Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Quantitative MRI Morphometry Predicts Functional Disability in Patients with Lumbar Spinal Stenosis: A Retrospective Study

Bandari Kaavya
SRM Institute of Science and Technology
S R Gopika
SRM Institute of Science and Technology
Nisha Shaji
SRM Institute of Science and Technology
Malathy Krishnamoorthy
SRM Institute of Science and Technology
Senthil Kumar Aiyappan
asenthilkumarpgi@gmail.com
SRM Institute of Science and Technology

Research Article

Keywords: Lumbar spinal stenosis, Magnetic resonance imaging, Morphometry, Dural sac, Oswestry Disability Index, Lateral recess stenosis, Functional disability

Posted Date: November 12th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11508551/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Quantitative MRI Morphometry Predicts Functional Disability in Patients with Lumbar Spinal Stenosis: A Retrospective Study

Bandari Kaavya, S R Gopika, Nisha Shaji, Malathy Krishnamoorthy, Senthil Kumar Aiyappan*

Department of Radio Diagnosis, SRM Medical College Hospital and Research Centre, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology, Kattankulathur-603203, Tamil Nadu, India.

E-mail - asenthilkumarpgi@gmail.com

Abstract

Background: To evaluate the association between magnetic resonance imaging (MRI) findings, lumbar spine morphometric parameters, and functional disability in patients with lumbar spinal stenosis (LSS).

Methods: In this retrospective observational study, patients with MRI-confirmed LSS were evaluated using axial T2-weighted MRI. Imaging findings, including central stenosis, lateral recess stenosis (LRS), facet joint effusion (FJE), and sedimentation sign, were assessed. Quantitative morphometric measurements of the dural sac, spinal canal, and lateral recess were obtained. Functional disability was evaluated using the Oswestry Disability Index (ODI). Associations between MRI findings, morphometric parameters, ODI scores, and symptom categories were analyzed.

Results: Central stenosis and LRS were significantly associated with higher ODI scores and symptom categories (both $p < 0.0001$), whereas FJE and the sedimentation sign showed no significant associations. ODI demonstrated significant negative correlations with total spinal canal cross-sectional area ($r = -0.6965$), dural sac cross-sectional area ($r = -0.6549$), and transverse dural sac diameter ($r = -0.5863$). Morphometric threshold analysis identified severe stenosis at a dural sac cross-sectional area <0.201 cm² and a total spinal canal cross-sectional area <0.04 cm².

Conclusions: Quantitative MRI morphometric parameters demonstrated significant associations with functional disability in patients with LSS. Objective measurements of the dural sac and spinal canal may complement conventional MRI grading and assist in evaluating disease severity and clinical decision-making.

Keywords: Lumbar spinal stenosis; Magnetic resonance imaging; Morphometry; Dural sac; Oswestry Disability Index; Lateral recess stenosis; Functional disability.

Introduction

Lumbar spinal stenosis (LSS) is one of the most common degenerative disorders of the spine and a leading cause of pain, neurogenic claudication, and functional disability among older adults. It results from narrowing of the central spinal canal, lateral recess, or neural foramina, leading to compression of neural and vascular structures and substantial impairment in mobility and quality of life [1–3].

Magnetic resonance imaging (MRI) is the imaging modality of choice for evaluating LSS because of its superior soft-tissue contrast and ability to accurately demonstrate spinal canal narrowing and neural element compression [3–5]. However, imaging findings frequently do not correlate well with the severity of clinical symptoms, as radiological evidence of stenosis may also be present in asymptomatic individuals [4–6]. Consequently, establishing objective imaging markers that better reflect functional impairment remains a clinical challenge.

Conventional MRI assessment primarily relies on qualitative grading systems, including central stenosis, lateral recess stenosis (LRS), facet joint effusion (FJE), and the sedimentation sign [7–11]. More recently, quantitative MRI morphometric parameters, such as dural sac cross-sectional area, spinal canal dimensions, and lateral recess measurements, have emerged as objective indicators of stenosis severity. Nevertheless, their association with functional disability and symptom severity remains incompletely understood, and clinically useful morphometric thresholds have not been well established.

Therefore, this study aimed to investigate the association between qualitative MRI findings, quantitative lumbar spine morphometric parameters, and functional disability measured using the Oswestry Disability Index (ODI) in patients with lumbar spinal stenosis. In addition, we sought to identify morphometric parameters that may complement conventional MRI assessment in the objective evaluation of disease severity.

Materials and Methods

Study Design and Sample Size Calculation

This retrospective observational study evaluated patients with lumbar spinal stenosis (LSS) who underwent lumbar spine magnetic resonance imaging (MRI) in the Department of Radiodiagnosis. Patients presenting with gluteal and/or lower extremity pain, numbness, or neurogenic claudication and MRI findings consistent with LSS were eligible for inclusion. Patients with contraindications to MRI, previous spinal surgery, or a history of spinal trauma were excluded. The minimum sample size was estimated using the standard formula for prevalence studies, and 50 patients were included in the final analysis. The sample size was calculated using the following formula (1):

$$N = \frac{Z^2 * P * (1-P)}{d^2} \quad (1)$$

Substituting the values: For practical purposes, the final sample size was rounded to 50 patients**.**

Inclusion Criteria

Patients presenting for MRI of the lumbar spine to the Department of Radio diagnosis who met the following criteria were included:

- Presence of gluteal and/or lower extremity pain, numbness, and/or neurogenic claudication.
- MRI findings consistent with lumbar spinal canal stenosis.

