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RADIOGRAPHIC EVALUATION OF THE RELATIONSHIP BETWEEN SPINAL CANAL AREA AND THE ANATOMIC DIMENSIONS OF THE SPINAL CANAL AT THE THORACOLUMBAR JUNCTION IN THE TURKISH POPULATION

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ABSTRACT

***Aim**:* To investigate the relationship between spinal canal area and the anatomic dimensions of the spinal canal at the thoracolumbar junction measured by computed tomography (CT) in the Turkish population.

***Materials and Methods**:* The retrospective study reviewed the CT records of 100 consecutive patients that presented to the emergency services in Koc University Hospital. Measurements were performed for the anatomic dimensions of the spinal canal in both T12 and L1 by the same physician. The anatomic dimensions of the spinal canal including pediculolaminar angle, interlaminar angle, bipedicular base distance, spinal canal anterior-posterior (AP) diameter, spinal canal transverse diameter, and spinal canal area were measured and their relationships with spinal canal area were analyzed.

Results: The 100 patients comprised 62 (62%) women and 38 (38%) men with a mean age of 48 (range, 16-87) years. A significant difference was found between T12 and L1 with regard to bipedicular base distance in women and no significant difference was found between T12 and L1 in both men and women. In both T2 and L1, although spinal canal area had no significant correlation with the pediculolaminar and interlaminar angles, it had a moderate correlation with spinal canal transverse diameter, spinal canal AP diameter, and bipedicular base distance.

***Conclusion**:* The results indicated that no significant relationship was found between spinal canal area and the pediculolaminar and interlaminar angles while a significant relationship was found between spinal canal area and spinal canal transverse diameter, spinal canal AP diameter, and bipedicular base distance in both T12 and L1. Moreover, no significant relationship was found between age and spinal canal area in these vertebrae.

Key words: Spinal canal area, bipedicular base distance, AP diameter.

INTRODUCTION

Morphometric analysis of the spine has been performed in numerous radiographic studies via computed tomography (CT) or magnetic resonance imaging (MRI) (1,6). Some of these studies focused on selected areas in the spine while the others examined the whole spine (4,9). Moreover, while some of these studies focused on either children or old-age individuals, the others evaluated both patient groups (7,10).

Spinal disorders resulting from traumatic, degenerative, and inflammatory conditions lead to spinal canal stenosis which has been associated with an increased risk of spinal cord injury. Literature indicates that the thoracolumbar junction (T12-L1) is the most common site for lumbar spine injury (8). In the present study, we investigated the relationship between spinal canal area and the anatomic dimensions of the spinal canal measured by computed tomography (CT) in T12 and L1 and we also evaluated the effect of age on the changes in spinal canal in the Turkish population. Additionally, we evaluated the measurements for both genders.

MATERIALS AND METHODS

The retrospective study reviewed the CT records of 100 consecutive patients that presented to the emergency services in Koc University Hospital and underwent thoracolumbar CT for any reason and had no signs of fracture. Patients with prior surgery in the thoracolumbar junction were excluded from the study. The patients were initially evaluated as a whole group and then were evaluated and compared in two groups: men and women. Measurements were performed for the anatomic dimensions of the spinal canal in both T12 and L1. These measurements included pediculolaminar angle (angle between the pedicle and lamina), interlaminar angle (angle between two laminae), bipedicular base distance (distance between two pedicle base), spinal canal anterior-posterior (AP) diameter, spinal canal transverse diameter, and spinal canal area (Figure-1).

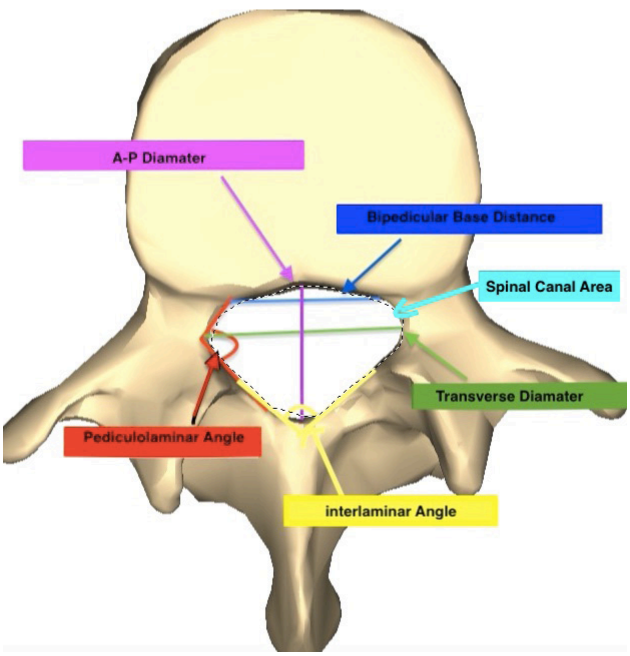

Figure-1. Schematic representation of measurements

Relationships between spinal canal area and the anatomic dimensions of the spinal canal were analyzed. Moreover, correlation between age and spinal canal area was also examined. All the CT scans (Siemens, Munich, Germany) were obtained in an axial plane using a standardized protocol. The images were reviewed on a PACS workstation (General Electric Healthcare, Little Chalfont, United Kingdom). All the measurements were performed by the same physician.

