



Original Article

Magnetic resonance imaging findings in intervertebral disc herniation: Comparison of canal compromise and canal size in patients with and without cauda equina syndrome

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ABSTRACT

Background: Surgical decompressions are typically warranted in patients with magnetic resonance (MR) and clinical evidence of cauda equina syndromes (CESs). However, it is still unclear what MR findings best correlate with such CES. Here, we compared MR-documented canal size and level/extent of compromise in 52 patients with and 56 others without CES attributed to lumbar disc herniation.

Methods: This was a retrospective study of 52 patients with and 56 patients without CES attributed to MR-documented lumbar disc herniations (IDHs). The anteroposterior diameters of the spinal canal and the levels of maximal compression were documented and compared utilizing MR scans from both groups.

Results: The 52 patients with CES had more extensive narrowing of the canal diameters at the L4-L5 and L5-S1 levels and higher mean canal compression ratios versus 56 patients without CES. The mean percentage of compression in the CES group at L4-L5 and L5-S1 levels (70% and 67.5%, respectively) was less versus L2-L3 and L3-L4 levels (89.7% and 81.8%, respectively).

Conclusion: The 52 patients with CES due to IDH had greater canal compromise versus 56 without CES. Further, the percentage of canal compromise was less at L4-L5 and L5-S1 levels compared to other levels in patients with CES.

Keywords: Cauda equina syndrome, Diagnosis, Disc prolapse, Magnetic resonance imaging, Spinal canal

INTRODUCTION

Cauda equina syndrome (CES) is one of the few surgical emergencies in spine surgery and most surgeons consider it a reason for urgent/emergent surgical decompression.^[5] Here, we correlated the magnetic resonance imaging (MRI) canal measurements from 52 patients who presented with versus 56 patients who presented without CES attributed to IDH.

MATERIALS AND METHODS

This retrospective study included patients with ($n = 52$) or without ($n = 56$) CES attributed to intervertebral IDH (2015–2018). Although multiple clinical variables were studied, we focused on

the MR documented canal diameter, and levels and extent of compression for both groups [Figures 1–3 and Table 1]. Although a radiologist and a spine surgeon independently evaluated the MR studies, both were blinded to the clinical data.

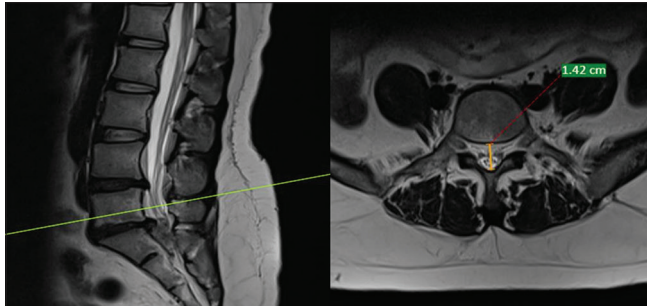


Figure 1: T2 sagittal and axial magnetic resonance imaging cut of the lumbar spine showing the measurement of anteroposterior diameter of the spinal canal at the mid-vertebral level in a case of intervertebral disc herniation. It was measured from the midpoint of the posterior vertebral body to the anterior ligamentum flavum. Green line on left side depicts a line through L5 midvertebral level (pedicle level) in T2 sagittal magnetic resonance imaging with corresponding T2 axial cut on right side. Orange line shows maximum antero-posterior diameter at midvertebral level (Pedicle level) in an axial magnetic resonance imaging cut with corresponding sagittal cut on left side. Red line which is a dotted line with 1.42 cm at the end shows the measurement of orange line, that is maximum antero-posterior diameter at L5 midvertebral level (Pedicle level).

