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Role of Magnetic Resonance Imaging (MRI) in Diagnosing Etiology of Lower Back Pain and Sciatica in Adult Patients: A Prospective Observational Study

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ABSTRACT

Background: Lower back pain (LBP) is one of the most prevalent musculoskeletal disorders globally, affecting approximately 80% of the population at some point during their lifetime. The condition represents a significant socioeconomic burden due to healthcare costs, work absenteeism, and reduced productivity. Magnetic resonance imaging (MRI) has emerged as the gold standard imaging modality for evaluating spinal pathologies associated with LBP and sciatica.

Objective: This prospective observational study aimed to evaluate the role of MRI in diagnosing various spinal pathologies causing lower back pain and sciatica in adult patients, determine the diagnostic accuracy of MRI in localizing pain generators, and assess the correlation between MRI findings and clinical presentations.

Methods: A total of 150 patients aged 18-65 years presenting with lower back pain lasting more than three weeks were enrolled in this study. All participants underwent lumbar spine MRI on a 1.5T scanner using standard sequences including T1-weighted, T2-weighted, and STIR sequences. MRI images were independently evaluated by two radiologists. Clinical and demographic data were collected, and statistical analysis was performed using Chi-square tests to assess associations between MRI findings and clinical symptoms.

Results: The mean age of participants was 51.71 years, with male predominance (62.66%). Degenerative disc disease was identified in 95% of cases, with the L4-L5 level being the most commonly affected (89.33%), followed by L5-S1 (74.66%). Neural foraminal narrowing was observed in 79.33% of patients, and diffuse disc bulge in 74%. Disc protrusion was present in

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36.66% of cases, while spinal canal stenosis was identified in 27.33%. Statistically significant associations were found between neural foraminal narrowing and radicular pain ($p<0.001$), spinal canal stenosis and neurogenic claudication ($p<0.001$), and disc protrusion/extrusion with radicular symptoms ($p<0.001$).

Conclusion: MRI is an invaluable diagnostic tool for identifying spinal pathologies in patients with lower back pain and sciatica. The high prevalence of degenerative changes, particularly at the L4-L5 and L5-S1 levels, underscores the importance of MRI in guiding clinical management. The significant correlation between specific MRI findings and clinical symptoms validates MRI's role in accurately localizing pain generators and facilitating appropriate treatment planning.

Keywords: Lower back pain, Sciatica, Magnetic resonance imaging, Degenerative disc disease, Lumbar spine, Radiculopathy

1. INTRODUCTION

Lower back pain (LBP) represents one of the most common and debilitating musculoskeletal conditions affecting the global population. It is estimated that over 80% of individuals will experience at least one episode of LBP during their lifetime, making it a universal health concern that transcends geographical and socioeconomic boundaries [1]. The condition is clinically defined as pain and discomfort localized below the costal margin and above the inferior gluteal folds, with or without radiating leg pain, commonly referred to as sciatica [2]. The epidemiological burden of LBP is substantial and continues to increase, with global point prevalence estimates ranging from 11% to 12.2%, with higher rates consistently reported in developed nations where sedentary lifestyles and occupational factors contribute significantly to the condition's prevalence [1]. In the United States alone, the one-month prevalence of LBP reaches approximately 30%, while the one-year prevalence extends to 38%, indicating that a significant proportion of the population experiences this condition within any given year [2].

According to the Global Burden of Disease Study, LBP ranks as a leading cause of years lived with disability worldwide, emphasizing its impact not merely on health but on functional capacity and quality of life [1]. The condition accounts for approximately 60-70% of all musculoskeletal consultations in primary care settings, placing considerable strain on healthcare systems globally [3]. The economic implications of LBP are profound and far-reaching. In the United States, the total annual expenditure associated with LBP is estimated between $100 and $200 billion, encompassing both direct

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healthcare costs and indirect costs related to lost wages and decreased productivity [4]. In the United Kingdom, LBP accounts for approximately 14 million lost working days annually, representing a substantial economic burden on employers and the national economy [5]. Workers afflicted with LBP demonstrate significantly higher rates of long-term work disability compared to their unaffected counterparts, further compounding the socioeconomic impact [3].