Exclusion Criteria

Patients were excluded if they had any of the following:

- General contraindications for MRI.
- History of previous spine surgery.
- History of spinal trauma.

Method of Data Collection

Data were collected prospectively from patients undergoing MRI scans at the Department of Radio diagnosis. MRI images were reviewed and classified by two independent radiologists to ensure interobserver reliability. Clinical data, including patient demographics, symptoms, and self-reported questionnaire responses, were recorded in a structured data collection form given below.

MRI Protocol and Imaging Analysis

Axial T2-weighted MRI images from L1 to S1 evaluated the dimensions of the spinal canal. Central stenosis was classified from A to D according to the appearance of cerebrospinal fluid and rootlet (Fig S1). Lateral recess stenosis varied from Grade 0 (normal) to Grade 3 (severe compression) (Fig S2). Facet joint effusion was classified from 0 to 2 based on effusion size (Fig S3). The Sedimentation Sign was negative when nerve roots were positioned below the midpoint of the spinal canal and positive when the roots remained compressed above this point (Fig S4).

Clinical Assessment and Self-Reported Questionnaire

A standardized questionnaire that was self- administered was employed to categorize LSS according to symptoms. A score of 4 on questions 1–4 showed LSS, but a score of 4 on questions 1–4 combined with a "No" response to questions 5–10 indicated radicular LSS. Neurogenic claudication was indicated by a yes response to a minimum of one of questions 1–4 and two of questions 5–10. Symptoms comprised numbness or pain in the legs, aggravated by walking or standing, reduced by rest or forward bending.

Ethical Considerations

The study was conducted in accordance with the ethical guidelines set by the institutional review board (IRB). Written informed consent was obtained from all participants. Patient confidentiality and data protection were ensured throughout the study.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are expressed as frequencies and percentages. Associations between categorical variables were assessed using the Chi-square test. Correlation analysis was performed to evaluate the relationship between Oswestry Disability Index (ODI) scores and

lumbar spine morphometric parameters. A two-tailed p value < 0.05 was considered statistically significant.

Results

Results

Demographic Characteristics of the Study Population

Among the 50 patients included in the study, females accounted for 52% and males for 48%. The majority of patients (44%) belonged to the 51–70-year age group, followed by the 36–50-year group (36%), while the 18–35-year group represented the smallest proportion (20%). An equal distribution of males and females was observed in the 36–50-year age group, whereas the youngest age group showed a slight male predominance (Fig. 1).

Association of Oswestry Disability Index (ODI) Scores with MRI Findings

Fig. 2A demonstrates a significant association between central stenosis grade and ODI score ($\chi^2 = 33.94$, $p < 0.0001$). Grade 0 central stenosis was predominantly associated with moderate disability, whereas Grades 1 and 2 were more frequently associated with severe and crippled disability. Most patients with Grade 3 stenosis belonged to the crippled disability category.

Similarly, lumbar recess stenosis (LRS) showed a significant association with ODI score ($\chi^2 = 45.96$, $p < 0.0001$) (Fig. 2B). Grade 0 LRS was primarily associated with mild disability, whereas Grade 3 LRS was predominantly observed in patients with crippled disability, indicating increasing functional impairment with greater stenosis severity.

In contrast, neither facet joint effusion (FJE) nor the sedimentation sign demonstrated significant associations with ODI scores (Fig. 2C and Fig. 2D). The distribution of disability categories was comparable across FJE grades ($p = 0.36$), and no significant relationship was observed between the sedimentation sign and ODI scores ($p = 0.663$).

Overall, central stenosis and LRS were significantly associated with increasing functional disability, whereas FJE and the sedimentation sign showed no significant relationship with ODI scores.

Association between MRI Findings and Symptom Categories

A significant association was observed between central stenosis grade and symptom category ($\chi^2 = 36.78$, $p < 0.0001$) (Fig. 3A). Grade 0 central stenosis was predominantly associated with typical LSS symptoms, whereas higher grades were more frequently associated with radicular and neurogenic symptoms. No patients with Grade 3 central stenosis presented with typical LSS symptoms.

Lumbar recess stenosis also demonstrated a significant association with symptom category ($\chi^2 = 20.48$, $p = 0.002$) (Fig. 3B). Higher LRS grades were increasingly associated with radicular and neurogenic symptoms, while typical LSS symptoms were less frequent in advanced grades.

No significant associations were identified between FJE grade and symptom category ($p = 0.5419$) or between the sedimentation sign and symptom category ($p = 0.50$) (Fig. 3C and Fig. 3D). The distribution of symptom patterns was similar irrespective of FJE grade or sedimentation sign status.

