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Research Article

Clinical and Radiological Analysis of Dural Sac Diameter in Lumbar Spinal Stenosis

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Abstract

Objectives: Lumbar spinal stenosis (LSS) is a severe degenerative disease that affects the human spine. The relationship between its symptoms and dural sac diameter is not apparent. In this study, we investigated the relationship between clinical signs of LSS and morphological parameters using magnetic resonance imaging (MRI) data.

Methods: A total of 218 patients included in the study. All patients were divided into two groups(group A- the level of the dural sac diameter <70 mm^2 and group B- the level of the dural sac diameter >70 mm^2). Clinical signs as the estimated walking distance (EWD), visual analog scale (VAS) and Oswestry disability index (ODI).

Results: MRI data, and types of surgery recorded for each patient. Decompressive laminectomy and fusion (DL+F) or unilateral laminotomy bilateral decompression (ULBD) preferred in 76 patients of this group.

Conclusion: Magnetic resonance imaging (MRI) has an essential role in the diagnosis of LSS. Our study showed a positive correlation between dural sac diameter and EWS, VAS and ODI values on axial T2-weighted MR images of patients undergoing surgery.

Keywords: Lumbar spinal stenosis, magnetic resonance

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Magnetic resonance imaging (MRI) has an important role in the diagnosis of spinal stenosis. Lumbar spinal stenosis (LSS) is a very serious degenerative disease that affects the human spine. Degenerative lumbar canal stenosis often occurs with disc bulging, ligamentum flavum thickness, and facet joint hypertrophies.[22, 33] In many studies today, the dural sac cross-sectional area (DSA) 70-80 mm^2 is used as a marker of stenosis. The limit value in which the neurological signs of central spinal stenosis occur is 75 mm^2 for DSA.[17, 18] In this article, ıt was analyzed preoperatively the relationship between the clinical symptoms of the patients and the DSA values measured in MRI as well as the states of the patients undergoing surgery.

Methods

Between 2016 and 2017, a total of 218 patients diagnosed as degenerative LSS by a specialist radiologist and neurosurgeon were included in the study. Clinical signs, MRI results and operative methods of each patient were collected. EWD, grade: I- (<100 m), II- (100-500 m), III- (500-1.000 m), and IV- (>1.000 m), VAS in a horizontal line (between 1-10), and ODI, 1-0% to 20% minimal disability, 2-20% to 40% moderate disability, 3-40% to 60% severe disability, 4-60% to 80% disabled, 5-80% to100% crippled as evaluation criteria were recorded in all patients. Conventional lumbar MRI was performed preoperatively. The number of

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stenosis levels was evaluated. For diagnosis, 70 mm^2 critical diameter (Shönnström criteria) of DSA was used as the objective diagnostic criteria. All patients were divided into two groups (group A- the level of the dural sac diameter <70 mm^2 and group B- the level of the dural sac diameter >70 mm^2). The narrowest level area of the dural sac diameter <70 mm^2 and the number of spondylolisthesis were check-ups. In this study, the patients with degenerative LSS who were suffering from low back pain with or without leg pain, the patients older than 50 years old,vertebral fracture in history were included. Of these patients, 76 patients underwent decompressive laminectomy and fusion (DL+F) or unilateral laminotomy bilateral decompression (ULBD).

Statistics

For discrete and continuous variables, descriptive statistics (mean, standard deviation, and percentile) were given. A chi-square test was used for determining the relationships between two discrete variables. When the expected sources were less than 20%, values were determined through the Monte Carlo Simulation Method to include such sources in the analysis. The data were evaluated via SPPS 20 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.). P<0.05 and p<0.01 were taken as significance levels.

Statistical Analysis

Although there was no significant correlation between preoperative DSA and the severity of single-level symptoms (p=0.883), the patients were undergoing surgery on a single level seen a statistically significant relationship found between EWD and DL+F categories (p<0.05) and between VAS and ULBD categories (p<0.05). On multiple levels; There was a statistically significant relationship between DL+F and ULBD categories (p<0.05) with ODI.

Results

Of the patients included in the study, 158 (72.47%) were female and 60 (27.53%) were male. The mean age was 67.70 in females and 68.62 in males. EWD mean values in 154 (70.64%) patients with grade I and II levels, VAS mean values between 5-6, 7-8 in 185 (84.86%) patients, ODI result moderate and severe disability in 136 (66.97%) patients, also in 13 (5.9%) patients were seen disabled (Table 1).

