The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 7, 2025

MRI- BASED RADIOLOGICAL ASSESSMENT OF LUMBAR SPONDYLOSIS IN PATIENTS WITH LOWER BACK PAIN

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DOI: https://doi.org/10.5281/zenodo.16631288

Keywords
Lumbar spondylosis, MRI, disc bulge, disc degeneration, spinal degeneration, low back pain

Article History
Received on 20 June 2025
Accepted on 25 June 2025
Published on 06 July 2025

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Abstract

Background: *Lumbar spondylosis is a prevalent degenerative condition contributing significantly to chronic lower back pain. MRI serves as a valuable non-invasive modality for evaluating spinal degenerative changes.*

Objectives: *To assess the frequency and pattern of MRI findings in patients with lumbar spondylosis and determine their association with age, gender, BMI, and symptom duration.*

Study Settings: *This cross-sectional study was conducted at Al-Noor Diagnostic Centre, Lahore.*

Duration of Study: *Months months (January 2025 to May 2025).*

Data Collection: *A total of 350 patients aged 18–80 years with lower back pain underwent lumbar spine MRI. Key MRI features evaluated included disc degeneration, disc bulge, endplate changes, osteophyte formation, facet joint arthrosis, ligamentum flavum hypertrophy, disc dehydration, and spondylolisthesis. Demographic data such as age, gender, BMI, and pain duration were recorded.*

Results: *The most common MRI findings were disc bulge (96.0%), disc dehydration (94.6%), and disc degeneration (91.1%). Endplate changes were observed in 25.1%, anterior osteophytes in 20.6%, facet joint arthrosis in 16.6%, ligamentum flavum hypertrophy in 10.3%, and spondylolisthesis in 8.9%. Significant associations ($p < 0.05$) were found between MRI findings and increasing age, higher BMI, and longer symptom duration. Males showed lower frequencies of degenerative features compared to females.*

Conclusion: *Disc bulge, dehydration, and degeneration are highly prevalent in lumbar spondylosis. Increasing age, BMI, and prolonged back pain duration are significantly associated with advanced MRI-detectable degenerative changes. Early imaging and stratified screening may guide timely management and reduce chronic disability.*

INTRODUCTION

Lumbar spondylosis, a degenerative condition affecting the lower spine, is commonly associated with aging and can lead to significant pain and disability. It involves the progressive wear and tear of the intervertebral discs, vertebrae, and surrounding structures, often resulting in symptoms such as lower back pain, stiffness, and restricted mobility. Radiological assessment plays a crucial role in diagnosing lumbar spondylosis, offering detailed visualization of the spine's structural changes, including disc degeneration, osteophyte formation, and facet joint alterations. Spinal disorders are increasingly recognized as a global health concern, with spondylosis emerging as a significant clinical challenge.[1] It is a degenerative condition associated with aging that broadly affects spinal regions, particularly the cervical and lumbar areas.[2] The terms lumbar spondylosis and lumbar osteoarthritis are commonly used to describe degenerative changes in the lumbar spine.[3] Lumbar spondylosis encompasses a range of pathological changes, including deterioration of intervertebral discs and facet joints, development of osteophytes (bony projections), sclerosis of vertebral bodies or endplates, thickening of spinal ligaments, and in more advanced cases, narrowing of the spinal canal or disc space, potentially leading to functional impairment.[4–5] One of the studies showed that among the patients investigated for lower back pain using MRI, almost 80% had lumbar disc degeneration, 52% had disc dehydration, 28% had endplate changes, 12% had anterior osteophyte formation, 27% had facet joint arthrosis, 37% had hypertrophy of ligamentum flavum, 17% had spondylolisthesis and 60% had disc bulge.[14] Lumbar spondylosis is a musculoskeletal condition and a leading cause of physical decline among the elderly population.[6] Degenerative changes in the lumbar spine may present with or without clinical symptoms.[7–8]