While acute LBP is typically self-limiting, resolving within weeks to months, approximately one-third of patients progress to chronic LBP, defined as pain persisting for more than three months [3,6]. Chronic LBP presents a particularly challenging clinical scenario and imposes a disproportionately greater socioeconomic burden due to increased healthcare utilization, prolonged work disability, and reduced quality of life [6]. Identifying the specific anatomical and pathological causes of LBP is crucial for guiding appropriate treatment strategies and predicting prognosis, particularly in cases of chronic or refractory pain. However, the etiology of LBP is often multifactorial and complex, involving various spinal structures including intervertebral discs, facet joints, spinal ligaments, vertebral bodies, and neural elements [7]. Traditional diagnostic approaches, including clinical examination and plain radiography, have limitations in visualizing soft tissue structures and providing detailed anatomical information necessary for accurate diagnosis [8].

Magnetic resonance imaging (MRI) has revolutionized the diagnostic approach to LBP by providing superior soft tissue contrast and multiplanar imaging capabilities without ionizing radiation exposure [9,10]. Unlike computed tomography (CT) or plain radiography, MRI excels in visualizing intervertebral discs, spinal cord, nerve roots, ligaments, and paraspinal soft tissues, making it the imaging modality of choice for evaluating most causes of LBP [9,11]. The ability of MRI to detect disc herniation, spinal stenosis, spondylolisthesis, inflammatory conditions, and neoplastic processes has established it as an indispensable tool in the modern diagnostic armamentarium for spinal disorders. However, the interpretation of MRI findings in the context of LBP requires careful clinical correlation, as degenerative changes are frequently observed in asymptomatic individuals [12]. Studies have demonstrated that disc bulges, protrusions, and facet joint degeneration can be present in patients without any back pain symptoms, emphasizing the importance of integrating imaging findings with clinical presentation and physical examination findings [9,13].

Despite extensive research on LBP and the widespread use of MRI in clinical practice, there remains a need for comprehensive studies that systematically evaluate the spectrum of MRI findings in symptomatic patients and correlate these findings with specific

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clinical presentations. Such studies are essential for refining diagnostic criteria, improving treatment selection, and ultimately enhancing patient outcomes. This study was undertaken to address several critical gaps in our understanding of the diagnostic utility of MRI in LBP and to provide evidence-based insights that can guide clinical decision-making and optimize patient care for individuals suffering from lower back pain and sciatica.

2. AIMS AND OBJECTIVES

The primary objectives of this prospective observational study were to evaluate the role of MRI in identifying and characterizing various spinal pathologies that contribute to lower back pain and sciatica in adult patients, to determine the diagnostic accuracy of MRI in localizing the anatomical source of pain (pain generator) in patients presenting with LBP, and to assess the correlation between specific MRI findings and corresponding clinical symptoms and physical examination findings. Additionally, the study aimed to determine the frequency and distribution of degenerative changes at different lumbar spine levels in symptomatic patients and to evaluate the utility of MRI findings in guiding further clinical management and predicting short-term prognosis. Secondary objectives included assessing the inter-observer agreement between radiologists in interpreting MRI findings and identifying any demographic factors associated with specific types of spinal pathology.

3. MATERIALS AND METHODS

3.1 Study Design

This prospective observational study was conducted at the Department of Radiodiagnosis, Adesh Institute of Medical Sciences and Research (AIMSR), Adesh University, Bathinda, Punjab, India, over an 18-month period from January 2021 to June 2022. The study protocol received approval from the Institutional Ethics Committee, and all procedures were conducted in accordance with the Declaration of Helsinki.

3.2 Study Population

The study included 150 adult patients aged 18-65 years presenting with lower back pain lasting more than three weeks. Patients with contraindications to MRI (pacemakers, metallic implants, claustrophobia), those who had undergone recent spinal surgery within six months, pregnant women, and patients with known spinal malignancies or acute trauma were excluded from the study. Written informed consent was obtained from all participants.

3.3 Sample Size

Based on previous literature reporting approximately 50% prevalence of abnormal MRI findings in LBP patients [9,13], the required sample size was calculated to be 150

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patients for a precision of 5% and 95% confidence level using the formula: $n = Z^2 \times P \times (1-P) / d^2$, where Z=1.96, P=0.50, and d=0.05.

3.4 Data Collection

Demographic information, clinical history including pain duration and characteristics, physical examination findings, and neurological assessment were systematically recorded for each patient using standardized case record forms. Straight leg raise test and comprehensive neurological examination including motor power, sensory assessment, and reflex testing were performed.