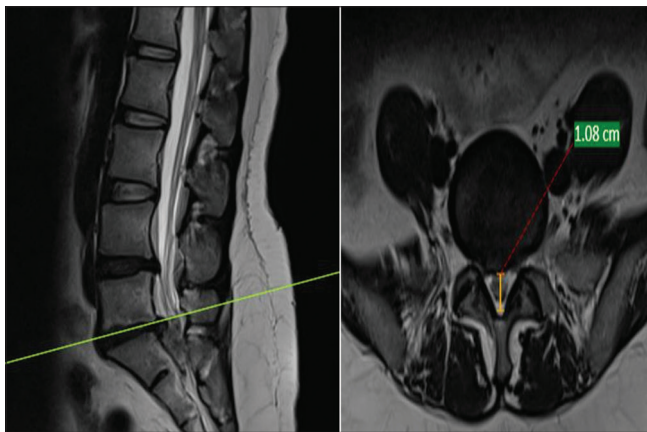


Figure 2: T2 axial magnetic resonance imaging cuts of the lumbar spine showing the measurement of anteroposterior diameter of the spinal canal at the disc level (level of maximum compression) in a case of intervertebral disc herniation without cauda equina syndrome. It was measured from the posterior disc border to the anterior ligamentum flavum. Green line depicts cut through L5-S1 disc level in a T2 sagittal magnetic resonance imaging on left side with corresponding T2 axial cut on right side at level of maximum compression in a patient without cauda equina syndrome. Orange line shows antero-posterior diameter in axial magnetic resonance imaging cut at level of maximum compression in a patient with L5-S1 disc herniation without cauda equina syndrome. Red dotted line with 1.08 cm at the end shows measurement of orange line.

Statistical analysis was performed using IBM Corp. Released in 2017, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Chi-square test, Fisher exact test, Student *t*-test (2* 1 tailed), and Mann–Whitney U-test were utilized.

RESULTS

The details were retrieved for 56 patients (33 males and 23 females) in Group A (without CES) and compared to those for 52 patients (25 males and 27 females) in Group B (with CES). Our analysis showed that both groups were statistically matched regarding age ($P > 0.1$) and gender ($P > 0.17$). The most common level of disc herniations was L4-L5 followed by L5-S1 in both the groups. Notably, patients in Group B with CES had more motor deficits (39 vs. 28), sensory deficits (45 vs. 41), impaired perianal sensation (33 vs. 2), and impaired voluntary anal contraction (45 vs. 14) versus Group A patients [Table 1].

MR studies

Comparison of AP canal diameters between the two groups showed no significant differences from L1-L2 ($P = 0.4$), L2-L3 ($P = 0.39$), to L3-L4 ($P = 0.36$) levels [Table 2]. However, the canal diameters at L4-L5 (mean: 1.23 cm vs. 1.43 cm) and L5-S1 (mean 1.35 cm vs. 1.52 cm) were significantly narrowed ($P = 0.003$ at L4-L5 and $P = 0.023$ at L5-S1) in Group B versus Group A patients [Tables 2a, b and Figure 4].

At the levels of maximal compression, Group B patients had statistically greater mean neural/canal compression versus Group A [Tables 2c, d and Figure 5].

The mean percentage of compression in Group B versus Group A patients was greater at both the L4-L5 (70% vs.

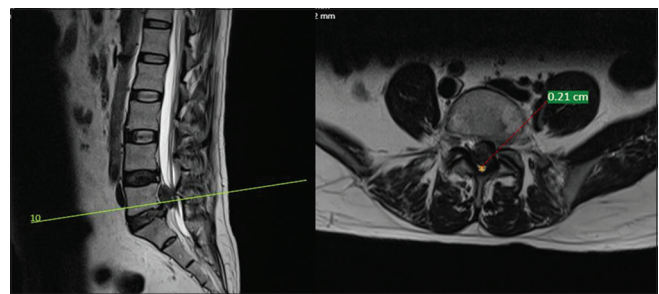


Figure 3: T2 axial magnetic resonance imaging cuts of the lumbar spine showing the measurement of anteroposterior diameter of the spinal canal at the disc level in a case of cauda equina syndrome. Green line in a T2 sagittal magnetic resonance imaging on left side depicts at line through L5-S1 cephalic disc migration with corresponding T2 axial cut on right side at level of maximum compression in a case of cauda equina syndrome. Orange line depicts antero-posterior diameter at level of maximum compression in case of L5-S1 cephalic disc migration with cauda equina syndrome. Red dotted line with 0.21 cm shows measurement of orange line which shows severely compromised thecal space.

Table 1: A table describing the comparison of various clinical variables assessed for the study.