These findings indicate that central stenosis and LRS are significantly associated with symptom severity, whereas FJE and the sedimentation sign have limited value in predicting the clinical presentation of LSS.

Correlation among Lumbar Spine Morphometric Parameters

The relationships among lumbar spine morphometric parameters are presented in Table 1. Total cerebrospinal (CS) area demonstrated strong positive correlations with dural sac dimensions, indicating that dural sac morphology is a major determinant of spinal canal area. The anteroposterior and transverse dural sac diameters also showed strong positive correlations with total CS area. Lateral recess depth and angle were moderately correlated with dural sac dimensions and strongly correlated with each other, reflecting their coordinated contribution to nerve root accommodation. In contrast, ligamentous interfacet distance demonstrated relatively weaker correlations with cross-sectional canal measurements but showed moderate associations with lateral recess depth.

Correlation between ODI and Lumbar Spine Morphometric Parameters

The correlations between ODI scores and lumbar spine morphometric measurements are summarized in Table 2. ODI demonstrated significant negative correlations with total CS area ($r = -0.6965$), dural sac CS area ($r = -0.6549$), and transverse dural sac diameter ($r = -0.5863$), indicating that smaller spinal canal dimensions were associated with greater functional disability. Moderate negative correlations were also observed for lateral recess area, depth, and angle, while weaker negative correlations were found for anteroposterior dural sac diameter and ligamentous interfacet distance.

Dimensions of the Spinal Canal and Severity of Stenosis

The descriptive statistics and critical reference values for lumbar spinal canal morphometric parameters are presented in Table 3. The mean dural sac cross-sectional area was 0.555 cm^2, with a lower reference limit of 0.201 cm^2 suggestive of severe stenosis. The mean anteroposterior and transverse dural sac diameters were 6.25 mm and 10.11 mm, respectively, with lower reference limits of 3.26 mm and 4.62 mm. The lateral recess cross-sectional area averaged approximately 0.05 cm^2 bilaterally, with lower limits approaching zero, indicating near-complete recess obliteration in severe stenosis. The mean total CS area was 0.66 cm^2, with a

lower reference limit of 0.04 cm^2. Based on coefficient of stenosis estimations, moderate-to-severe spinal canal narrowing corresponded to reductions of 48% in anteroposterior diameter, 54% in transverse diameter, 64% in dural sac area, and 94% in total CS area.

Discussion

The present study evaluated the relationship between MRI findings, lumbar spine morphometric parameters, and functional disability in patients with lumbar spinal stenosis (LSS). The study population demonstrated an almost equal sex distribution, with a slightly higher proportion of females, while most patients were between 51 and 70 years of age. These findings are consistent with previous studies reporting an increased prevalence of LSS among older adults, particularly those aged over 60 years, highlighting the contribution of age-related degenerative changes to disease progression [12,13].

A key finding of the present study was the significant association of both central stenosis and lateral recess stenosis (LRS) with increasing Oswestry Disability Index (ODI) scores. Patients with higher grades of stenosis demonstrated greater functional impairment, supporting previous reports that central and lateral recess narrowing are closely associated with disability and reduced walking capacity [14,15]. In contrast, neither facet joint effusion (FJE) nor the sedimentation sign showed significant associations with ODI scores. Similar observations have been reported by Barz et al. [16] and Fujiwara et al. [17], suggesting that although these MRI findings may accompany degenerative spinal disease, their value as independent indicators of functional disability remains limited [18–20]. These findings reinforce the clinical importance of grading central and lateral recess stenosis during MRI evaluation.

The present study also demonstrated significant associations between MRI findings and clinical symptom patterns. Higher grades of central stenosis were associated with neurogenic and radicular symptoms, whereas lower grades were predominantly observed in patients with typical LSS symptoms. Similarly, increasing LRS severity was associated with radicular and neurogenic symptom categories. These findings are consistent with previous studies reporting that symptom severity increases with progressive central and lateral recess stenosis [12,18,21]. Conversely, FJE and the sedimentation sign were not significantly associated with symptom categories, despite previous reports describing a higher prevalence of these findings in symptomatic individuals [12,22]. Collectively, these results suggest that central stenosis and LRS are more reliable MRI markers of the clinical presentation of LSS than auxiliary imaging findings.

Correlation analysis demonstrated strong positive relationships among the principal morphometric parameters of the lumbar spinal canal. Dural sac cross-sectional area showed an excellent correlation with total canal area and strong correlations with both anteroposterior and transverse dural sac diameters, confirming that these measurements collectively reflect the degree of spinal canal narrowing. The lateral recess depth and angle were also strongly correlated, indicating their complementary role in assessing nerve root accommodation. In contrast, ligamentous interfacet distance demonstrated relatively weak correlations with central canal dimensions,

suggesting a limited contribution to central stenosis. These observations support the value of comprehensive morphometric assessment during MRI interpretation and preoperative evaluation.