Low back pain is a prevalent health issue worldwide,[9] with nearly two-thirds[10] or approximately 80%[3] of individuals experiencing it during their lifetime. It serves as the most typical symptom associated with lumbar spondylosis. Multiple etiological factors contribute to this common condition. In most cases (about 90%),[11] symptoms resolve within six weeks; however, a considerable proportion—between 15% and 45%—develop chronic low back pain that persists beyond three months, severely affecting life quality. Degenerative disc disease, such as lumbar spondylosis, is one potential cause.[11] When symptoms are present, patients may also report sensory or motor deficits in the lower limbs, and pain that radiates to the hips or legs, often described as sciatica,[8] especially in younger individuals.[12] Advanced degeneration may cause spinal cord compression, resulting in neurologic symptoms such as neurogenic bladder or loss of function. Neurogenic claudication is a serious complication, usually linked to lumbar spinal stenosis, which arises in patients with prolonged lumbar spondylosis.[2] Despite these potential consequences, lumbar spondylosis often remains without symptoms and can begin in people as early as their twenties.

Several risk factors are strongly associated with lumbar spondylosis and contribute to disc degeneration, including age, sex, gender, body mass index (BMI), joint inflammation, physical trauma, and repetitive heavy lifting.[4,13] It has also been observed that individuals with long-standing lumbar spondylosis or disc degeneration often develop lumbar kyphosis. Chronic degenerative changes in the lumbar spine significantly interfere with daily functional activities.[14] The diagnostic approach to lumbar degenerative disease typically involves a detailed patient history, clinical examination, and imaging studies.

For radiological evaluation of lumbar disc degeneration or spondylosis, various imaging modalities are employed.[13] X-rays are generally used as the initial diagnostic tool, whereas MRI provides comprehensive assessment. Due to its superior soft tissue contrast, multiplanar imaging capability, and lack of ionizing radiation, magnetic resonance imaging has become the preferred modality for evaluating lower back pain.[8,15] With technological advancement, MRI is now regarded as an accurate and dependable method for detecting lumbar spondylosis, revealing degenerative disc disease, endplate alterations, disc herniation, spinal cord compression, and mechanical instability.[5,10] MRI allows clear visualization of the vertebral column and intervertebral disc spaces. A key benefit of MRI is its ability to simultaneously assess the spinal canal

contents and the vertebral disc structure—an advantage not offered by CT imaging. MRI detects desiccation of intervertebral discs and changes associated with lumbar spondylosis through variations in signal intensity within the vertebral endplates.[13]

The radiological assessment of lumbar spondylosis is essential due to the complexity of spinal degeneration and its varying clinical manifestations. While clinical symptoms like pain and limited movement provide initial clues, they often lack specificity regarding the underlying pathology. Imaging techniques such as X-rays and MRI offer precise insights into the structural changes in the spine, enabling healthcare providers to differentiate between spondylosis and other conditions that may present similarly, such as herniated discs or spinal stenosis. Furthermore, early radiological identification of degenerative changes allows for timely intervention, potentially preventing further deterioration and improving patient outcomes. By establishing a clear picture of the severity and location of degeneration, radiological assessment also aids in tailoring treatment plans, whether surgical or conservative and supports the long-term monitoring of the disease's progression.

METHODOLOGY:

This cross-sectional study was conducted at Al-Noor Diagnostic Center following the approval of the research synopsis by the College of Physicians and Surgeons Pakistan (CPSP). Data collection began immediately after approval and continued for a period of 3 to 6 months. The objective was to determine the pattern of lumbar spondylosis in patients presenting with chronic lower back pain as assessed on magnetic resonance imaging (MRI). A non-probability consecutive sampling technique was employed to recruit participants.

