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MORPHOMETRY OF THE LUMBAR SPINE IN TURKISH PEOPLE

TÜRK TOPLUMUNDA LOMBER OMURGANIN MORFOMETRİK ÖZELLİKLERİ

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SUMMARY:

Objectives: At present, due to advances in neuroradiological imaging techniques, computer-aided MRI measurements can be conducted on personal computers. In this way, we performed measurements of lumbar MR images digitally to obtain the lumbar spinal canal diameter in sagittal and axial MR cross-sections, in order to acquire a standard national value for a Turkish population. Our study included a group of 200 patients (105 female, 95 male) who applied to our outpatient clinic with lower back pain.

Methods: We divided the patients into three groups: the first group were those under the age of 40 (109 people), the second group were those between the ages of 41 and 60 (64 people) and the third group were those over the age of 61 (27 people). Measurements of the canal diameter were made at the following locations: axial cross-section measurements from the facet joint level, front–rear diameter and left–right diameter measurements from the level where the canal was broadest, and sagittal cross-section measurements from the cross-sections where the vertebral canal was broadest. When the sagittal cross-section measurements were performed, the range was taken from the exact middle of the corpus to the farthest middle point of the lamina by taking the dural sac as the border. Height and width measurements of the corpus were made from the middle points. At the axial cross-section, the canal inner area was measured.

Findings: The largest canal diameter was 15.1 mm, obtained from the sagittal cross-section of the lumbar first spine (sL1), whilst the smallest value was 12.8 mm from the sagittal cross-section of the lumbar fourth spine (sL4). In all patients, while the average canal diameter decreased from sL1 to sL3, in sL4 and sL5 a diameter increase was observed. When comparison was done by age, the canal diameter from sL1 to sL4 was inversely proportional to age.

Results: The values for the canal diameter of the lumbar spine and the corpus height vary with age, gender and the level of measurement.

Key words: Spinal stenosis, spinal stenosis, lumbar morphometry, canal diameter.

Level of Evidence: Retrospective clinical study, Level III

ÖZET:

Amaç: Günümüzde nöroradyolojik görüntüleme tekniklerinin ilerlemesi ile birlikte bilgisayar destekli MR ölçümleri artık kişisel bilgisayarlarda yapılabilmektedir. Bu çalışmada polikliniğimize bel ağrısı nedeniyle başvurup MR çekilen 200 hastanın (105 kadın, 95 erkek) lomber MR görüntülerinin dijital ortamda ölçümleri yapılarak Türk toplumunun lomber spinal kanal çapının sagittal ve aksiyel MR kesitlerinde ortalamasını hesaplayıp belli bir standart toplumsal değer elde edilmesi amaçlanmıştır.

Yöntem: Hastaları üç gruba ayrılmış, 1. grup 40 yaş altı (109 kişi), 2. grup 41-60 yaş arası (64 kişi) ve 3. grup 61 yaş ve üzeri (27 kişi) olarak oluşturulmuştur. Aksiyel kesitlerde, faset eklem seviyesinden, ön-arka çap ve sağ sol çap kanalın en geniş olduğu seviyeden, sagittal kesitlerde ise vertebral kanalın en geniş görüldüğü kesitlerden kanal çapı ölçülmüştür. Sagittal kesit ölçülürken korpusun tam ortasından laminanın en uzak orta noktasına dural kese sınır olacak şekilde ölçüm yapılmıştır. Korpusun yükseklik ve genişlik ölçümü orta noktalardan yapılmıştır. Aksiyel kesitte kanal iç alanı da hesaplanmıştır.

Bulgular: En büyük kanal çapı; lomber birinci omurganın sagittal kesitinde elde edilen 15.1 mm, en küçük değer ise lomber dördüncü omurganın sagittal kesitinde çıkan 12.8 mm' dir. Tüm hastalar da ortalama kanal çapı L1 den L3'e gittikçe azalırken L4 ve L5'te çap artış görülmüştür. Yaşlara göre mukayese yaptığımızda ise L1 den L4'e kadar kanal çapı yaşla ters orantı göstermektedir.

Sonuç: Lomber omurganın kanal çapı ve korpus yüksekliğine aşa, cinsiyete ve ölçüldüğü seviyeye göre değişkenlik gösterdiği sonucuna varılmıştır.