Statistical analysis

Sample size was determined using the following formula: n= t2pq/d2. In this formula;

n: total number of individuals to be included in the sample

t: theoretical value calculated according to the T-distribution table based on a certain significance level

p: probability of occurrence

q: probability of nonoccurrence

d: deviation from prevalence (sampling error)

Correlations between numerical data were analyzed using Pearson's Correlation Coefficient. Means were compared between the two groups using Independent Samples *t*-test.

RESULTS

The 100 patients comprised 62 (62 %) women and 38 (38 %) men with a mean age of 48 (range, 16-87) years. Bipedicular base distance was significantly larger in T12 compared to L1 (p=0.037), although no significant difference was found in the other dimensions (Table-1).

Table-1. Comparison of measurements in T12 and L1

		n	Mean	SD	*p*
A-P diameter (mm)	T12	100	17.92	1.55	0.691
	L1	100	17.82	1.71	
Transverse diameter (mm)	T12	100	24.07	2.30	0.224
	L1	100	24.46	2.18	
Bipedicular base distance (mm)	T12	100	18.18	2.04	**0.037**
	L1	100	18.75	1.78	
Pediculolaminar angle (^{0})	T12	100	96.41	11.23	0.267
	L1	100	98.06	9.59	
Spinal canal area (mm^2)	T12	100	265.44	38.46	0.625
	L1	100	268.14	39.53	
Interlaminar angle (^{0})	T12	100	105.92	12.24	0.089
	L1	100	108.33	6.96	

SD: Standard deviation; p<0.05

A significant difference was found between T12 and L1 with regard to bipedicular base distance in women (p=0.035) while no significant difference was found in men (p=0.450). In the remaining dimensions, however, no significant difference was found between T12 and L1 in both men and women (p>0.05) (Tables-2, 3).

Table-2. Comparison of measurements in T12 and L1 in women					
		n	Mean	SD	p
A-P diameter (mm)	T12	62	17.84	1.54	0.905
	L1	62	17.88	1.61	
Transverse diameter (mm)	T12	62	23.77	2.16	0.278
	L1	62	24.22	2.33	
Bipedicular base distance (mm)	T12	62	17.96	1.94	**0.035**
	L1	62	18.68	1.75	
Pediculolaminar angle (^{0})	T12	62	97.70	11.45	0.855
	L1	62	98.06	10.34	
Spinal canal area (mm^2)	T12	62	262.80	39.39	0.527
	L1	62	267.30	38.88	
Interlaminar angle (^{0})	T12	62	104.07	14.54	0.063
	L1	62	108.02	7.65	

SD: Standard deviation; $p<0.05$

Table-3. Comparison of measurements in T12 and L1 in men					
		n	Mean	SD	p
A-P diameter (mm)	T12	38	18.03	1.56	0.461
	L1	38	17.74	1.87	
Transverse diameter (mm)	T12	38	24.53	2.47	0.549
	L1	38	24.83	1.89	
Bipedicular base distance (mm)	T12	38	18.52	2.17	0.450
	L1	38	18.87	1.83	
Pediculolaminar angle (^{0})	T12	38	94.40	10.81	0.100
	L1	38	98.06	8.41	
Spinal canal area (mm^2)	T12	38	269.55	37.08	0.989
	L1	38	269.43	41.00	
Interlaminar angle (^{0})	T12	38	108.80	6.55	0.993
	L1	38	108.82	5.78	

SD: Standard deviation; $p<0.05$

Correlation analysis

Anatomic dimensions in T12

Spinal canal area had no significant correlation with pediculolaminar angle (r=-0.006; n=100; p=0.949) and interlaminar angle (r=0.109; n=100; p=0.279) for both genders. However, spinal canal area had a moderate correlation with spinal canal transverse diameter (r=0.729; n=100; p=0.000), spinal canal AP diameter (r=0.620; n=100; p=0.000), and bipedicular base distance (r=0.620; n=100; p=0.000). On the other hand, no correlation was found between age and the measurements in T12.

In women, no significant correlation was found between spinal canal area and pediculolaminar angle (r=0.078; n=62; p=0.578) and interlaminar angle (r=0.030; n=62; p=0.818). However, spinal canal area had a moderate correlation with spinal canal transverse diameter (r=0.678; n=62; p=0.000), spinal canal AP diameter (r=0.650; n=62; p=0.000), and bipedicular base distance (r=0.597; n=62; p=0.000).