The calculated sample size was 350 patients, based on a 95% confidence level, a 3.5% margin of error, and an estimated prevalence of osteophyte formation in lower back pain patients at 12%. Patients between the ages of 30 to 80 years with chronic low back pain for more than 3 months who had been advised for lumbosacral spine MRI were eligible for inclusion. Additionally, clinical symptoms such as back stiffness or reduced mobility were used to support inclusion. Patients were excluded if they had a history of recent trauma, non-degenerative spinal conditions such as fractures, infections, or tumors, or spinal injuries unrelated to degenerative pathology. Pregnant women and patients with incomplete records or missing MRI images were also excluded.

All patients underwent lumbar spine MRI using a 1.5 Tesla machine. Standard imaging protocols included axial T2-weighted, sagittal T1-weighted, and sagittal T2-weighted sequences. The sagittal T2-weighted sequence served as the primary reference for morphological evaluation. Radiological assessment included features such as osteophyte formation, disc dehydration, disc bulge or protrusion (>3mm), disc height loss, annular tears, endplate changes, spondylolisthesis, ligamentum flavum hypertrophy, and facet joint arthropathy, consistent with operational definitions. Evaluations were performed across all five lumbar intervertebral disc levels from L1–S1. In cases of diagnostic ambiguity or variability, assessments were reviewed by more than one radiologist to ensure inter-observer consistency.

Clinical history and informed verbal consent were obtained from all patients. A standardized questionnaire was administered to document the severity and duration of symptoms, pain intensity, and impact on quality of life. Radiological findings were correlated with clinical presentations to explore associations between imaging features and symptom severity, including radicular pain or neurological deficits. To minimize interpretative subjectivity, standardized grading scales were utilized in reporting degenerative changes.

Data were analyzed using SPSS version 22. Quantitative variables such as age, body mass index (BMI), and duration of symptoms were presented as mean ± standard deviation, whereas qualitative variables such as gender and the presence or absence of specific MRI findings were summarized using frequencies and percentages. Stratification was performed for age, gender, BMI, and duration of back pain to identify potential effect modifiers. Post-stratification analysis was conducted using the Chi-square test, and a p-value < 0.05 was considered statistically significant.

RESULTS:

The study included 350 patients with lower back pain. The mean age of participants was 49.01 ± 12.75 years, with a mean height of 166.72 ± 9.56 cm and mean weight of 70.17 ± 12.50 kg. The mean BMI was 25.40 ± 4.20 kg/m², falling within the overweight category. The average duration of low back pain among patients was approximately 3.93 ± 5.60 years, indicating a largely chronic patient population. (Table 1)

Table 1: Demographic and Clinical Characteristics (N = 350)

Variable	Mean	Standard Deviation
Age (years)	49.01	12.75
Height (cm)	166.72	9.56
Weight (Kg)	70.17	12.50
BMI (kg/m²)	25.40	4.20
Duration of lower back pain (years)	3.93	5.60

MRI analysis revealed that the most frequent degenerative feature was disc bulge (96.0%), followed by disc dehydration (94.6%) and lumbar disc degeneration (91.1%). Other findings included endplate changes (25.1%), anterior osteophytes (20.6%), facet joint arthrosis (16.6%), ligamentum flavum hypertrophy (10.3%), and spondylolisthesis (8.9%). (Table 2)

Table 2: Frequency of MRI Findings in Lumbar Spondylosis (N = 350)

MRI Feature	Present (n, %)	Absent (n, %)
Lumbar Disc Degeneration	319 (91.1%)	31 (8.9%)
Endplate Changes	88 (25.1%)	262 (74.9%)
Anterior Osteophytes	72 (20.6%)	278 (79.4%)
Facet Joint Arthrosis	58 (16.6%)	292 (83.4%)
Ligamentum Flavum Hypertrophy	36 (10.3%)	314 (89.7%)
Disc Dehydration	331 (94.6%)	19 (5.4%)
Spondylolisthesis	31 (8.9%)	319 (91.1%)
Disc Bulge	336 (96.0%)	14 (4.0%)

