001$, $d = -0.523$, 95% CI: -0.753 to -0.300) and pedicle height ($p < 0.001$, $d = -0.446$, 95% CI: -0.681 to -0.196), which revealed moderate effect sizes and potential overestimation by CT measurements. Although a statistically significant difference was found in pedicle width ($p = 0.015$), the effect size was very small (Cohen's $d = -0.163$, 95% CI: -0.413 to 0.060), indicating that the discrepancy is likely not clinically meaningful (Table V).

Pedicle angle measurements obtained from CT imaging were compared with direct anatomical measurements performed using a digital goniometer on dry vertebrae. A statistically and clinically significant difference was observed in the transverse pedicle angle ($p < 0.001$, Cohen's $d = -1.36$), indicating that CT may overestimate the actual transverse angle. However, no significant difference was found in sagittal angle measurements ($p = 0.70$, Cohen's $d = -0.12$), suggesting good agreement between CT and anatomical measurements in the sagittal plane (Table V).

DISCUSSION

The pedicles are the strongest components of the vertebrae and are located between the vertebral body and the neural arch (Standring, 2021). The present study was conducted to provide morphometric data on the thoracic vertebrae in the Turkish population. Morphometric measurements of the pedicles are essential in vertebral surgery and have been shown to vary across different ethnic groups. However, such data are currently insufficient for the Turkish population. Transpedicular spinal fixation is a commonly used surgical technique. Accurate morphometric data on vertebral pedicles are crucial for preoperative planning of appropriate screw dimensions. Furthermore, detailed knowledge of vertebral morphometry is critical for minimizing the risk of neurovascular injury (Demiroz & Erdem, 2020).

The morphometric results obtained in this study were compared with those reported in previous studies conducted in India, other Asian countries, and the United States.

Knowledge of both pedicle width and height is essential in transpedicular spinal fixation surgery, particularly for the selection of appropriate screw diameters. Singh *et al*. (2011) reported the smallest pedicle width as 3.61?±?0.66 mm. Morita *et al*. (2021) found values greater than this, while Zindrick *et al*. (1987) reported a minimum pedicle width of 4.5?±?0.9 mm. In our study, this parameter was measured as 2.4?±?1.16 mm on CT images and 2.3?±?1.43 mm on dry bone specimens (Zindrick *et al*., 1987; Singh *et al*., 2011; Morita *et al*., 2021).

We believe that these inter-study variations are due to both racial differences and discrepancies in measurement techniques. Measurements obtained from dry vertebrae tend to be lower than those derived from CT scans (as highlighted in the results section, although there was a statistically significant difference between CT and anatomical measurements of pedicle width, the effect size was very small). Based on our findings, smaller screw diameters may be required for the Turkish population.

In line with our findings, Datir & Mitra (2004) emphasized that the screw diameter in the mid-thoracic region should be less than 4 mm, suggesting 5 mm screws for T1, T2, T9, and T10, and 6 mm screws for T11 and T12. Since the vertebral levels of the dry bones in our study were not identifiable, a level-specific comparison could not be performed. However, considering that our mean values were smaller than those reported by Datir & Mitra (2004) it is suggested that even smaller screw diameters should be considered for use in the Turkish population.

Verma *et al*. (2020) reported pedicle height measurements ranging from a minimum of 3.65?±?0.4 mm to a maximum of 15.45?±?0.78 mm. Morita *et al*. (2021) recorded larger values, while Zindrick *et al*. (1987) reported a minimum pedicle height of 9.9?±?2.0 mm and a maximum of 17.4?±?2.5 mm. In our study, the pedicle height was measured as 5.05 mm (minimum) to 16.4 mm (maximum) in CT-based assessments, and from 7.62 mm to 18.4 mm in direct anatomical measurements (Zindrick *et al*., 1987; Verma *et al*., 2020; Morita *et al*., 2021).

Morita *et al*. (2021) reported pedicle length values ranging from 33.5?±?2.3 mm to 48.5?±?5.7 mm. Zindrick *et al*. (1987) found minimum and maximum pedicle lengths of 35.7?±?4.7 mm and 45.4?±?4.8 mm, respectively. In our study, pedicle length measured by CT ranged from 19.2 mm to 46.7 mm, whereas in direct anatomical measurements it ranged from 22.00 mm to 42.86 mm (Zindrick *et al*., 1987; Morita *et al*., 2021.)