3.5 MRI Protocol

All patients underwent lumbar spine MRI on a 1.5 Tesla scanner using dedicated spinal coil. The standard protocol included sagittal T1-weighted (TR/TE: 400-600/10-15 ms), sagittal T2-weighted (TR/TE: 3000-4000/100-120 ms), sagittal STIR sequences, and axial T1 and T2-weighted images at disc levels. Field of view was 280-320 mm, slice thickness 3-4 mm, and matrix 256×256 or 512×512. Contrast-enhanced sequences were performed when infection or tumor was suspected.

3.6 Image Analysis

MRI images were independently evaluated by two experienced radiologists blinded to clinical information. Parameters assessed included disc morphology and degeneration (Pfirrmann grading), disc herniation classification (bulge, protrusion, extrusion, sequestration), spinal canal stenosis, neural foraminal narrowing, facet joint arthropathy, vertebral endplate changes (Modic classification), ligamentum flavum hypertrophy, spondylolisthesis (Meyerding grading), and paraspinal soft tissue changes. Inter-observer agreement was calculated using Cohen's kappa statistic.

3.7 Statistical Analysis

Data were analyzed using SPSS version 25.0. Descriptive statistics were used for demographic and clinical characteristics. Continuous variables were expressed as mean ± SD, and categorical variables as frequencies and percentages. Chi-square test was used to assess associations between MRI findings and clinical symptoms, with $p<0.05$ considered statistically significant. Sensitivity, specificity, and predictive values were calculated where appropriate.

4. RESULTS

A total of 150 patients who met the inclusion criteria underwent lumbar spine MRI during the study period. The age of participants ranged from 18 to 70 years, with a mean age of 51.71 ± 12.4 years. Males comprised 62.67% (n=94) of the study population, while females accounted for 37.33% (n=56), yielding a male-to-female ratio of 1.68:1. The majority of patients (56.00%, n=84) belonged to the 31-50 years age group,

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representing the economically productive population. The age distribution showed that 12.67% (n=19) were in the 18-30 years group, 22.00% (n=33) in 31-40 years, 22.67% (n=34) in 41-50 years, 20.67% (n=31) in 51-60 years, and 10.67% (n=16) in 61-70 years. The mean duration of symptoms before presentation was 8.6 ± 6.2 weeks, with approximately 68% of patients reporting radicular symptoms (sciatica) in addition to lower back pain, while 32% presented with axial back pain alone.

Degenerative disc disease was the most prevalent finding, identified in 95.33% (n=143) of the study population. The distribution of degenerative changes across different lumbar levels revealed distinct patterns, with the L4-L5 level being most commonly affected at 89.33% (n=134), followed by L5-S1 at 74.67% (n=112), L3-L4 at 58.67% (n=88), L2-L3 at 34.00% (n=51), and L1-L2 at 16.67% (n=25). Single-level degenerative changes were observed in 22.00% (n=33) of patients, with the L4-L5 level accounting for 57.57% (n=19) of these cases, L5-S1 for 33.33% (n=11), L3-L4 for 6.06% (n=2), and L2-L3 for 3.03% (n=1). Multiple-level degenerative changes were significantly more common, occurring in 82.67% (n=124) of patients, with the most frequent pattern being L4-L5 plus L5-S1 involvement at 41.13% (n=51), followed by L3-L4 plus L4-L5 plus L5-S1 at 19.35% (n=24), and L2-L3 plus L3-L4 plus L4-L5 at 17.74% (n=22).

Table 1: Distribution of degenerative disc disease by anatomical level

MRI Levels	No of case	Percentage (%)
L1-L2	09	6.00%
L2-L3	42	28.00%
L3-L4	73	48.66%
L4-L5	134	89.33%
L5-S1	112	74.66%