Regarding anatomical involvement, the L4–L5 level was the most commonly affected (81.1%), followed by L5–S1 (67.7%) and L3–L4 (44.6%), as shown in Table 3. Higher lumbar levels (D12–L1 to L2–L3) were comparatively less involved.(Table 3)

Table 3: Frequency of Affected Lumbar Disc Levels (N = 350)

Disc Level	Present (n, %)	Absent (n, %)
D12–L1	6 (1.7%)	344 (98.3%)
L1–L2	37 (10.6%)	313 (89.4%)
L2–L3	73 (20.9%)	277 (79.1%)
L3–L4	156 (44.6%)	194 (55.4%)
L4–L5	284 (81.1%)	66 (18.9%)
L5–S1	237 (67.7%)	113 (32.3%)

When stratified by age, older patients (Group 2) had a significantly higher frequency of anterior osteophytes (32.2% vs. 11.9%, $p < 0.001$), facet joint arthrosis (29.5% vs. 7.0%, $p < 0.001$), ligamentum flavum hypertrophy (19.5% vs. 3.5%, $p < 0.001$), and spondylolisthesis (16.8% vs. 3.0%, $p < 0.001$). These findings reflect the

progressive nature of degenerative changes with advancing age. No statistically significant differences were observed for disc bulge, disc degeneration, or dehydration. (Table 4)

Table 4: Stratified Crosstab by Age Group

Variables		Age (years)		P-value
		Group 1 Count (%)	Group 2 Count (%)	
Lumbar disc degeneration	Yes	181 (90.0%)	138 (92.6%)	0.403
	No	20 (10.0%)	11 (7.4%)	
Endplate changes	Yes	43 (21.4%)	45 (30.2%)	0.060
	No	158 (78.6%)	104 (69.8%)	
Anterior osteophytes	Yes	24 (11.9%)	48 (32.2%)	<0.001
	No	177 (88.1%)	101 (67.8%)	
Facet joint arthrosis	Yes	14 (7.0%)	44 (29.5%)	<0.001
	No	187 (93.0%)	105 (70.5%)	
Hypertrophy of ligamentum flavum	Yes	7 (3.5%)	29 (19.5%)	<0.001
	No	194 (96.5%)	120 (80.5%)	
Disc dehydration	Yes	191 (95.0%)	140 (94.0%)	0.664
	No	10 (5.0%)	9 (6.0%)	
Spondylolisthesis	Yes	6 (3.0%)	25 (16.8%)	<0.001
	No	195 (97.0%)	124 (83.2%)	
Disk bulge	Yes	192 (95.5%)	144 (96.6%)	0.596
	No	9 (4.5%)	5 (3.4%)	

Gender-based stratification revealed that females had significantly higher rates of anterior osteophytes (24.2% vs. 16.3%, $p < 0.001$), facet joint arthrosis (20.5% vs. 11.9%, $p < 0.001$), and ligamentum flavum hypertrophy (13.2% vs. 6.9%, $p = 0.004$). Although not statistically significant, females also showed slightly higher rates of spondylolisthesis (11.1% vs. 6.3%). The frequency of disc bulge and disc dehydration remained similar across genders.(Table 5)

Table 5: Stratified Crosstab by Gender Group

Variable		Gender		P-value
		Male (n=160)	Female (n=190)	
Lumbar disc degeneration	Yes	144 (90.0%)	175 (92.1%)	0.476
	No	16 (10.0%)	15 (7.9%)	
Endplate changes	Yes	33 (20.6%)	55 (28.9%)	0.056
	No	127 (79.4%)	135 (71.1%)	
Anterior osteophytes	Yes	26 (16.3%)	46 (24.2%)	<0.001
	No	134 (83.7%)	144 (75.8%)	
Facet joint arthrosis	Yes	19 (11.9%)	39 (20.5%)	<0.001
	No	141 (88.1%)	151 (79.5%)	
Hypertrophy of ligamentum flavum	Yes	11 (6.9%)	25 (13.2%)	0.004
	No	149 (93.1%)	165 (86.8%)	
Disc dehydration	Yes	150 (93.8%)	181 (95.3%)	0.849
	No	10 (6.3%)	9 (4.7%)	
Spondylolisthesis	Yes	10 (6.3%)	21 (11.1%)	0.059