Table 1. Demographics of patients, EWD, VAS, ODI results

Gender	Female	Male	Total		
%	72.47	27.53	100		
n	158	60	218		
Average age	67.70	68.62			
EWD	Grade I	Grade II	Grade III	Grade IV	
	58	96	50	14	
VAS	**0-2**	**3-4**	**5-6**	**7-8**	**9-10**
	2	24	93	92	7
ODI	**0-20**	**20-40**	**40-60**	**60-80**	**80-100**
	62	81	55	13	–

EWD: Estimated walking distance; VAS: Visual analog scale; ODI: Oswestry disability index.

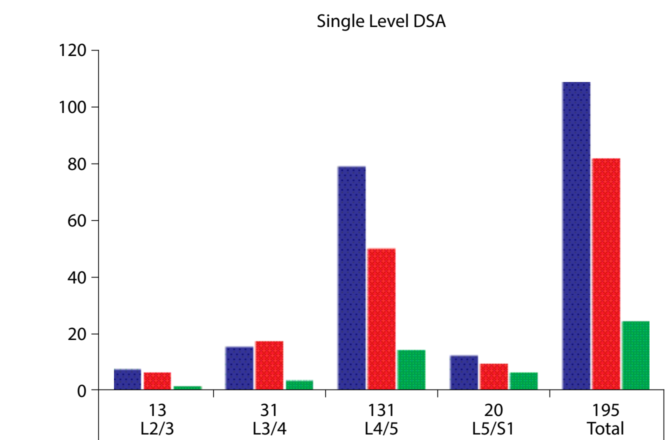
On the comparison of quality of life criteria of the groups with DSA; the In first group (A), the number of patients at the single level was 113 (58.83%). It observed to EWD mean values were grade 1.84 (100-500 m). VAS mean values were 6.72 moderate pain severity. ODI results moderate and severe disability in 77 patients, disabled in 6 patients. In the second group (B), the number of patients at a single level was 82 (37.61%). EWD mean values were grade 2.28 (100-500 m), VAS values were 6.00 moderate pain, with ODI results mild and moderate disability in 59 patients, and disabled in 3 patients. The patients with multiple level stenoses were 23 (10.55%). 23 patients had multiple levels of DSA stenosis, their EWD (1.69) and VAS (6.82) averaged those with one level of stenosis, but ODI results showed moderate and severe disability in 17 patients. 3 patients had serious disability (Table 2).

L4/5 and L3/4 distances were frequently affected in patient groups. Multiple DSA stenosis and spondylolisthesis were also observed in L4/5 distances (Fig. 1–3). There was no statistically significant relationship between DSA and single

Table 2. Preoperative estimated walking distance (EWD), leg and back pain (VAS) and oswestry disability index (ODI), the dural sac cross-sectional area (DSA)- mean values

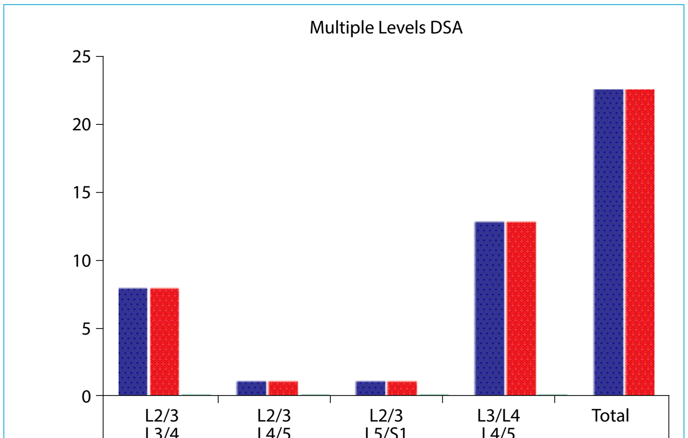
mm^2	n	DSA	EWD	VAS	ODI					Operation	
Single	195				0-20	20-40	40-60	60-80	80>	DL+F	ULBD
<70	113	44	1.84	6.72	30	43	34	6	–	34	8
>70	82	108. 3	2.28	6	30	29	20	3	–	21	8
Multiple	23										
<70	23		1.69	6.82	3	12	5	3	–	2	3
Total	218					57	19				

DSA: Dura cross-sectional area; EWD: Estimated walking distance; VAS: Visual analog scale; ODI: Oswestry disability index.



	13 L2/3	31 L3/4	131 L4/5	20 L5/S1	195 Total
<0.70	7	15	79	12	113
>0.70	6	17	50	9	82
Lystesis	1	3	14	6	24

Figure 1. Between the L2-3 and L5-S1 levels, single level dural sac cross-sectional area (DSA).