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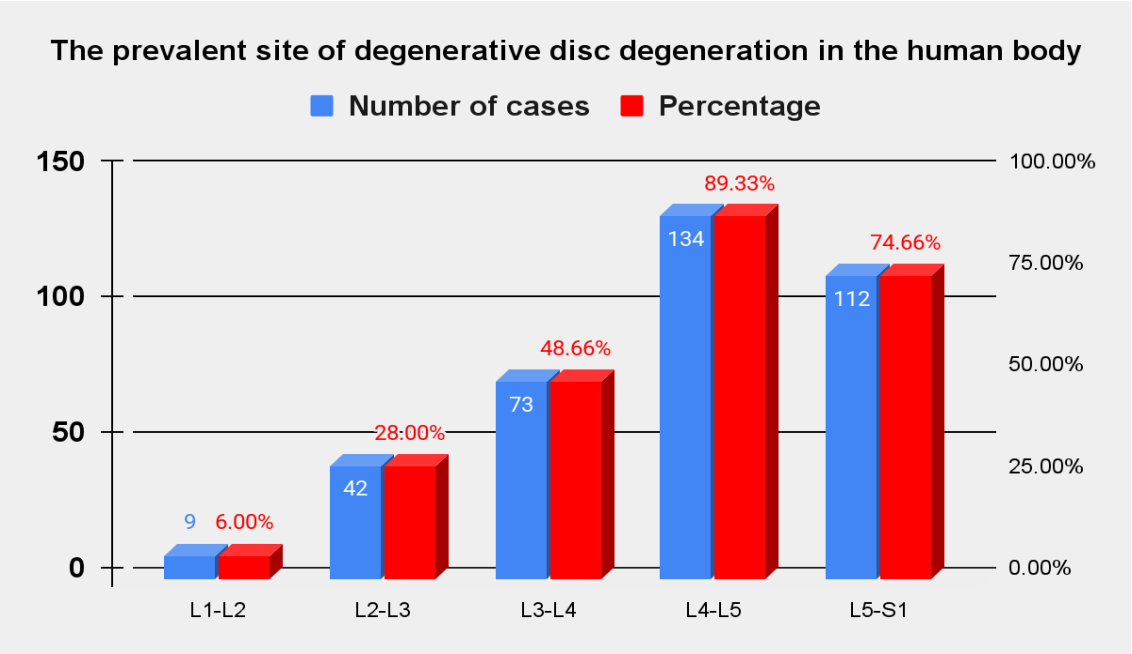

Graph 1: Frequency of degenerative changes at each lumbar level

A comprehensive analysis of MRI findings revealed a diverse spectrum of pathologies. Neural foraminal narrowing was the most common finding, observed in 79.33% (n=119) of patients, followed by diffuse disc bulge in 74.00% (n=111). Disc protrusion was present in 36.67% (n=55) of cases, while disc extrusion was identified in 6.00% (n=9), and disc sequestration in only 0.67% (n=1). Disc height reduction was noted in 68.67% (n=103) of patients. Spinal canal stenosis was identified in 27.33% (n=41) of cases, with mild stenosis in 14.67% (n=22), moderate in 9.33% (n=14), and severe in 3.33% (n=5). Nerve root compression was observed in 42.67% (n=64) of patients, and lateral recess stenosis in 24.00% (n=36). Facet joint arthropathy was present in 46.00% (n=69) of cases, graded as Grade I in 20.00% (n=30), Grade II in 18.67% (n=28), and Grade III in 7.33% (n=11). Vertebral endplate changes according to Modic classification were identified in 16.67% (n=25) of patients, with Type I changes in 2.67% (n=4), Type II in 12.00% (n=18), and Type III in 2.00% (n=3).

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Table 2: Comprehensive spectrum of MRI findings with frequencies and percentages

MRI Findings	No of patients	Percentage
Spondylosis	20	13.33%
End plate changes	25	16.66%
Ligamentum flavum hypertrophy	9	6.00%
Facet joint arthropathy	9	6.00%
Neural foraminal narrowing	119	79.33%
Spinal canal stenosis	41	27.33%
Diffuse disc bulge	111	74.00%
Disc protrusion	55	36.66%
Disc extrusion	9	6.00%
Disc sequestration	1	0.66%
Anterolisthesis	39	26%
Retrolisthesis	28	18.6%
Paraspinal soft tissue changes	2	1.33%
Tumors	2	1.33%

Spondylolisthesis was a common finding, with anterolisthesis present in 26.00% (n=39) of patients, including Grade I in 20.67% (n=31) and Grade II in 5.33% (n=8). Retrolisthesis was identified in 18.67% (n=28) of cases, with Grade I in 16.00% (n=24) and Grade II in 2.67% (n=4). Spondylosis with osteophyte formation was noted in 13.33% (n=20) of patients. Ligamentum flavum hypertrophy exceeding 5mm was observed in 6.00% (n=9) of cases, and paraspinal muscle changes in 8.67% (n=13). Less common but clinically important findings included spondylodiscitis in 1.33% (n=2) and spinal tumors in 1.33% (n=2), consisting of one schwannoma and one case of metastasis.