An important finding of this study was the significant inverse relationship between ODI scores and quantitative lumbar morphometric parameters, particularly total canal area, dural sac cross-sectional area, and transverse dural sac diameter. These findings indicate that progressive reduction in spinal canal dimensions is associated with greater functional disability and are consistent with the observations of Hughes et al. [23], who reported similar inverse relationships between morphometric measurements, stenosis coefficients, and disability. The moderate correlations observed for lateral recess measurements further emphasize their contribution to symptomatic stenosis. Collectively, these findings suggest that quantitative MRI morphometry may complement conventional qualitative grading by providing objective indicators of disease severity that could assist clinical assessment and surgical decision-making.

The morphometric analysis also demonstrated considerable variability in lumbar spinal canal dimensions, particularly within the dural sac and lateral recesses. Several measurements approached the calculated lower reference limits, indicating severe canal narrowing. Similar anatomical variability has been reported in previous morphometric studies of both healthy individuals and patients with spinal stenosis [24–27]. These findings highlight the importance of establishing quantitative reference values to improve the objective assessment of stenosis severity and facilitate standardized MRI evaluation in patients with LSS.

Limitations

This study has a few limitations. It was a single-center retrospective study with a relatively small sample size, which may limit the generalizability of the findings. In addition, postoperative outcomes and long-term follow-up were not evaluated, and interobserver reliability of MRI measurements was not assessed. Therefore, larger prospective multicenter studies are needed to validate these findings.

Conclusion

In conclusion, quantitative MRI morphometric parameters, particularly total spinal canal area, dural sac cross-sectional area, and transverse dural sac diameter, demonstrated significant associations with functional disability in patients with lumbar spinal stenosis. Central stenosis and lateral recess stenosis were significantly associated with both disability severity and symptom patterns, whereas facet joint effusion and the sedimentation sign showed limited clinical relevance. These findings suggest that quantitative morphometric assessment may complement conventional qualitative MRI grading by providing objective measures of stenosis severity. Incorporating these parameters into routine MRI evaluation may improve the assessment of disease severity and support clinical decision-making in patients with lumbar spinal stenosis. Further prospective multicenter studies

with larger cohorts and longitudinal follow-up are warranted to validate these findings and establish clinically relevant morphometric thresholds.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest.

Consent for Publication

All magnetic resonance imaging (MRI) images included in this manuscript have been fully anonymized and de-identified in accordance with institutional ethical guidelines. No identifiable patient information is presented. Therefore, separate consent for publication was not required.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Ethical approval

The study was conducted following ethical principles and has been approved by the institutional ethics committee of SRM Medical College and Hospital with Ethics certificate number: SRMIEC-ST0323-524. Informed consent was obtained from all participants before enrollment. Participants were provided with detailed information about the study, and their confidentiality was maintained throughout. No additional cost or risk was incurred by the participants.

Abbreviations

AP: Anteroposterior

CS: Cross-sectional

CSA: Cross-sectional area

FJE: Facet joint effusion

ICC: Intraclass correlation coefficient (if used)

LR: Lateral recess

LRS: Lateral recess stenosis

LSS: Lumbar spinal stenosis

MRI: Magnetic resonance imaging

ODI: Oswestry Disability Index

SD: Standard deviation

SPSS: Statistical Package for the Social Sciences

TR: Transverse

References

[1] Siebert E, Prüss H, Klingebiel R, Failli V, Einhäupl KM, Schwab JM. Lumbar spinal stenosis: syndrome, diagnostics and treatment. Nat Rev Neurol. 2009;5(7):392-403.

[2] Kitamura M, Eguchi Y, Inoue G, Orita S, Takaso M, Ochiai N, et al. A case of symptomatic extra-foraminal lumbosacral stenosis ("far-out syndrome") diagnosed by diffusion tensor imaging. Spine (Phila Pa 1976). 2012;37(14):E854-E857.

[3] Kreiner DS, Shaffer WO, Baisden JL, Gilbert TJ, Summers JT, Toton JF, et al. An evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spinal stenosis. Spine J. 2013;13(7):734-743.

[4] Abdou A, Kades S, Masri-Zada T, Asim S, Bany-Mohammed M, Agrawal DK. Lumbar spinal stenosis: pathophysiology, biomechanics, and innovations in diagnosis and management. J Spine Res Surg. 2025;7(1):1-17.

[5] Matz PG, Meagher RJ, Lamer T, Tontz WL Jr, Annaswamy TM, Cassidy RC, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of degenerative lumbar spondylolisthesis. Spine J. 2016;16(3):439-448.

[6] Otani K, Kikuchi S, Yabuki S, Onda A, Nikaido T, Watanabe K, et al. Prospective one-year follow-up of lumbar spinal stenosis in a regional community. J Pain Res. 2018; 11:455-464.

[7] Zhou Z, Jin Z, Zhang P, Shan B, Zhou Z, Zhang Y, et al. Correlation between dural sac size in dynamic magnetic resonance imaging and clinical symptoms in patients with lumbar spinal stenosis. World Neurosurg. 2020;134: e866-e873.

[8] Ko YJ, Lee E, Lee JW, Park CY, Cho J, Kang Y, et al. Clinical validity of two different grading systems for lumbar central canal stenosis: Schizas and Lee classification systems. PLoS One. 2020;15(5): e0233633.