	Group A (n=56)	Group B (n=52)
Clinical variables		
Age (Mean±SD) in years	41.14 (±2.13)	46.29 (±2.28)
Gender (number of males:females)	33:23	25:27
Duration of leg symptoms (Mean±SD) in weeks	18.02 (±1.8)	25.03±2.64
Duration of bowel/bladder symptoms (mean) in days	-	10.63
Level of herniation (number of patients)		
L1-L2	2	3
L2-L3	5	3
L3-L4	9	5
L4-L5	22	26
L5-S1	18	15
Leg symptoms (number of patients)		
Unilateral	43	22
Bilateral	13	22
None	-	8
Perianal sensation(number of patients)		
Normal	54	19
Reduced	2	28
Absent	-	5
Voluntary anal contraction(number of patients)		
Normal	42	7
Reduced	14	27
Absent	-	18
Motor deficits (number of patients)	28	39
Sensory deficits (number of patients)	41	45

Table 2a: A table depicting the mean spinal canal sizes at the mid vertebral level in patients with intervertebral disc herniation.

	n (number of patients)	Mean canal diameter (in cm)	SD	SE
L1-L2	2	1.1800	0.11,358	0.06,557
L2-L3	5	1.4833	0.27,319	0.15,773
L3-L4	9	1.4800	0.29,283	0.13,096
L4-L5	22	1.4304	0.21,959	0.04,307
L5-S1	18	1.5220	0.20,505	0.05,294
Total	56	1.4502	0.22,694	0.03,147

Table 2c: A table depicting the mean spinal canal sizes at the level of maximum compression in patients with intervertebral disc herniation.

	n (number of patients)	Mean canal diameter (in cm)	SD	SE
L1-L2	2	0.4700	0.28,284	0.20,000
L2-L3	5	0.7420	0.16,053	0.07,179
L3-L4	9	0.9211	0.14,075	0.04,692
L4-L5	22	0.8432	0.30,007	0.06,398
L5-S1	18	0.9117	0.27,318	0.06,439
Total	56	0.8554	0.26,838	0.03,586

Table 2b: A table depicting the mean spinal canal sizes at the mid vertebral level in patients with cauda equina syndrome.

	n (number of patients)	Mean canal diameter (in cm)	SD	SE
L1-L2	3	1.3100	0.14,142	0.10,000
L2-L3	3	1.2600	0.21,645	0.09,680
L3-L4	5	1.3156	0.17,707	0.05,902
L4-L5	26	1.2277	0.20,005	0.04,265
L5-S1	15	1.3494	0.20,593	0.04,854
Total	52	1.2868	0.19,904	0.02,660

Table 2d: A table depicting the mean spinal canal sizes at the level of maximum compression in patients with cauda equina syndrome.

	n (number of patients)	Mean canal diameter (in cm)	SD	SE
L1-L2	3	0.1400	0.13,077	0.07,550
L2-L3	3	0.1300	0.04,583	0.02,646
L3-L4	5	0.2420	0.20,450	0.09,145
L4-L5	26	0.3688	0.30,787	0.06,038
L5-S1	15	0.4380	0.16,428	0.04,242
Total	52	0.3496	0.25,874	0.03,588

41%) and L5-S1 (67.5% vs. 40.1%) levels [Table 3]. However, in Group B, the mean percentage of compression was less at

L4-L5 (70%) and L5-S1 (67.5%) levels compared to L2-L3 (89.7%) and L3-L4 (81.8%) levels.

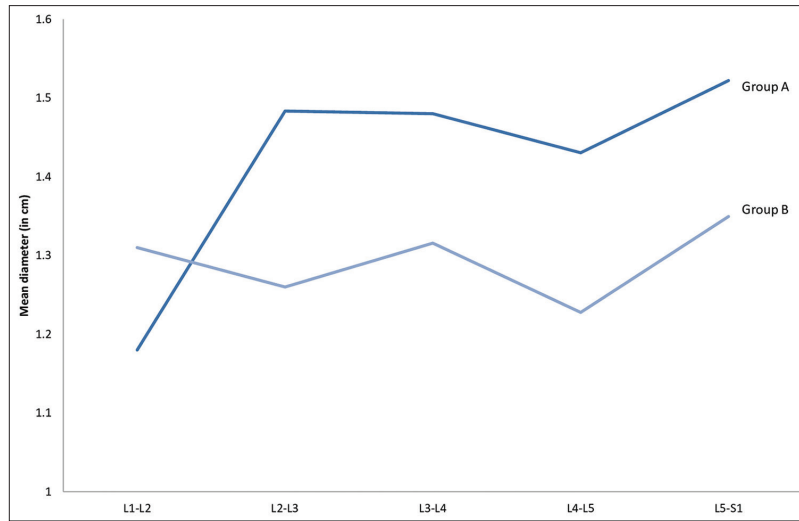


Figure 4: A line graph showing the comparison of the normal spinal canal size (at mid vertebral level) in patients with and without cauda equina syndrome.