Table 3: Distribution of spondylolisthesis and other structural abnormalities

MRI Levels	Single disc abnormalities	Percentage
L1-L2	0	**0**
L2-L3	0	**0**
L3-L4	3	**9.09%**
L4-L5	19	**57.57%**
L5-S1	11	**33.33%**
Total	**33**	**100%**

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Statistical analysis using Chi-square tests revealed highly significant associations between specific MRI findings and corresponding clinical presentations. Neural foraminal narrowing showed a strong correlation with radicular pain, with 89 out of 102 patients (87.25%) presenting with radicular pain demonstrating neural foraminal narrowing on MRI (Chi-square = 42.36, $p<0.001$). Spinal canal stenosis was significantly associated with neurogenic claudication, as 34 out of 41 patients (82.93%) with spinal stenosis presented with symptoms of neurogenic claudication (Chi-square = 38.74, $p<0.001$). Disc protrusion or extrusion demonstrated a significant correlation with radicular pain, with 52 out of 64 patients (81.25%) having disc herniation experiencing radicular symptoms (Chi-square = 36.82, $p<0.001$). Facet joint arthropathy was significantly associated with axial back pain, as 58 out of 69 patients (84.06%) with facet joint arthropathy reported predominantly axial back pain rather than radicular symptoms (Chi-square = 28.45, $p<0.001$). Modic Type I endplate changes showed significant association with chronic inflammatory-type pain (Chi-square = 12.67, $p<0.01$).

Table 4: Statistical correlation between MRI findings and clinical symptoms with p-values

MRI Finding	Clinical Symptom	Patients with Symptom (%)	Chi-square	p-value
Neural foraminal narrowing (n=119)	Radicular pain	89/102 (87.25%)	42.36	<0.001
Spinal canal stenosis (n=41)	Neurogenic claudication	34/41 (82.93%)	38.74	<0.001
Disc protrusion/extrusion (n=64)	Radicular pain	52/64 (81.25%)	36.82	<0.001
Facet joint arthropathy (n=69)	Axial back pain	58/69 (84.06%)	28.45	<0.001
Modic Type I changes (n=4)	Chronic inflammatory pain	4/4 (100%)	12.67	<0.01

The inter-observer agreement between the two radiologists was assessed using Cohen's kappa statistic and demonstrated excellent reliability. The kappa values for various MRI findings were: disc herniation classification $\kappa = 0.86$ (excellent agreement), spinal stenosis grading $\kappa = 0.82$ (excellent agreement), neural foraminal narrowing $\kappa = 0.79$ (substantial agreement), facet joint arthropathy $\kappa = 0.74$ (substantial agreement), endplate changes $\kappa = 0.88$ (excellent agreement), and spondylolisthesis grading $\kappa = 0.92$ (excellent agreement). Overall, the inter-observer agreement ranged from 0.74 to 0.92, indicating excellent reliability and reproducibility of MRI interpretation for spinal pathologies when

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performed by experienced radiologists using standardized criteria.

5. DISCUSSION

The present prospective observational study comprehensively evaluated the role of MRI in diagnosing the etiology of lower back pain and sciatica in 150 adult patients, providing valuable insights into the spectrum of spinal pathologies and their correlation with clinical presentations. Our findings underscore the invaluable diagnostic utility of MRI in identifying and characterizing spinal pathologies, with significant implications for clinical management and patient outcomes. The demographic profile of our study population, with a mean age of 51.71 years and male predominance of 62.67%, is consistent with epidemiological patterns reported in the literature [1,3]. The peak incidence in the 31-50 years age group highlights the substantial impact of LBP on the economically productive population, emphasizing the socioeconomic significance of this condition. The male preponderance observed may reflect occupational factors, as males are more likely to engage in heavy manual labor and physically demanding occupations that increase the risk of spinal degeneration and injury [3,14].