[9] Splettstößer A, Khan MF, Zimmermann B, Vogl TJ, Ackermann H, Middendorp M, et al. Correlation of lumbar lateral recess stenosis in magnetic resonance imaging and clinical symptoms. World J Radiol. 2017;9(5):223-229.

[10] Kanno H, Ozawa H, Koizumi Y, Morozumi N, Aizawa T, Itoi E. Increased facet fluid predicts dynamic changes in the dural sac size on axial-loaded MRI in patients with lumbar spinal canal stenosis. AJNR Am J Neuroradiol. 2016;37(4):730-735.

[11] Vardeh D, Mannion RJ, Woolf CJ. Toward a mechanism-based approach to pain diagnosis. J Pain. 2016;17(9 Suppl): T50-T69.

[12] Fushimi Y, Otani K, Tominaga R, Nakamura M, Sekiguchi M, Konno SI. The association between

clinical symptoms of lumbar spinal stenosis and MRI axial imaging findings. Fukushima J Med Sci. 2021;67(3):150-160.

[13] Ishimoto Y, Yoshimura N, Muraki S, Yamada H, Nagata K, Hashizume H, et al. Associations between radiographic lumbar spinal stenosis and clinical symptoms in the general population: the Wakayama Spine Study. Osteoarthritis Cartilage. 2013;21(6):783-788.

[14] Norisyam Y, Salim AA, Bahrin Z, Yusof MI, Paiman M, Nadarajan C. Lateral lumbar spinal stenosis: associations with the Oswestry Disability Index, visual analogue scale, and magnetic resonance imaging. Cureus. 2023;15(12): e50475.

[15] Hatakka J, Pernaa K, Kostensalo J, Mäkelä K, Laaksonen I. Preoperative evaluation of Oswestry Disability Index in lumbar spinal stenosis: new evidence of time independence of variation up to 1 year. Int J Spine Surg. 2025;19(1):110-116.

[16] Barz T, Melloh M, Staub LP, Lord SJ, Lange J, Röder CP, et al. Nerve root sedimentation sign: evaluation of a new radiological sign in lumbar spinal stenosis. Spine (Phila Pa 1976). 2010;35(8):892-897.

[17] Fujiwara A, Tamai K, Yamato M, An HS, Yoshida H, Saotome K, et al. The relationship between facet joint osteoarthritis and disc degeneration of the lumbar spine: an MRI study. Eur Spine J. 1999;8(5):396-401.

[18] Wu L, Munakomi S, Cruz R. Lumbar spinal stenosis. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025.

[19] Fusco M, Skaper SD, Coaccioli S, Varrassi G, Paladini A. Degenerative joint diseases and neuroinflammation. Pain Pract. 2017;17(4):522-532.

[20] Amodeo G, Magni G, Galimberti G, Riboldi B, Franchi S, Sacerdote P, et al. Neuroinflammation in osteoarthritis: from pain to mood disorders. Biochem Pharmacol. 2024; 228:116182.

[21] Schizas C, Theumann N, Burn A, Tansey R, Wardlaw D, Smith FW, et al. Qualitative grading of severity of lumbar spinal stenosis based on the morphology of the dural sac on magnetic resonance images. Spine (Phila Pa 1976). 2010;35(21):1919-1924.

[22] Laudato PA, Kulik G, Schizas C. Relationship between sedimentation sign and morphological grade in symptomatic lumbar spinal stenosis. Eur Spine J. 2015;24(10):2264-2268.

[23] Hughes A, Makirov SK, Osadchiy V. Measuring spinal canal size in lumbar spinal stenosis: description of method and preliminary results. Int J Spine Surg. 2015; 9:3.

[24] Reddy M, Gangavelli DR, Priyanka, Saikiran DP. Influence of lumbar spinal canal dimensions on

neurological claudication symptomatology: a case-control study. Biomed Pharmacol J. 2021;14(2):1019-1024.

[25] Hughes A, Makirov SK, Osadchiy V. Measuring spinal canal size in lumbar spinal stenosis: description of method and preliminary results. Int J Spine Surg. 2015; 9:3. *(Duplicate of Reference 23; remove one of these references and renumber the list.)*

[26] Spinal stenosis: practice essentials, anatomy, pathophysiology. Medscape. Updated October 28, 2024. Available from: https://emedicine.medscape.com/article/1913265-overview

[27] Raja A, Patel P, Mesfin FB. Spinal stenosis. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025.

Figure Legends

Fig. 1 Demographic characteristics of the study population. (A) Age and sex distribution of the study participants. (B) Age distribution of the study participants.

Fig. 2 Association between Oswestry Disability Index (ODI) scores and MRI findings. (A) Central stenosis. (B) Lateral recess stenosis (LRS). (C) Facet joint effusion (FJE). (D) Sedimentation sign.

Fig. 3 Association between MRI findings and symptom categories. (A) Central stenosis grades. (B) Lateral recess stenosis (LRS) grades. (C) Facet joint effusion (FJE) grades. (D) Sedimentation sign.