Anahtar Kelimeler: Spinal stenoz, lomber morfometri, kanal çapı

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

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INTRODUCTION:

Lower back pain is a health problem commonly seen in all populations. Lumbar spinal stenosis (LSS) is the most common reason for chronic lower back pain, especially for elderly individuals. Patients with LSS are individuals that have long-term lower back pain that is characterized by degenerative changes in the joint complexes providing spinal movement and by symptoms resulting from pressure due to these changes. A narrowing of the canal occurs as a result of changes in the bone and connective tissues around the spinal canal and nerve root canal, disc degeneration, ligament and facet hypertrophy, and osteophyte formation[9,11]. The sagittal diameter of the lumbar spinal canal varies between 15 and 25 mm. If the canal is less than 15 mm, it is defined as relative stenosis, while if the canal is less than 12 mm, it is defined as absolute stenosis[6].

Based on morphometric studies that have been previously performed, both in Turkish populations and in other populations, the aim of this study is to reveal the morphometric features of the lumbar spine in a Turkish population, to calculate the average spinal canal diameter, and therefore to determine clinical symptoms in spinal stenosis cases.

MATERIALS AND METHODS:

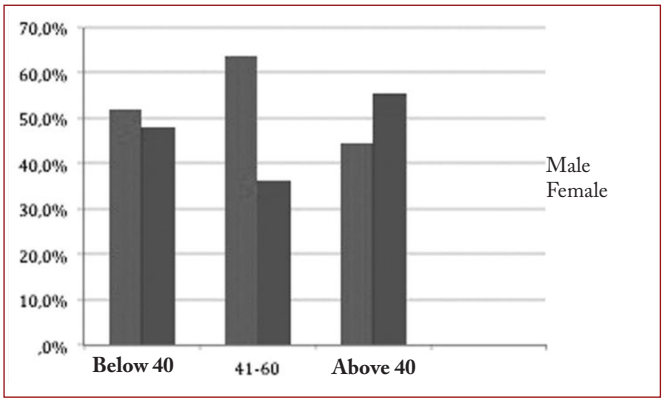
200 patients (105 female, 95 male) who were admitted to our clinic with lower back pain and who received MRIs were included in this study. The patients were divided into three groups. The first group contained those patients under the age of 40 (109 patients), the second group contained those between the ages of 41 and 60 (64 patients) and the third group contained those patients over the age of 61 (27 patients).

When the female–male distribution was considered, the number of males was lowest in group 3, the number of males was about twice as high as females in group 2, and the distribution was similar in the other group (Table-1).

All of the MR images were measured by the same person. Because some MRIs were taken outside the center, any patients who did not meet the measurement standards, had coronal or sagittal plane deformities, did not have images of all lumbar levels, and had MRIs outside a suitable measurement program, were excluded.

To perform the measurements, the patient MRIs were opened on a computer by DVD with the eFilm Lite Software 1998-2003, Merge eMed Program, and the transverse and axial sections were examined. The measurements were performed in T2 sections, where better separation of the soft tissue was available.

Table-1. Gender distribution of the groups



All lumbar vertebral canal diameters (antero–posterior and transverse) and the spinal canal area were measured in mm in the axial sections, and the heights of vertebrae and antero–posterior diameters were measured in mm in the sagittal plane.

While the axial sections were being measured, the antero–posterior diameter and right left diameter were measured at the level where the canal was the widest. When the sagittal section was measured, this was performed with the osseous diameter from the center of the corpus to the farthest midpoint of the lamina (Figure-1).

The data obtained from the study were analyzed by IBM PASW® Statistics 17.0 (SPSS Inc. IBM, Illinois, USA). Kolmogorov-Smirnov tests were used to determine whether the obtained data fit a normal distribution. Because all of the data fit a normal distribution, parametric tests were used for statistical analyses. After separation of the data according to specific features, the Student's t-test was used to understand the differences between the groups. A p-value less than 0.05 was considered significant.