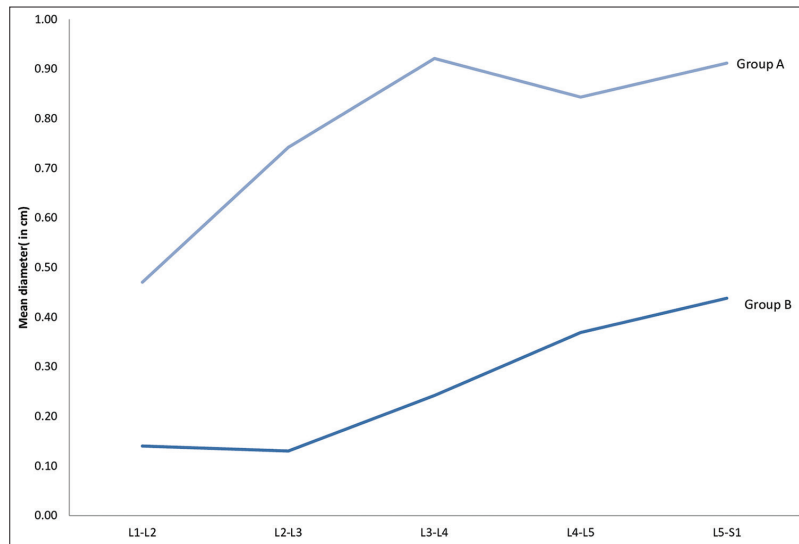


Figure 5: A line graph showing the comparison of the spinal canal size at the level of maximum compression in patients with and without cauda equina syndrome.

Table 3: A table depicting the mean percentage of compression at various lumbar levels* in group A versus group B.

	Group A (%)	Group B (%)
L2-L3	50	89.7
L3-L4	37.8	81.8
L4-L5	41	70
L5-S1	40.1	67.5

*L1-L2 level is not included due to lesser number of patients required for analysis

DISCUSSION

Quantifying the amount of compression on lumbar MR's should provide objective evidence to establish a patient's

relative risk for developing a CES attributed to a IDH. At present, there are no clear MR measurements that readily correlate with a patient's risk for developing a CES secondary to a IDH.^[5] Prior studies found a poor correlation between the extent of lumbar canal compromise due to lumbar discs, and the extent of neurological deficit (i.e., CES).^[4]

Does the percent of MR-documented canal compromise help predict whether a patient develops a CES with a IDH?

Bell *et al.* and Domen *et al.* determined that the extent of cauda equina compression best correlates with the clinical findings of a CES.^[2,3] Some authors considered that 75%

of canal compromise was necessary for patients to exhibit a CES.^[1,2] However, Qureshi *et al.* found that only 45% of patients with CES had compression >75% on imaging.^[7]

Korse *et al.* also reported statistically significant differences in the normal spinal canal diameters between patients with versus those without CES.^[6] However, we found greater canal narrowing form Group B versus Group A patients at the L4-L5 and L5-S1 levels; the lesser canal sizes in Group B patients at L4-L5 and L5-S1 explained the occurrence of CES despite a lesser mean percentage of compression due to IDH versus the higher lumbar levels.

Lumbar disc-related canal compression on lumbar MR best correlated with clinical CES

Greater thecal sac compression was seen on 52 lumbar MR scans of patients clinically presenting with CES due to IDH versus 56 patients with lumbar discs without CES. Knowing the mean MR-documented compression at the lower lumbar levels can help identify those patients with IDH at greater risk for developing CES warranting early surgical intervention.

CONCLUSION

Patients with L4-L5 and L5-S1 IDH presenting with CES have greater MR-documented preoperative canal compromise (Group B) versus those with IDH without CES and lesser canal compromise (Group A).

Declaration of patient consent

Patient's consent not obtained as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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