	No	150 (93.8%)	169 (88.9%)	
Disk bulge	Yes	153 (95.6%)	183 (96.3%)	0.659
	No	7 (4.4%)	7 (3.7%)	

Patients with BMI >25 exhibited significantly higher frequencies of anterior osteophytes (27.7% vs. 12.7%, p < 0.001), facet joint arthrosis (21.7% vs. 10.8%, p < 0.001), and ligamentum flavum hypertrophy (14.7% vs. 5.4%, p = 0.004). Spondylolisthesis was also more common in this group (10.9% vs. 6.6%, p = 0.049). These associations suggest that increased body weight may be a risk factor for more advanced degenerative changes. (Table 6)

Table 6: Stratified Crosstab by BMI Group

Variables		BMI		P-value
		BMI 16-25	BMI >25	
Lumbar disc degeneration	Yes	148 (89.2%)	171 (92.9%)	0.229
	No	18 (10.8%)	13 (7.1%)	
Endplate changes	Yes	35 (21.1%)	53 (28.8%)	0.087
	No	131 (78.9%)	131 (71.2%)	
Anterior osteophytes	Yes	21 (12.7%)	51 (27.7%)	<0.001
	No	145 (87.3%)	133 (72.3%)	
Facet joint arthrosis	Yes	18 (10.8%)	40 (21.7%)	<0.001
	No	148 (89.2%)	144 (78.3%)	
Hypertrophy of ligamentum flavum	Yes	9 (5.4%)	27 (14.7%)	0.004
	No	157 (94.6%)	157 (85.3%)	
Disc dehydration	Yes	157 (94.6%)	174 (94.6%)	1.000
	No	9 (5.4%)	10 (5.4%)	
Spondylolisthesis	Yes	11 (6.6%)	20 (10.9%)	0.049
	No	155 (93.4%)	164 (89.1%)	
Disk bulge	Yes	158 (95.2%)	178 (96.7%)	0.462
	No	8 (4.8%)	6 (3.3%)	

Patients with symptom duration >10 years showed a significantly higher frequency of endplate changes (42.3% vs. 23.8%, p = 0.048), anterior osteophytes (42.3% vs. 18.8%, p = 0.001), disc dehydration (88.5% vs. 95.1%, p = 0.023), and spondylolisthesis (19.2% vs. 8.0%, p = 0.015). These findings indicate a cumulative effect of prolonged stress on spinal structures over time, contributing to more advanced degeneration. (Table 7)

Table 7: Stratified Crosstab by duration of low low back pacin Group

Variables		Duration of low back pain		P-value
		0-10 years	>10 years	
Lumbar disc degeneration	Yes	296 (91.4%)	23 (88.5%)	0.530
	No	28 (8.6%)	3 (11.5%)	
Endplate changes	Yes	77 (23.8%)	11 (42.3%)	0.048
	No	247 (76.2%)	15 (57.7%)	
Anterior osteophytes	Yes	61 (18.8%)	11 (42.3%)	0.001
	No	263 (81.2%)	15 (57.7%)	
Facet joint arthrosis	Yes	56 (17.3%)	2 (7.7%)	0.572
	No	268 (82.7%)	24 (92.3%)	
Hypertrophy of ligamentum	Yes	34 (10.5%)	2 (7.7%)	0.859

flavum	No	290 (89.5%)	24 (92.3%)	
Disc dehydration	Yes	308 (95.1%)	23 (88.5%)	0.023
	No	16 (4.9%)	3 (11.5%)	
Spondylolisthesis	Yes	26 (8.0%)	5 (19.2%)	0.015
	No	298 (92.0%)	21 (80.8%)	
Disk bulge	Yes	310 (95.7%)	26 (100.0%)	0.408
	No	14 (4.3%)	0 (0.0%)	