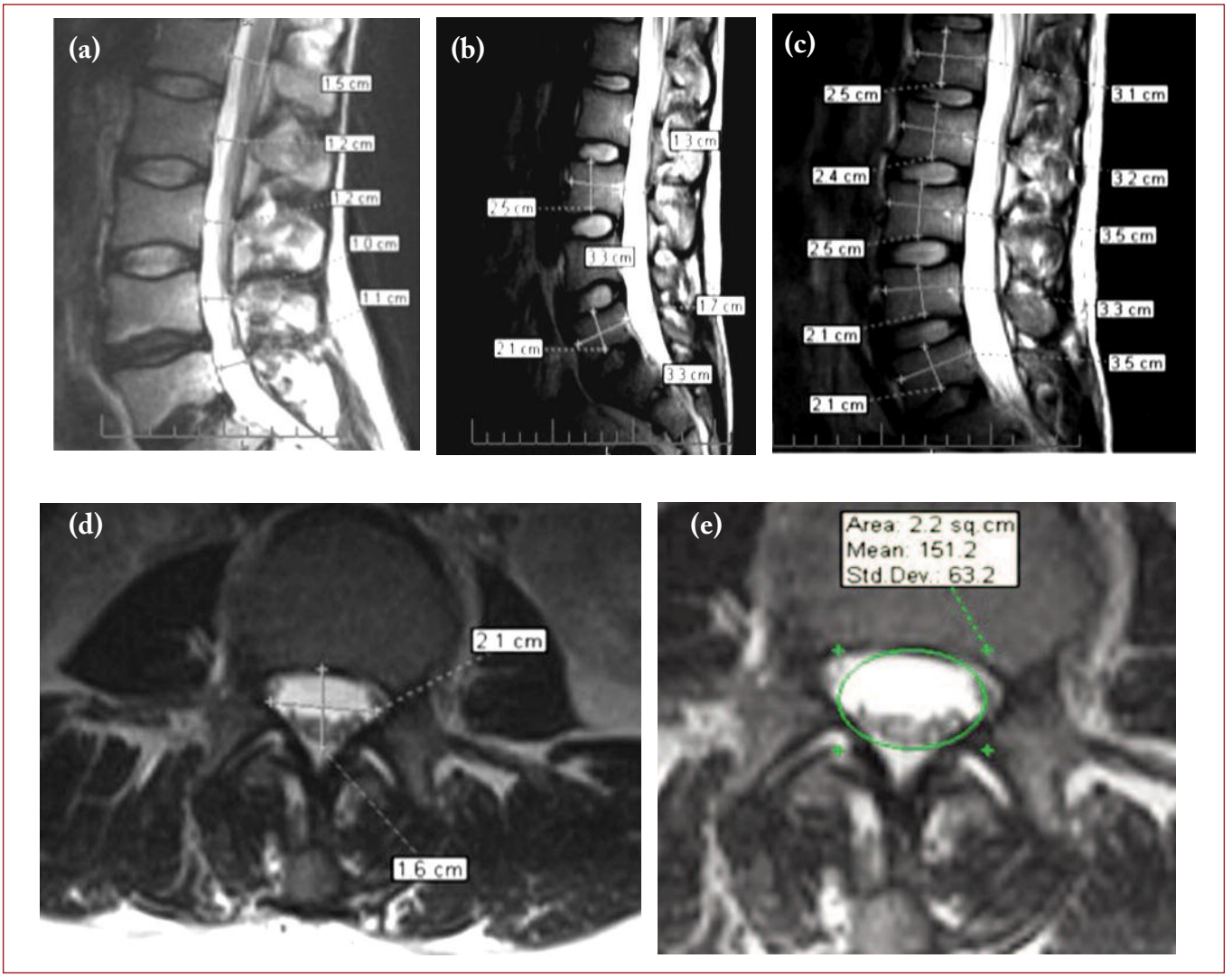


Figure-1. a) C hannel diameter measurement in sagittal sections was performed at the level where the canal is widest. **b,c)** Measurement of height and length of corpus in sagittal sections, **d)** Measurement of antero-posterior and right-left diameter of the canal in axial sections, **e)** Measurement canal area in axial sections.

RESULTS:

The largest canal diameter was 15.1 mm in group 1, and the lowest value was 12.8 mm at the L4 level in group 2 and 3. While the average canal diameter decreased from L1 to L3 in all patients, the diameter increased at levels L4 and L5. When we compared the results according to age, there was an inverse ratio between age and canal diameter from L1 to L4 (Table-2).

In young patients (Group-1), while the spinal canal was wide at the L1–2 levels, it gradually decreased toward L5, and the narrowest diameter was measured at L5. In patients aged 61 and over, the narrowest level was found at L4 and it was observed that the canal expanded again at L5 (Table-3).