In men, no significant correlation was found between spinal canal area and pediculolaminar angle (r=-0.132; n=38; p=0.431). However, spinal canal area had a moderate correlation with spinal canal transverse diameter (r=0.806; n=38, p=0.000), spinal canal AP diameter (r=0.562; n=38; p=0.000), and bipedicular base distance (r=0.646; n=38; p=0.000). Additionally, a slight correlation was found between spinal canal area and interlaminar angle (r=0.358, n=38, p=0.027).

Anatomic dimensions in L1

Spinal canal area had no significant correlation with pediculolaminar angle (r=-0.079; n=100; p=0.434) and interlaminar angle (r=0.081; n=100; p=0.423). A moderate correlation was found between spinal canal area and spinal canal transverse diameter (r=0.716; n=100; p=0.000), spinal canal AP diameter (r=0.703; n=100; p=0.000), and bipedicular base distance (r=0.530; n=100; p=0.000). However, no correlation was found between age and the measurements in L1.

In women, no significant correlation was found between spinal canal area and pediculolaminar angle (r=-0.109; n=62; p=0.398) and interlaminar angle (r=0.187; n=62; p=0.146). However, a moderate correlation was found between spinal canal area and spinal canal transverse diameter (r=0.651; n=62; p=0.000), spinal canal AP diameter (r=0.677; n=62; p=0.000), and bipedicular base distance (r=0.516; n=62; p=0.000).

In men, no significant correlation was found between spinal canal area and pediculolaminar angle (r=-0.025; n=38;

p=0.880) and interlaminar angle (r=-0.143; n=38; p=0.391). However, a moderate correlation was found between spinal canal area and spinal canal transverse diameter (r=0.857; n=38, p=0.000), spinal canal AP diameter (r=0.745; n=38; p=0.000), and bipedicular base distance (r=0.548; n=38; p=0.000).

DISCUSSION

Thoracolumbar junction (T12-L1) is the most common site for traumatic spine injury [14]. In the present study, we measured the anatomic dimensions of the spinal canal in T12 and L1 and calculated mean values for each of them. Moreover, we also evaluated the age-related changes in spinal canal area. Previous anatomical and radiographic studies have indicated that spinal canal area can vary based on age, gender, and ethnic differences [2,12]. Depending on this finding, we evaluated spinal canal area in the Turkish population.

Numerous morphometric studies have documented significant relationships between spinal canal area and the anatomic dimensions of the spinal canal [8]. In our study, although no significant relationship was found between spinal canal area and the pediculolaminar and interlaminar angles for both genders, a significant relationship was found between spinal canal area and bipedicular base distance, spinal canal transverse diameter, and spinal canal AP diameter. Similarly, cadaveric studies have also indicated a significant correlation between spinal canal area and spinal canal AP diameter [8].

A study conducted in 2011 evaluated transaxial CT images and found a significant relationship between lateral recess angle and spinal canal area [13]. In our study, however, no significant relationship was found between spinal canal area and the pediculolaminar and interlaminar angles.

The spinal canal AP diameter has been shown to have the strongest correlation with spinal canal area and also to be an indicator of spinal canal diameter [3]. In our study, spinal canal AP diameter as well as bipedicular base distance and spinal canal transverse diameter were also found to have a significant correlation with spinal canal area.

A morphometric study of thoracic vertebrae reported that the mean spinal canal AP diameter was 17.2 mm in both T12 and L1 [1]. Similarly, in our study, mean spinal canal AP diameter was 17.9 mm and 17.8 mm in T12 and L1, respectively. Additionally, spinal canal area was 265.4 mm^2 and 268.1 mm^2 in T12 and L1, respectively.

A morphometric study conducted in the Korean population revealed that the spinal canal AP diameter decreased from L1 to L3 and increased from L3 to L5 and also noted that the mean spinal canal diameter was 15.4 mm in L1, 13.8 mm in L3, and 14.4 mm in L5 [7]. These findings implicate that spinal canal area varies across ethnic groups.

It is commonly known that spinal canal becomes narrower as a person grows older, due to age-related degenerative processes [5]. However, we found no relationship between age and spinal canal stenosis. This finding could be attributed to several notions. First, spinal canal stenosis associated with degenerative processes mostly occurs in the lower lumbar spine and rarely at the thoracolumbar junction. Secondly, the measurement of spinal canal diameters by CT in lieu of MRI and at the pedicular level could have affected the measurement outcomes in our study [11].

CONCLUSION

The results indicated that no significant relationship was found between spinal canal area and the pediculolaminar and interlaminar angles while a significant relationship was found between spinal canal area and spinal canal transverse diameter, spinal canal AP diameter, and bipedicular base distance in both T12 and L1. Moreover, no significant relationship was found between age and spinal canal area in these vertebrae. Further studies are needed to substantiate our findings.

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