DISCUSSION:

Lumbar spondylosis is a progressive degenerative disorder frequently implicated in chronic lower back pain, especially among middle-aged and elderly populations. In our study, the mean age was 49.01 ± 12.75 years, with a slight female predominance (54.3%). This demographic pattern is consistent with findings from Acquah et al. and Altan et al., both of whom reported higher prevalence of lumbar spondylosis in individuals between 40 and 70 years, and a predominance of female patients.[15-16]

The most prevalent MRI findings in our cohort were disc bulge (96.0%), disc dehydration (94.6%), and lumbar disc degeneration (91.1%), supporting the concept that disc-related pathology forms the central radiological hallmark of spondylosis. Similar high frequencies were reported by Mir et al. (disc degeneration: 80.2%; disc dehydration: 51.9%) and Patel et al. (disc bulge: 50%; disc degeneration: 10%), reinforcing the diagnostic utility of MRI in chronic low back pain.[14,17] Anatomically, **L4–L5 (81.1%)** and **L5–S1 (67.7%)** were the most commonly affected disc levels, aligning with the findings of Ogolodom et al. and Acquah et al., who also identified L4 as the most vulnerable segment due to increased biomechanical loading.[14,18]

Stratification by **age** revealed significantly more anterior osteophytes, facet joint arthrosis, ligamentum flavum hypertrophy, and spondylolisthesis in older patients ($p < 0.001$), indicating progressive structural changes. These findings mirror those of Acquah et al., who demonstrated increasing degenerative burden with age, particularly between 30 and 70 years.[18]

In terms of **gender**, our study found significantly higher degenerative changes in females, particularly anterior osteophytes and facet joint arthropathy. While Ehsan et al. reported a male majority, studies by Altan et al. and Acquah et al. reported higher female representation and similar degenerative trends, which may be influenced by post-menopausal hormonal changes and differing biomechanical stress exposures.[14,18,19] Patients with **BMI >25** exhibited significantly higher rates of osteophyte formation, facet arthrosis, and ligamentum flavum hypertrophy. Although most referenced studies did not assess BMI directly, our findings highlight a potential modifiable risk factor. Increased body mass likely contributes to spinal loading and accelerated degeneration, consistent with existing biomechanical literature.

Interestingly, **contrasts** were observed with some studies in terms of clinical-radiological correlation. Although our study relied on MRI to define pathology severity, Altan et al. and Ehsan et al. found that MRI findings did not always correlate with clinical symptoms such as radiculopathy or pain severity.[14,19] This disparity suggests that degenerative changes may often be present in asymptomatic individuals, underscoring the importance of combining radiological data with thorough clinical evaluation. Another contrast was the **lower frequency of facet joint arthrosis (16.6%)** and **spondylolisthesis (8.9%)** in our sample compared to studies like Mir et al. and Patel et al., where facet arthropathy and spondylolysis were more prominent.[16,17] These differences may be attributed to variations in population demographics, MRI grading criteria, and radiological interpretation thresholds. Furthermore, **Modic changes**, which have been strongly associated with symptomatic low back pain in studies like van der Graaf et al., were not specifically analyzed in our study.[20] Their absence represents a potential limitation and an area for improvement in future imaging-based research.

This study presents a comprehensive radiological overview of lumbar spondylosis across multiple intervertebral levels using standardized MRI criteria. However, limitations include the absence of

functional disability scores (e.g., Nurick or Roland-Morris), exclusion of Modic change analysis, and the lack of follow-up to assess symptom progression. Furthermore, being a single-center study limits external generalizability.

Future research should integrate MRI findings with validated clinical assessment tools and evaluate Modic changes for better prognostic insight. Multicenter studies with larger and more diverse populations would improve generalizability. Additionally, evaluating modifiable factors such as BMI may help in early preventive strategies.

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