In the sagittal sections, the antero–posterior diameters of the lumbar vertebrae gradually increased from L1 to L5 in the three groups. The height of the corpus increased from L1 to L4 in groups 1 and 2, and it decreased at L5. In group 3, there was no discernible pattern. While the antero–posterior diameter of the corpus increased from L1 to L5, the height of the corpus increased from L1 to L5 and then decreased at L5 (Table-4).

Table-2. The average canal diameter values of the patients in sagittal sections.
(Group 1: below age 40, group 2: between ages 41–60, group 3: over age 61, sL: lumbar canal diameter in sagittal section)

Groups		Case number	Average diameter	Between range, average * Lower limit	Std. Deviation Upper limit	95% confidence	Minimum	Maximum
Sagittal	1	109	1.51	0.19	1.48	1.55	0.8	1.9
L1	2	64	1.46	0.22	1.41	1.51	1	1.93
	3	27	1.45	0.17	1.39	1.52	1.1	1.8
Sagittal	1	109	1.43	0.19	1.39	1.47	0.7	1.9
L2	2	64	1.37	0.22	1.31	1.42	1	1.9
	3	27	1.34	0.2	1.26	1.42	0.94	1.8
Sagittal	1	109	1.36	0.17	1.32	1.39	0.8	1.79
L3	2	64	1.31	0.2	1.26	1.36	0.82	1.9
	3	27	1.3	0.19	1.22	1.37	0.69	1.6
Sagittal	1	109	1.37	0.19	1.33	1.41	1	1.9
L4	2	64	1.28	0.24	1.22	1.34	0.68	2.1
	3	27	1.28	0.23	1.19	1.37	0.61	1.76
Sagittal	1	109	1.39	0.22	1.34	1.43	0.82	1.9
L5	2	64	1.36	0.25	1.29	1.42	0.8	2.1
	3	27	1.37	0.18	1.29	1.44	0.89	1.75

Table-3. The average canal diameters measured in axial sections.

(aLxRL: right–left diameters in axial MRI section taken from x level of lumbar vertebra, aLxAP: antero–posterior diameters in axial MRI section taken from x level of lumbar vertebra, aLxa: areas in axial MRI section taken from x level of lumbar vertebra)

Groups		Case number	average diameter	BetweenStd. Deviation range, average *Lower limit	Upper limit	95% Confidence	Minimum	Maximum
Axial	1	109	1.81	0.32	1.75	1.87	1.2	2.5
L1RL	2	64	1.7	0.4	1.6	1.79	0.9	2.5
	3	27	1.54	0.44	1.36	1.71	0.5	2.4
Axial	1	109	1.57	0.22	1.53	1.61	1	2
L1AP	2	64	1.48	0.22	1.43	1.54	0.9	2
	3	27	1.42	0.25	1.32	1.52	0.99	2.09
Axial	1	69	1.92	0.44	1.82	2.03	1	2.9
L1a	2	36	1.83	0.44	1.69	1.98	1	2.9
	3	27	1,56	0.42	1.39	1.72	1	2.4
Axial	1	109	1.74	0.3	1.69	1.8	1	2.5
L2RL	2	64	1.61	0.38	1.52	1.71	0.9	2.47
	3	27	1.53	0.44	1.36	1.7	0.6	2.3
Axial	1	109	1.48	0.19	1.45	1.52	1	2
L2AP	2	64	1.42	0.24	1.36	1.47	0.85	2.2
	3	27	1.39	0.19	1.32	1.47	0.89	1.8
Axial	1	69	1.82	0.4	1.72	1.92	0.9	2.8
L2a	2	36	1.74	0.48	1.58	1.9	0.8	3
	3	27	1.51	0.33	1.38	1.64	0.9	2.4
Axial	1	109	1.66	0.3	1.61	1.72	1.1	2.4
L3RL	2	64	1.51	0.37	1.42	1.6	0.66	2.4
	3	27	1.4	0.36	1.25	1.54	0.84	2.2
Axial	1	109	1.48	0.23	1.43	1.52	0.9	2
L3AP	2	64	1.39	0.25	1.33	1.45	0.85	2.2
	3	27	1.34	0.24	1.24	1.43	0.84	1.9
Axial	1	69	1.7	0.37	1.61	1.79	0.8	2.5
L3a	2	36	1.52	0.45	1.37	1.67	0.8	3
	3	27	1.37	0.37	1.23	1.52	0.8	2.3
Axial	1	109	1.58	0.3	1.52	1.63	0.8	2.4
L4RL	2	64	1.48	0.39	1.38	1.58	0.5	3
	3	27	1.31	0.35	1.17	1.45	0.8	2.2
Axial	1	109	1.42	0.24	1.37	1.46	0.9	2.1
L4AP	2	64	1.33	0.28	1.26	1.4	0.9	2.1
	3	27	1.27	0.24	1.18	1.37	0.86	1.92
Axial	1	69	1.56	0.45	1.45	1.67	0.5	2.8
L4a	2	36	1.44	0.59	1.24	1.64	0.5	3.3
	3	27	1.3	0.32	1.17	1.43	0.7	2.1
Axial	1	109	1.56	0.29	1.51	1.62	0.7	2.5
L5RL	2	64	1.45	0.34	1.36	1.53	0.98	2.5
	3	27	1.38	0.33	1.25	1.51	0.84	2.1
Axial	1	109	1.4	0.23	1.35	1.44	0.81	2
L5AP	2	64	1.33	0.29	1.26	1.4	0.9	2.2
	3	27	1.33	0.22	1.24	1.41	0.94	1.8
Axial	1	69	1.55	0.43	1.45	1.65	0.6	3
L5a	2	36	1.35	0.51	1.17	1.52	0.7	3.3
	3	27	1.36	0.37	1.21	1.5	0.8	2.2