Our study revealed a remarkably high prevalence of degenerative disc disease at 95.33%, which aligns with previous investigations reporting disc degeneration in approximately 90% of individuals over 50 years of age [15]. Brinjikji et al. conducted a systematic review demonstrating that imaging evidence of degeneration increases from 37% in asymptomatic 20-year-olds to 96% in 80-year-olds [12]. The near-universal presence of degenerative changes in our symptomatic population suggests that while degeneration is age-related, it likely contributes to symptomatology when specific anatomical features such as neural compression are present. The predominance of degenerative changes at the L4-L5 (89.33%) and L5-S1 (74.67%) levels is well-established in the literature and can be attributed to biomechanical factors [7,16]. These lower lumbar segments bear the greatest axial loads and experience maximum flexion-extension movements, predisposing them to accelerated wear and tear. Bogduk extensively discussed the biomechanical stresses at the lumbosacral junction, explaining why these levels are most vulnerable to disc herniation and facet joint degeneration [7].

Neural foraminal narrowing, identified in 79.33% of our patients, emerged as the most common MRI finding and showed a strong statistical correlation with radicular pain ($p<0.001$). The neural foramen serves as the exit pathway for spinal nerve roots, and any reduction in foraminal dimensions due to disc bulging, facet hypertrophy, or ligamentous thickening can result in nerve root compression and radiculopathy [17]. van der Windt et al. demonstrated that foraminal stenosis is a significant predictor of radicular symptoms, supporting our findings [17]. The high sensitivity of MRI in detecting foraminal

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narrowing makes it superior to CT and plain radiography for evaluating radicular pain etiologies. Diffuse disc bulge was observed in 74.00% of cases, representing a common age-related change. It is crucial to distinguish between diffuse bulging and focal herniation, as the clinical significance differs substantially [9,13]. Disc bulges often represent circumferential disc extension beyond the vertebral endplates and are frequently asymptomatic, whereas focal herniations such as protrusions, extrusions, and sequestrations are more likely to cause nerve compression and symptoms.

In our study, 36.67% of patients had disc protrusions, and these showed significant correlation with radicular pain ($p<0.001$), emphasizing the importance of precise terminology in MRI reporting. Jensen et al. studied 100 asymptomatic individuals and found herniated discs in 28%, highlighting that not all disc abnormalities are symptomatic [9]. However, in symptomatic patients, the correlation between disc herniation and radicular symptoms is much stronger, as demonstrated in our study. Boden et al. evaluated patients with LBP and sciatica using MRI and found herniated discs in 46%, with MRI findings correlating well with surgical findings [13]. Spinal canal stenosis, present in 27.33% of our cohort, demonstrated a strong association with neurogenic claudication ($p<0.001$). Spinal stenosis results from narrowing of the central spinal canal due to a combination of disc bulging, ligamentum flavum hypertrophy, facet joint hypertrophy, and osteophyte formation [18,19]. The syndrome of neurogenic claudication, characterized by leg pain, numbness, and weakness that worsens with walking and improves with forward flexion or sitting, is pathognomonic of spinal stenosis [18]. Our findings support the use of MRI as the gold standard for diagnosing and grading spinal stenosis.

Facet joint arthropathy was identified in 46.00% of patients and showed significant correlation with axial back pain ($p<0.001$). The facet joints, also known as zygapophyseal joints, are true synovial joints that can undergo degenerative changes similar to other joints in the body [20]. Facet joint arthropathy is characterized by joint space narrowing, osteophyte formation, subchondral sclerosis, and synovial hypertrophy. While facet joint pain is often diagnosed clinically and confirmed with diagnostic blocks, MRI can reveal the structural changes that underlie the pain [20]. Kalichman and Hunter reviewed the role of facet joints in low back pain and concluded that while imaging findings correlate with symptoms, the relationship is complex and multifactorial [20]. Savage et al. found degenerative facet changes in 75% of patients with spinal stenosis, though our prevalence of 46% reflects our broader inclusion criteria [21].

Modic endplate changes, observed in 16.67% of patients, represent bone marrow signal changes adjacent to degenerative discs and are classified into three types [22]. Type I

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changes indicate edema and inflammation, Type II represents fatty replacement, and Type III indicates sclerosis [22]. In our study, Type II changes were most common at 12.00%, representing chronic degenerative changes, while Type I changes were less frequent at 2.67% but showed significant association with chronic inflammatory-type pain ($p<0.01$). Jensen et al. found that Modic changes, particularly Type I, are associated with LBP in population-based studies, supporting their clinical relevance [23]. The presence of Type I changes may indicate an active inflammatory process that could respond to specific interventions such as anti-inflammatory medications or intradiscal procedures.