Pedicle length and height is a critical parameter in transpedicular spinal fixation surgery, particularly for determining the appropriate screw length and diameter. Selecting a screw that exceeds the pedicle height can result in cortical breach, which may lead to neurological injury by

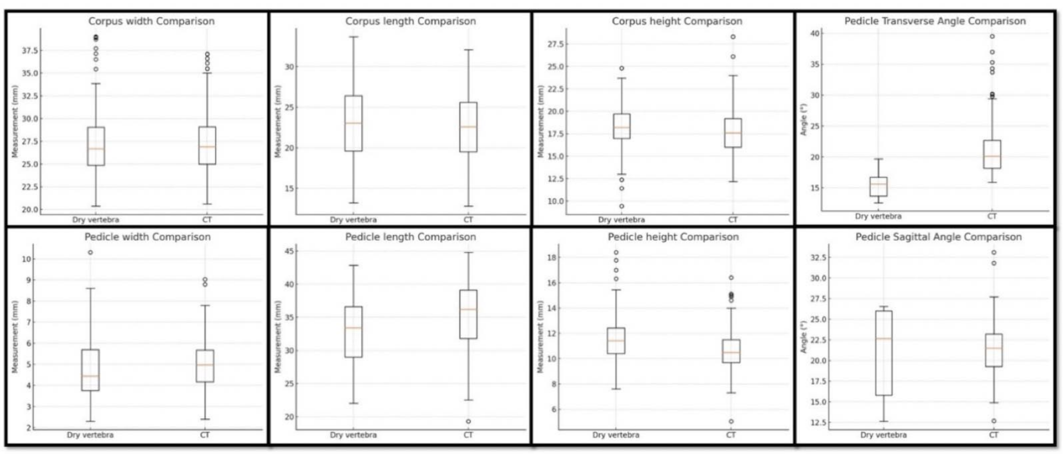

Table V. Morphometric comparison between CT-Based and direct anatomical (dry vertebra) measurements using the Mann-Whitney U Test.

Parameter	U values	p-value	Cohen's d	%95 CI
Corpus Width	12596.5	0.7357	0.061	[-0.157-0.285]
Corpus Length	12837.5	0.524	0.076	[-0.16-0.308]
Corpus Height	14178.0	**0.0212**	0.186	[-0.043-0.434]
Pedicle Width	10363.5	**0.0148**	-0.163	[-0.413-0.06]
Pedicle Lenght	8663.0	**<0.0001**	-0.523	[-0.753-(-0.3)]
Pedicle Height	16079.0	**<0.0001**	-0.446	[-0.27-0.701]
PTA	222.0	**<0.0001**	-1.36	[-1.686-(-1.098)]
PSA	1491.5	0.702	-0.12	[-0.831-0.593]

Variables did not follow a normal distribution. Effect sizes are reported as Cohen's d with 95% confidence intervals.

damaging the dural sac or neural elements within the vertebral canal, and to vascular injury on the lateral side. In transpedicular spinal fixation surgery, selecting a screw longer than the pedicle length may result in screw protrusion beyond the vertebral body, posing a risk of injury to critical structures located in the posterior mediastinum, such as the esophagus, thoracic aorta, azygos vein, hemiazygos vein, and thoracic duct. Conversely, the use of a screw that is smaller than optimal may compromise fixation strength and stability (Kim *et al*., 2004; Weise *et al*., 2008; Chua *et al*., 2019).

Morita *et al*. (2021) reported PTA ranging from 5.3° to 31.6°. Singh *et al*. (2011) found a broader range, with values between 10.03° and 32.26°, while Zindrick *et al*. (1987) documented angles from 4.2° to 26.6°. In our study, the PTA was measured between 13.7° and 39.5° on CT scans and between 12.6° and 19.7° in direct anatomical measurements (Zindrick *et al*., 1987; Singh *et al*., 2011; Morita *et al*., 2021).

Singh *et al*. (2011) reported PSA ranging from 3.31° to 16.15°, while Zindrick *et al*. (1987) measured PSA values between 11.6° and 17.5°. Verma *et al*. (2020) documented a slightly wider range, with values between 9.55° and 19.22°. In our study, PSA values ranged from 12.7° to 33.1° based on CT measurements and from 12.65° to 26.55° in direct anatomical assessments (Zindrick *et al*., 1987; Singh *et al*., 2011; Verma *et al*., 2020).

Accurate control of pedicle screw trajectory angles—both transverse and sagittal—is of paramount importance in spinal surgery. Improper angulation in either plane can lead to serious iatrogenic complications. An excessive medial angulation may lead to screw breach into the vertebral canal, potentially resulting in nerve root injury and, in severe cases, postoperative neurological deficits such as paralysis. Conversely, an overly lateral screw trajectory may cause the tip of the screw to penetrate the lateral pedicle wall, increasing the risk of injury to vital posterior mediastinal structures and associated complications (Gautschi *et al*., 2011; Gümüs¸suyu *et al*., 2021; Mulyadi *et al*., 2024).