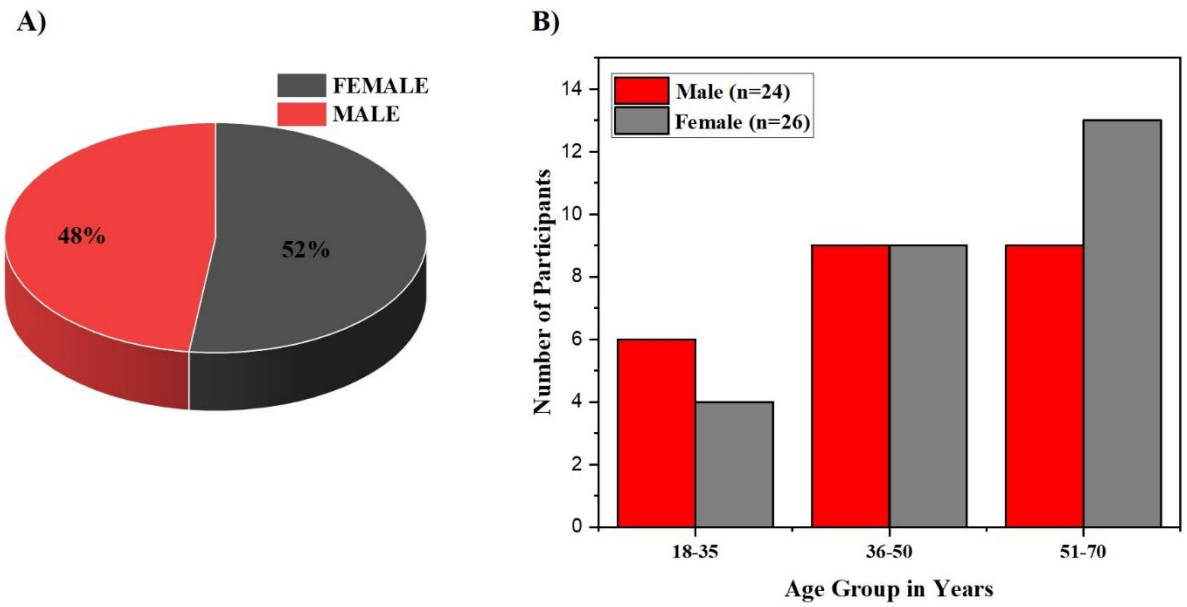

A)
FEMALE
MALE
48%
52%
B)
Male (n=24)
Female (n=26)
Number of Participants
0
2
4
6
8
10
12
14
18-35
36-50
51-70
Age Group in Years