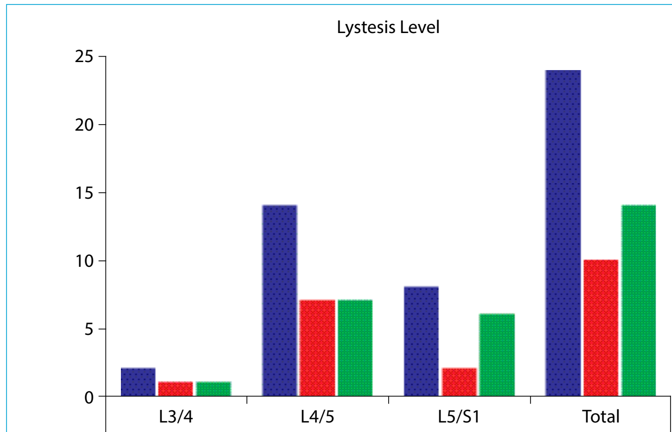


	L2/3 L3/4	L2/3 L4/5	L2/3 L5/S1	L3/L4 L4/5	Total
n	8	1	1	13	23
<70	8	1	1	13	23
>70	0	0	0	0	

Figure 2. Between the L2-3 and L5-S1 levels, multiple levels dural sac cross-sectional area (DSA).

level variables (p=0.833). There is no statistical significance of the distribution of DSA variable in a single level as below or above 70 mm^2 with L2/3, L3/4, L4/5, L5/S1 categories as in Figure 1. There was no statistically significant relationship between DSA and multıple levels (p=0.999) and listesis levels (p=0.686).

Twenty patients out of 34 patients who underwent DL+F from group A were operated with EWD grade I (<100 m). A statistically significant relationship was found between EWD and DL+F categories (p<0.05). The mean VAS of 14 patients of group A+B-total 16 patients was moderate and severe leg and back pain and was administered ULBD. There



	L3/4	L4/5	L5/S1	Total
n	2	14	8	24
<0.70	1	7	2	10
>0.70	1	7	6	14

Figure 3. Between the L2-3 and L5-S1 levels, lysthesis levels.

was also a statistically significant relationship between the ULBD categories with VAS (p<0.05). The distributions in the variables that are statistically insignificant are completely random (Table 3).

Surgical Procedure

Seventy-six patients with DL+F and ULBD diagnosed with lumbar spinal stenosis were included in the study. In group A, DL+F performed in 34 patients, ULBD in 8 patients, 21 patients in Group B, and eight patients in ULBD. Preoperative EWD, VAS, and ODI results of both groups were determined. In conclusion, preoperative EVD and VAS mean values were similar in group A and Group B patients. However, ODI results showed that DL+F surgery performed for patients with severe disabilities in group A and B and ULBD applied for patients with moderate impairment in group B. Besides from multiple-level stenosis underwent three patients with DL+F and two patients with ULBD (Table 3).

Discussion

Lumbar spinal stenosis is the most common degenerative spine disease in middle-aged and elderly patients.[1, 2, 22, 33] It is caused by hypertrophy of facet joints, reduction in disc height with or without an intervertebral disc herniation and as a result of ligamentum flavum hypertrophy.[8, 16] Back and leg pain, intermittent neurological claudication, and urinary retention occur. MRI is an examination method that has been selected to diagnose spinal stenosis in patients who are over 60 years of age.[18] For LSS, some studies reveal the relationship between symptoms and signs and morphological parameters in MRI.[5, 6, 18, 19, 22, 23] These studies focus on the dura cross-sectional area (DSA), spinal canal cross-sectional area (SCA), ligamentum flavum cross-sectional area (LFA) and ligamentum flavum thickness (LFT).[27]

Table 3. Analysis of clinical markers with preoperative DSA in patients undergoing laminotomy

Operation	n	DSA	EWD				VAS				ODI			
Single		(mm²)	I	II	III	IV	0-4	5-8	9-10	0-20	20-40	40-60	60-80	80>
DL+F	34	<0.70	20	12	2	1	1	30	3	2	4	23	5	–
	21	>0.70	5	13	3	1	1	17	3	–	6	13	2	–
p			0.047	0.621	0.372									
ULBD	8	<0.70	–	8	–	–		8	–	–	6	2	–	–
	8	>0.70	1	7	–	–	2	6	–	6	2	–	–	–
p			0.302	0.032	0.429									
Multipl														
DL+F	2	<0.70	2	–	–	–	2	–	–	–	–	–	2	–
ULBD	3	<0.70	1	2	–	–	2	–	–	1	2	–	–	–
p			0.088	0.361	0.046									
Total	76		29	42	5	2	8	61	6	9	20	38	9	

DSA: Dura cross-sectional area; EWD: Estimated walking distance; VAS: Visual analog scale; ODI: Oswestry disability index; ULBD: Unilateral laminotomy bilateral decompression.