When the average sagittal canal diameter was compared by gender, it was found that the sagittal lumbar canal diameter was wider at all levels in males than in females. However, a statistically significant difference was only detected at the L3, L4 and L5 levels, not at the L1 and L2 levels (Table-5).

It was found that the sizes of the lumbar vertebrae in sagittal sections were larger in males than in females, but a statistically significant difference was only found for four parameters. These parameters were the right–left canal diameter at the L2 level, the spinal canal area at both the L4 and L5 levels, and the spinal canal antero–posterior diameter at the L5 level. Based on these parameters, the differences between females and males were at lumbar levels such as L3, L4 and L5 (Table-6).

Table-4. The average corpus lengths and heights.

Groups		Case number	Average diameter	btw Std. dev. range average *Lower limit	Upper limit	95% Confidence	Minimum	Maximum
Corpus	1	61	2.76	0.3	2.68	2.83	2	3.4
APL1	2	31	2.79	0.37	2.65	2.93	2.2	3.7
	3	27	2.57	0.34	2.43	2.71	1.6	3.5
Corpus	1	61	2.34	0.2	2.29	2.39	1.9	2.8
HL1	2	31	2.22	0.23	2.14	2.3	1.7	2.6
	3	27	2.23	0.15	2.17	2.28	1.9	2.6
Corpus	1	61	2.92	0.27	2.85	2.99	2.2	3.4
APL2	2	31	2.99	0.32	2.87	3.11	2.3	3.9
	3	27	2.71	0.39	2.56	2.87	2.3	3.8
Corpus	1	61	2.42	0.2	2.37	2.48	1.9	2.9
HL2	2	31	2.31	0.2	2.24	2.39	1.9	2.8
	3	27	2.21	0.19	2.14	2.28	2	2.6
Corpus	1	61	3.09	0.31	3.01	3.17	2.5	3.8
APL3	2	31	3.11	0.4	2.96	3.25	1.6	3.9
	3	27	2.97	0.46	2.78	3.15	1.3	3.7
Corpus	1	61	2.44	0.2	2.39	2.49	2	2.8
HL3	2	31	2.3	0.2	2.22	2.37	1.8	2.7
	3	27	2.32	0.19	2.24	2.39	1.8	2.7
Corpus	1	61	3.16	0.32	3.08	3.25	2.6	3.9
APL4	2	31	3.23	0.43	3.08	3.39	1.7	3.9
	3	27	3.09	0.44	2.92	3.27	1.4	3.9
Corpus	1	61	2.46	0.22	2.41	2.52	2.1	3.1
HL4	2	31	2.35	0.2	2.28	2.42	2	2.8
	3	27	2.34	0.18	2.27	2.41	2	2.8
Corpus	1	61	3.21	0.34	3.12	3.29	2.6	3.8
APL5	2	31	3.29	0.45	3.13	3.46	1.6	4.1
	3	27	3.13	0.27	3.03	3.24	2.8	3.6
Corpus	1	61	2.36	0.22	2.3	2.41	1.9	2.8
HL5	2	31	2.24	0.2	2.17	2.32	1.9	2.9
	3	27	2.23	0.19	2.16	2.31	1.7	2.6

Table-5. The average results of sagittal canal diameter according to gender and t test.