Fig. 1

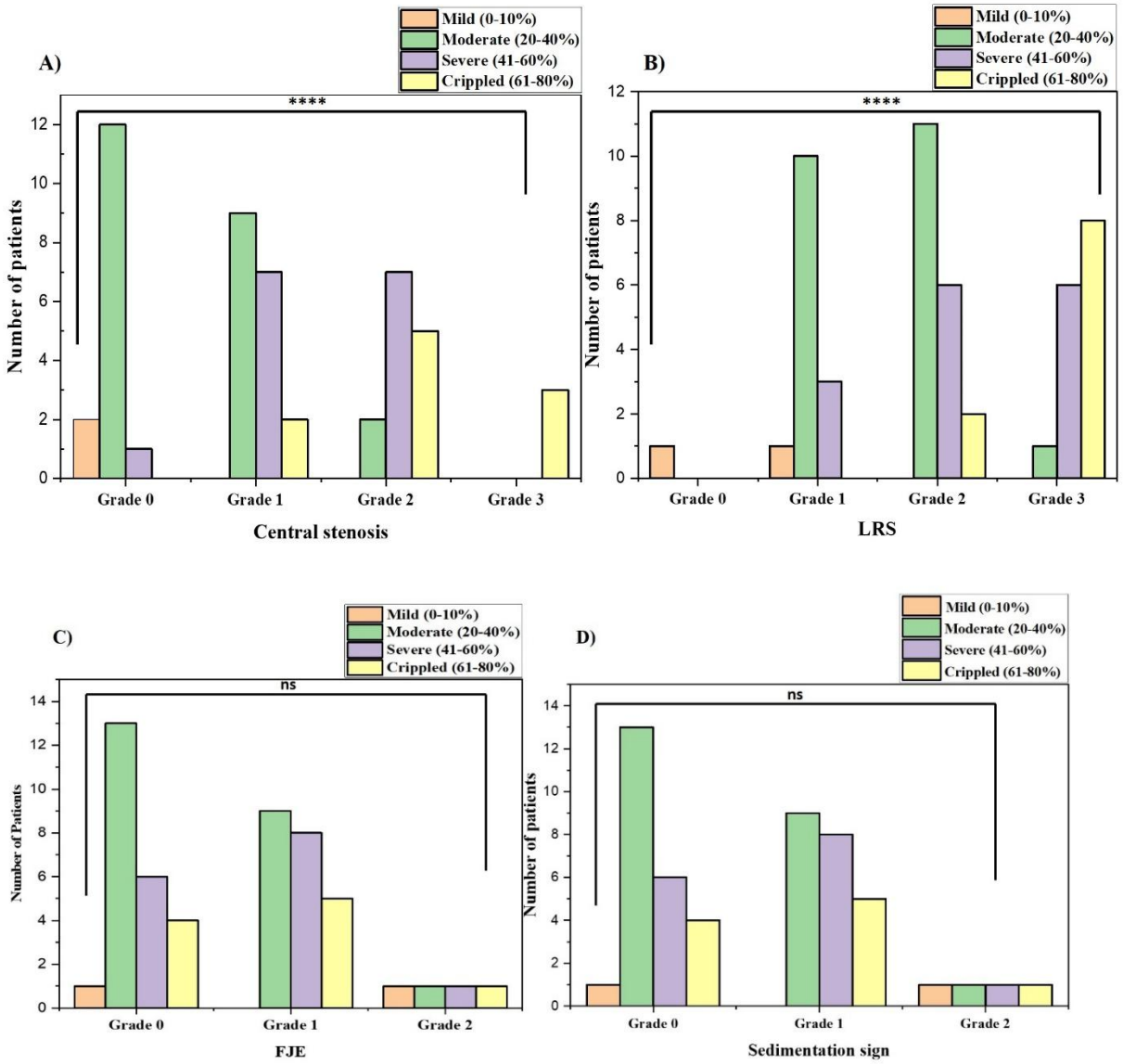

A)
Mild (0-10%)
Moderate (20-40%)
Severe (41-60%)
Crippled (61-80%)
****
Number of patients
Grade 0
Grade 1
Grade 2
Grade 3
Central stenosis
B)
****
LRS
C)
ns
Number of Patients
FJE
D)
Sedimentation sign