The most common diagnosis of radiological LSS is assessed by DSA measurement.[13–15, 28] Clinical diagnosis is based on patient history, examination, and supportive imaging methods showing spinal canal narrowing. We purposed in this study to correlate between the DSA measurement with clinical impairment in patients with lumbar spinal stenosis. DSA was measured by conventional MRI. In patients with single and multiple spinal canal stenosis, preoperative symptoms were compared. In our patient groups, the mean age was 67.70 in females and 68.62 in males. Preoperative EWD, VAS values, and ODI results adversely affected our patients over 60 years of age, causing neurological dysfunction and disability symptoms in some patients. It observed in single-level stenosis that walking capacity decreased, the severity of back and leg pain was moderate and severe, disability or loss of function developed from mild to severe dependence on the bed.Few studies have identified any significant correlation between the severity of stenosis on MRI and clinical disability.[7, 25, 29] In the sensitivity studies between DSA and SCA in lumbar stenosis, a positive relationship between preoperative high VAS results and narrow DSA reported.[19] Our study showed a correlation between the moderate leg and back pain scores and a small dural sac area. In our study, it observed that the small dural cross-sectional area adversely affected the lives of patients with moderate and severe low back pain and walking distance of less than 500 m. The mean DSA of the patients in group A was 44 mm². However, studies are showing that EWD results are not a specific marker and other factors may be active.[20] The relationship between spinal canal stenosis and ODI is also essential. Although many articles show the relationship between the degree of stenosis and ODI, some authors reported that there was no correlation between MRI results and ODI.[5, 7, 18, 32] In our study, it observed that the results of ODI in group A and group B patients were affected from minimal neurological dysfunction to severe disability. Many other factors may play a role in determining the onset and progression of clinical impairment in patients with spinal stenosis. Various clinical and radiological factors in clinical disability may vary from patient to patient. The degree of spinal stenosis is dynamic and may vary with the patient's posture. In the axial loading spine, swelling of the ligament flavum causes the narrowing of the lumbar spinal canal. In the supine position, the ligament flavum reduces the diameter of the spinal canal by 50-85%. Numerous studies have reported a significant reduction in dural cross-sectional area measurements in axially loaded MRIs compared to supine MRIs.[9, 12, 13]

In our article, although there were no statistically significant results in EWD, VAS, and ODI parameters in the single distance, these parameters were affected by DSA narrowing. Besides, definite and satisfactory clinical results reported between DSA measurements and clinical outcome parameters in the early and late postoperative period.Some authors pointed out that both DSA and clinical parameters improved significantly after ULBD.[3, 4, 26, 28]

The patients with multiple level stenosis and lystesis not included in the study because of the small number, but no statistically significant results obtained between the clinical parameters and DSA measurements of both groups. Patients with multiple stenosis and listesis included in the study because of the small number, but no statistically significant results obtained between the clinical parameters and DSA measurements of both groups. Multilevel stenosis is very common in degenerative vertebrae. In this study, we recorded 23 patients showing that root compression in cauda equina and multiple stenoses. Several studies have shown that multiple nerve conduction levels are affected in the two-level cauda equina.[11, 21, 25, 31] Besides, 67-80% of patients with LSS can also have lower urinary tract disorder (LUTD).[30] The incidence of LUTD and urinary retention is associated with the severity of LSD.[10, 24] In patients with spinal canal stenosis, selective effect of the sacral segment of cauda equina fibers may occur due to the compression of the most medial part of the canal. Urinary retention may develop insidiously in older women. Therefore, it should be kept in mind that 5% of women with urinary retention may have LSS. In this regard, studies should be handled with a multidisciplinary approach.

Conclusion

This study demonstrated the relationship between DSA measurement and clinical disability in patients with LSS as well as the surgery assessment. Although MRI is an important diagnostic method, in the future,we think that techniques such as axial loading MRI rather than conventional MRI will be more effective in the radiological diagnosis of LSS.

Disclosures

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Ethics Committee Approval: This study was approved by Baskent University Institutional Review Board (Project no: 94603339-604.01.02/24845).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – F.A.; Design – F.A.; Supervision – H.Y.; Materials – F.A., H.Y.; Data collection &/or processing – H.Y.; Analysis and/or interpretation – F.A., H.Y.; Literature search – F.A., H.Y.; Writing – F.A.; Critical review – H.Y.

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