Similarly, improper sagittal angulation carries distinct risks. If the angle is too steep, the screw may perforate the inferior pedicle wall, potentially damaging spinal nerve roots. On the other hand, insufficient sagittal angulation may cause superior wall breach, leading to intervertebral disc injury and associated complications. These observations underscore the necessity of detailed preoperative morphometric evaluation and individualized screw trajectory planning based on vertebral anatomy (Wu *et al*., 2010; Takata *et al*., 2023).

These findings indicate that both PTA and PSA values obtained from CT imaging tend to be higher than those derived from direct anatomical assessment, potentially due to methodological differences such as imaging perspective, measurement tools, or specimen condition. Moreover, statistically significant differences were observed between CT-based and direct anatomical measurements of pedicle height, length, and PTA in our morphometric analysis.

The marked discrepancies in these specific dimensions highlight the potential limitations of relying solely on CT-based data for surgical planning. These findings emphasize the need for caution during intraoperative navigation and, where feasible, support the use of direct anatomical landmarks alongside radiological measurements to improve procedural safety and accuracy.

This study has several limitations that should be considered when interpreting the results. First, the vertebral levels of the dry bone specimens used for direct anatomical measurements could not be precisely identified, which limited the ability to perform level-specific comparisons. Second, although both CT and direct anatomical measurements were obtained from the same 157 thoracic vertebrae, this number represents a relatively limited sample size. As such, the statistical power of subgroup analyses may be insufficient, and studies with larger and more diverse sample populations are needed to validate and generalize these findings. Additionally, factors such as age, sex, and degeneration status of the specimens were not accounted for, which may influence pedicle morphology. Despite these limitations, the study offers valuable morphometric data for the Turkish population and provides insight into the discrepancies between radiological and anatomical measurements.

CONCLUSION

This study provides a comprehensive morphometric analysis of thoracic vertebrae in the Turkish population, revealing significant correlations between vertebral body dimensions and pedicle morphology. Additionally, the comparison between CT-based and direct anatomical measurements identified notable discrepancies, particularly in pedicle length, height, and angulation. These differences underscore the importance of careful preoperative planning and the potential benefit of correlating radiological data with anatomical references to optimize implant selection and trajectory. Our findings highlight the need for population-specific morphometric databases to improve the safety and accuracy of transpedicular screw placement—particularly in surgical settings where expensive computer-assisted navigation systems are not available and traditional free-hand techniques are more commonly used.

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RESUMEN: El objetivo del estudio fue realizar un análisis morfométrico exhaustivo de las vértebras torácicas en la población turca y evaluar la concordancia entre las mediciones basadas en tomografía computarizada (TC) y las mediciones anatómicas directas (vértebras secas), con especial atención a su relevancia quirúrgica para la colocación de tornillos transpediculares. Se evaluaron un total de 157 vértebras torácicas. Se midieron parámetros morfométricos, incluyendo el ancho, la longitud y la altura del cuerpo vertebral; el ancho, la longitud y la altura del pedículo; y los ángulos transversal y sagital del pedículo, utilizando tanto imágenes de TC como evaluación anatómica directa con calibrador. Las comparaciones estadísticas se realizaron mediante la prueba U de Mann-Whitney y el tamaño del efecto d de Cohen. Las correlaciones entre las dimensiones del cuerpo vertebral y del pedículo se evaluaron mediante el análisis de correlación de Spearman. Se encontraron correlaciones significativas entre las dimensiones del cuerpo vertebral y la morfología del pedículo, particularmente entre la longitud del cuerpo vertebral y la longitud del pedículo ($r = 0{,}812$, $p < 0{,}001$). Se observaron diferencias notables entre las mediciones basadas en TC y las anatómicas, especialmente en la altura, la longitud y el ángulo transversal del pedículo ($p < 0{,}001$). Los valores basados en TC tendieron a ser mayores que los obtenidos mediante mediciones anatómicas directas. El tamaño del efecto para algunas diferencias (p. ej., ancho del pedículo) fue pequeño, lo que sugiere un impacto clínico limitado, mientras que otras (p. ej., longitud y altura del pedículo) mostraron discrepancias de moderadas a grandes. Este estudio destaca características morfométricas importantes de las vértebras torácicas en la población turca y revela discrepancias de medición entre los métodos de TC y anatómicos. Estos hallazgos destacan la importancia de los datos morfométricos específicos de la población y sugieren precaución al confiar únicamente en mediciones basadas en TC, especialmente en entornos donde se utilizan técnicas quirúrgicas a mano alzada sin asistencia de navegación.

PALABRAS CLAVE: Columna vertebral; Vértebras torácicas; Tomografía; Anatomía; Corte transversal; Tornillos óseos.

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