Fig. 2

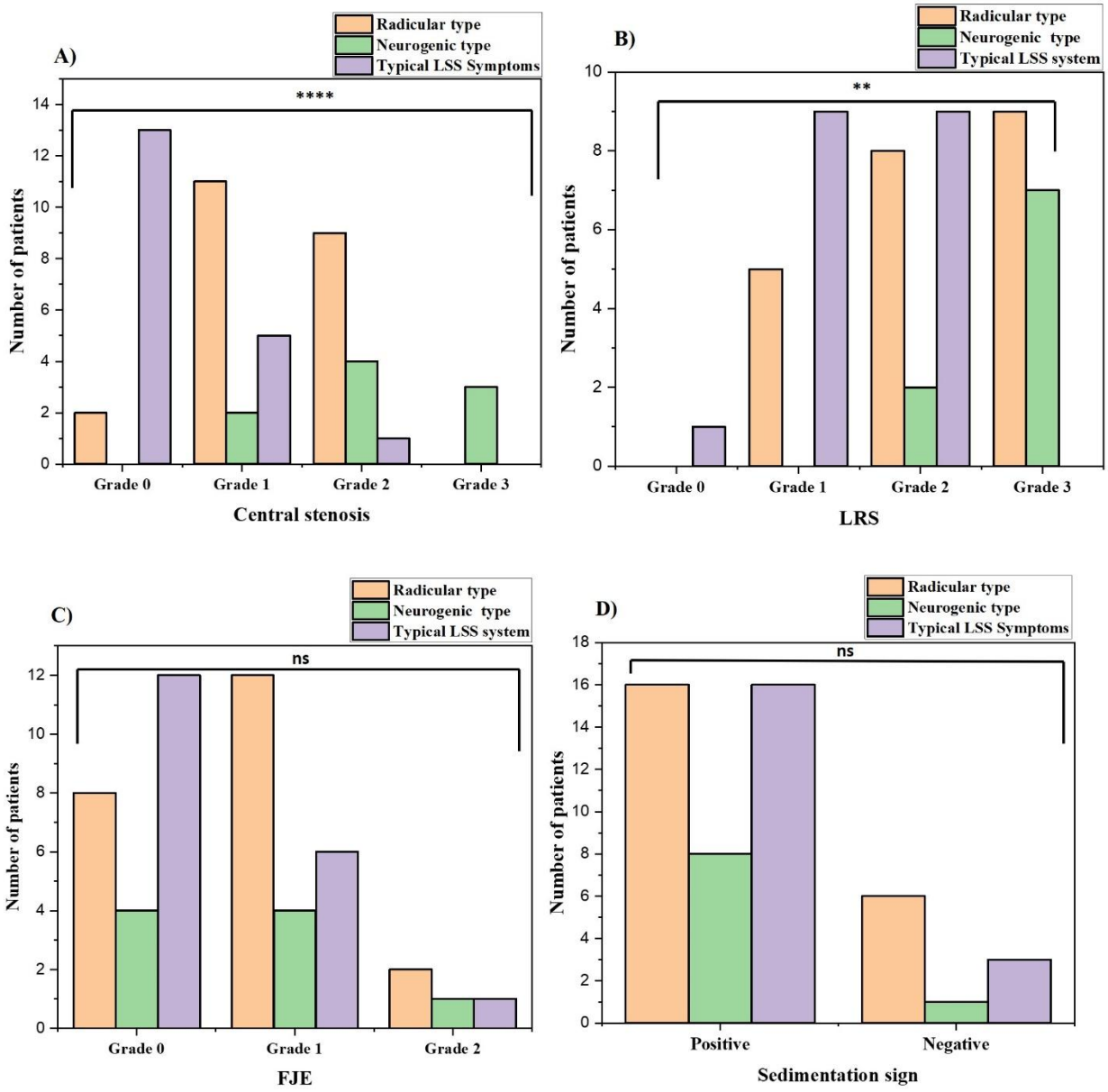

A)
Radicular type
Neurogenic type
Typical LSS Symptoms
****
Number of patients
Grade 0
Grade 1
Grade 2
Grade 3
Central stenosis
B)
Radicular type
Neurogenic type
Typical LSS system
**
Number of patients
Grade 0
Grade 1
Grade 2
Grade 3
LRS
C)
Radicular type
Neurogenic type
Typical LSS system
ns
Number of patients
Grade 0
Grade 1
Grade 2
FJE
D)
Radicular type
Neurogenic type
Typical LSS Symptoms
ns
Number of patients
Positive
Negative
Sedimentation sign

Fig. 3

1 **Tables**

2 **Table 1: Correlation Analysis of Lumbar Region Morphometric Parameters**

3

	CS area of Dural sac (cm2)	CS area of Lateral recess(cm2) Right	CS area of Lateral recess(cm2) left	Ligamentous interfacet distance	AP dia of Dural sac	TR dia of Dural sac	Total CS area(DS+LR) cm2	Depth of LR Right (mm)	Depth of LR left(mm)	Angle of LR(deg ree) Right	Angle of LR(deg ree) Left
CS area of Dural sac (cm2)	1	0.5762	0.547	0.3679	0.7459	0.7774	0.9589	0.5483	0.5894	0.4234	0.4053
CS area of Lateral recess(cm2) Right	0.5762	1	0.5684	0.4376	0.5458	0.5388	0.7311	0.8213	0.5142	0.8077	0.4887
CS area of Lateral recess(cm2) left	0.547	0.5684	1	0.2149	0.4175	0.3338	0.7127	0.5135	0.8493	0.4814	0.7581
Ligamentous interfacet distance	0.3679	0.4376	0.2149	1	0.1734	0.4554	0.4016	0.4896	0.3455	0.465	0.3234
AP dia of Dural sac	0.7459	0.5458	0.4175	0.1734	1	0.6384	0.7495	0.5764	0.4637	0.4825	0.3401

TR dia of Dural sac	0.7774	0.5388	0.3338	0.4554	0.6384	1	0.7478	0.5712	0.4486	0.4128	0.2716
Total CS area(DS+ LR) cm2	0.9589	0.7311	0.7127	0.4016	0.7495	0.7478	1	0.6642	0.7016	0.5696	0.5498
Depth of LR Right(mm)	0.5483	0.8213	0.5135	0.4896	0.5764	0.5712	0.6642	1	0.6605	0.8988	0.5588
Depth of LR left(mm)	0.5894	0.5142	0.8493	0.3455	0.4637	0.4486	0.7016	0.6605	1	0.5423	0.8402
Angle of LR(degree) Right	0.4234	0.8077	0.4814	0.465	0.4825	0.4128	0.5696	0.8988	0.5423	1	0.6423
Angle of LR(degree) Left	0.4053	0.4887	0.7581	0.3234	0.3401	0.2716	0.5498	0.5588	0.8402	0.6423	1

Table 2: Correlation Analysis of ODI and Lumbar Morphometric Parameters

Morphometric Parameters of the Lumbar Spine	OD (r- Value)
CS area of Dural sac (cm2)	-0.6549
CS area of Lateral recess(cm2) Right	-0.5708
CS area of Lateral recess(cm2) left	-0.508
Ligamentous interfacet distance	-0.4477
AP dia of Dural sac	-0.4431
TR dia of Dural sac	-0.5863
Total CS area (DS+ LR) cm2	-0.6965
Depth of LR Right(mm)	-0.5197
Depth of LR left(mm)	-0.5084
Angle of LR (degree) Right	-0.523
Angle of LR (degree) Left	-0.4536

Table 3: Critical Reference Values for Lumbar Spinal Canal Dimensions and Lateral Recess Parameters

Parameter	Mean	SD	Critical value (Mean + 2SD)	Critical value (Mean - 2SD)
			Upper limit	**Lower Limit**
CS area of Dural sac (cm^2)	0.555	0.25	0.982	0.201
CS area of Lateral recess (cm^2) Right	0.059	0.07	0.191	0
CS area of Lateral recess (cm^2) Left	0.053	0.07	0.203	0
AP diameter of Dural sac (mm)	6.25	1.49	9.23	3.26
TR diameter of Dural sac (mm)	10.11	2.74	15.59	4.62
Total CS area (cm^2)	0.66	0.35	1.36	0.04
Depth of LR Right (mm)	1.07	1.06	3.19	1.05
Depth of LR Left (mm)	0.98	1.11	3.2	1.24
Angle of LR Right (°)	9.3	9.91	29.12	10.53
Angle of LR Left (°)	7.77	9.93	27.63	12.09