Groups		Case number	Average diameter	Btw Std. dev. Range average		95% Confidence	Min.	Max.	t	p
				*Lower limit	Upper limit					
sL1	Female	73	1.48	0.19	1.44	1.53	1.1	1.8	-1.207	0.23
	Male	63	1.52	0.18	1.48	1.57	1	1.9		
sL2	Female	73	1.4	0.18	1.35	1.44	0.94	1.8	-1.662	0.099
	Male	63	1.45	0.21	1.4	1.51	1	1.9		
sL3	Female	73	1.32	0.19	1.28	1.36	0.69	1.7	-2.906	0.004
	Male	63	1.41	0.15	1.37	1.45	1.2	1.9		
sL4	Female	73	1.3	0.2	1.26	1.35	0.61	1.8	-3.219	0.002
	Male	63	1.41	0.21	1.36	1.47	1	2.1		
sL5	Female	73	1.34	0.17	1.3	1.38	0.89	1.7	-3.339	0.001
	Male	63	1.45	0.21	1.4	1.51	1.1	2.1		

Table-6. Comparison of canal diameters measured in axial sections between genders. (Shaded boxes are the data with statistically significant differences, $p<0.05$ or $p<0.001$)

Groups		Case number	Average diameter	Btw Std Dev range average		95% confidence	Min.	Max.	t	p
				*lower limit	Upper limit					
aL1RL	Female	73	1.78	0.36	1.69	1.86	0.5	2.5	-1.874	0.063
	Male	63	1.89	0.35	1.8	1.98	1	2.5		
aL1AP	Female	73	1.51	0.22	1.46	1.57	0.99	2.09	-0.635	0.527
	Male	63	1.54	0.24	1.48	1.6	1	2		
aL1a	Female	69	1.81	0.43	1.71	1.91	1	2.9	-0.371	0.711
	Male	63	1.84	0.49	1.72	1.96	1	2.9		
aL2RL	Female	73	1.69	0.37	1.61	1.78	0.6	2.5	-2.225	0.028
	Male	63	1.83	0.32	1.75	1.9	1.15	2.4		
aL2AP	Female	73	1.47	0.22	1.42	1.52	0.89	2.2	-0.077	0.939
	Male	63	1.47	0.19	1.42	1.52	1	1.9		
aL2a	Female	69	1.69	0.42	1.59	1.79	0.8	2.8	-1.358	0.177
	Male	63	1.79	0.43	1.68	1.9	1	3		
aL3RL	Female	73	1.6	0.31	1.53	1.68	0.84	2.2	-1.308	0.193
	Male	63	1.68	0.36	1.59	1.77	0.9	2.4		
aL3AP	Female	73	1.45	0.23	1.4	1.51	0.84	2	-0.598	0.551
	Male	63	1.48	0.26	1.41	1.54	0.9	2.2		
aL3a	Female	69	1.56	0.38	1.47	1.65	0.8	2.5	-0.677	0.5
	Male	63	1.61	0.45	1.5	1.72	0.8	3		
aL4RL	Female	73	1.49	0.33	1.41	1.57	0.8	2.2	-1.274	0.205
	Male	63	1.57	0.4	1.47	1.67	0.8	3		
aL4AP	Female	73	1.35	0.27	1.29	1.42	0.86	2.1	-1.118	0.266
	Male	63	1.4	0.24	1.34	1.46	0.9	2		
aL4a	Female	69	1.39	0.43	1.29	1.49	0.5	2.4	-2.108	0.037
	Male	63	1.56	0.52	1.43	1.69	0.6	3.3		
aL5RL	Female	73	1.45	0.25	1.39	1.51	0.84	2.1	-1.561	0.121
	Male	63	1.53	0.35	1.44	1.62	0.7	2.5		
aL5AP	Female	73	1.34	0.23	1.29	1.39	0.9	1.9	-2.18	0.031
	Male	63	1.43	0.25	1.37	1.49	0.9	2.2		
aL5a	Female	69	1.35	0.36	1.27	1.44	0.7	2.6	-2.818	0.006
	Male	63	1.57	0.51	1.44	1.7	0.6	3.3		

DISCUSSION:

Central spinal stenosis is a pathological narrowing of the spinal canal that causes pressure on the dural sac and/or nerve roots. Knowledge of the canal diameter of elderly patients with lower back pain is important in terms of differential diagnosis[4]. According to a study performed using CT by Karantanas et al., a spinal canal antero–posterior diameter less than 11.5 mm, an interpedicular width less than 16 mm and a spinal canal area less than 14.5 mm^2 at the pediculolaminar level were found to be significant for stenosis[7]. According to another study performed with CT by Ulrich et al., they defined a canal width at the mid-sagittal diameter greater than 11.5 mm or a canal area greater than 14.5 mm^2 [13]. Verbiest et al. stated that a canal diameter between 10–13 mm is accepted as relative spinal stenosis, and a canal diameter of less than 10 mm is accepted as absolute spinal stenosis[14].

It is not known from which level and which sections the values given in these studies were measured. The measurements of the canal diameter were performed on cadavers or CT sections, indicating that soft tissues such as the ligamentum flavum and the posterior longitudinal ligament narrowing the dural sac were not considered.

In this study, it was detected that various average values were revealed, according to which lumbar vertebral level the canal diameter was measured at, which direction it was measured in, and in which age group. When we compared by age, as the age increased from L1 to L4 the canal diameter decreased. In other words, there was an inverse ratio with age, and while the patients below the age of 40 had the widest canal diameter, the patients over the age of 60 had the narrowest canal diameter. In measurements performed at the L4 level, the diameter was the same in patients aged between 41 and 60 and those aged over 61, while at level L5, the diameter of the patients aged over 61 was greater than those aged between 41 and 60.

In the measurements performed on 100 CTs by Abbas et al., they calculated the average antero–posterior diameter of L3 vertebrae in axial sections (Axial L3AP) as 16.1 mm, while we calculated the antero–posterior diameter of L3 vertebrae as 14.3 mm. While they calculated the antero–posterior diameter of the L4 vertebrae (axial L4AP) as 16.7 mm, we calculated this as 13.4 mm. While they calculated the antero–posterior diameter of L5 vertebrae (axial L5AP) as 17.0 mm, we calculated it as 13.5 mm[1]. We concluded that these differences were due to the fact that our measurements were taken from MRIs, and CT measurements ignore soft tissues, such as the posterior longitudinal ligament and ligamentum flavum.

According to a study performed using CT by Dowart et al., the sagittal canal diameter increased from L1 to L4 and then decreased after L4 [5]. These findings are similar to the measurements that we obtained. In our study, the average canal diameter also decreased from L1 to L4, and increased from L5.

According to a study by Penning et al., and a retrospective study in Turkey that included 63 patients who received surgery due to stenosis by Adilay et al., the L3–4 level has been reported as the most common level at which stenosis occurs[2,9,12]. Based on measurements performed on axial sections of young patients, it has been shown that, while the spinal canal is wide at high

levels such as L1 and L2, it gradually decreases towards the L5 level, and the narrowest diameter has been measured at the L5 level. Particularly in patients over the age of 61, L4 was the narrowest level and the canal diameter again increased at the L5 level. This finding sheds light on why spinal stenosis occurs most frequently at the L3–L4 levels.

In a study performed by Amonoo-Kuofi in a Nigerian population and a study performed by Piera et al. in a Spanish population, they found that the average sagittal diameter of female lumbar vertebrae was narrower than that of male lumbar vertebrae[4,10]. According to these studies, the canal diameter of male vertebrae was wider than that of female vertebrae, and statistically significant differences were measured at the lower lumbar levels, such as L3, L4 and L5.

It is known that the height, width and depth of the vertebral corpus increase[15]. Conversely to the literature, we observed that the antero–posterior diameter of the corpus increased from L1 to L5. In our study, the height of vertebrae increased from L1 to L4 and then decreased at the L5 level.

Limitations of our study are that the measurements were performed by only one person, and there was no control group with stenosis for comparison of the average values.

Our study shows that the size of vertebrae and the spinal canal diameter and area vary according to the vertebral level, age and gender. However, broader studies with higher levels of evidence are needed to confirm these data, particularly in a Turkish population, and to determine which measurements are significant in representing a decrease relevant for a diagnosis of spinal stenosis.

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