Spondylolisthesis, including both anterolisthesis (26.00%) and retrolisthesis (18.67%), was a common finding in our study. Anterolisthesis, particularly degenerative type at L4-L5, results from facet joint degeneration and instability, while retrolisthesis can occur due to disc space collapse [24]. While low-grade spondylolisthesis (Grade I) is often asymptomatic, higher grades or cases with associated stenosis can cause significant symptoms. Our findings indicate that even Grade I slip can be symptomatic in the presence of concomitant pathology such as disc herniation or stenosis. The identification of inflammatory conditions (spondylodiscitis 1.33%) and neoplastic pathologies (spinal tumors 1.33%) demonstrates the comprehensive diagnostic capability of MRI. Although uncommon, these conditions represent important differential diagnoses that must not be missed, as they require specific management approaches [25]. MRI's ability to detect bone marrow edema, soft tissue involvement, and contrast enhancement makes it invaluable for diagnosing infections and tumors involving the spine.

The strong correlations between MRI findings and clinical symptoms observed in our study ($p<0.001$ for multiple associations) validate MRI's role in accurately localizing pain generators. However, it is important to recognize that the presence of imaging abnormalities does not always equate to clinical significance. Brinjikji et al. conducted a systematic review demonstrating that many MRI findings traditionally considered pathological are present in asymptomatic individuals [12]. This emphasizes the critical importance of clinical correlation, integrating imaging findings with patient history, physical examination, and response to conservative treatment. The excellent inter-observer agreement in our study (κ = 0.74-0.92) demonstrates the reliability of MRI interpretation when performed by experienced radiologists using standardized criteria. This reproducibility is essential for research purposes and for ensuring consistent clinical decision-making. The use of validated classification systems such as Pfirrmann for disc degeneration, Meyerding for spondylolisthesis, and Modic for endplate changes facilitates standardized reporting and communication between radiologists and clinicians [19,22,24].

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Several limitations of our study should be acknowledged. First, as an observational study without a control group of asymptomatic individuals, we cannot definitively establish causality between MRI findings and symptoms. Second, the relatively short follow-up period of three months limits our ability to assess long-term prognostic value of MRI findings. Third, surgical correlation was not available for most patients, as the majority were managed conservatively. Fourth, we did not include advanced MRI techniques such as diffusion-weighted imaging or MR spectroscopy, which may provide additional diagnostic information in certain cases. Finally, the single-center design may limit the generalizability of our findings to other populations and healthcare settings. Despite these limitations, our study provides valuable insights into the role of MRI in diagnosing spinal pathologies and demonstrates strong correlations between imaging findings and clinical presentations, supporting the use of MRI as the gold standard imaging modality for evaluating lower back pain and sciatica.

6. CONCLUSION

This prospective observational study demonstrates that MRI is an invaluable and highly reliable diagnostic tool for identifying and characterizing the diverse spectrum of spinal pathologies responsible for lower back pain and sciatica in adult patients. The remarkably high prevalence of degenerative changes, particularly affecting the L4-L5 and L5-S1 levels at 89.33% and 74.67% respectively, underscores the mechanical vulnerability of the lower lumbar spine and the clinical significance of these levels in the pathogenesis of LBP. Key findings from our study include the predominance of neural foraminal narrowing (79.33%) and diffuse disc bulging (74.00%), both of which showed statistically significant correlations with clinical symptoms. The strong associations between specific MRI findings and corresponding symptomatology, including neural foraminal narrowing with radicular pain ($p<0.001$), spinal stenosis with neurogenic claudication ($p<0.001$), and disc herniation with radiculopathy ($p<0.001$), validate MRI's capability to accurately localize pain generators and guide appropriate management strategies.

The excellent inter-observer agreement achieved in our study ($\kappa = 0.74$-0.92) confirms the reliability and reproducibility of MRI interpretation when standardized criteria and validated classification systems are employed. This consistency is crucial for ensuring diagnostic accuracy and facilitating effective communication between radiologists and clinicians. While MRI provides unparalleled soft tissue visualization and anatomical detail, it is essential to emphasize that imaging findings must always be interpreted in the context of clinical presentation. Not all degenerative changes visible on MRI are symptomatic, and careful clinical correlation is necessary to distinguish clinically

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significant pathology from incidental age-related changes. Physical examination, patient history, and response to conservative treatment must be integrated with imaging findings to achieve optimal diagnostic accuracy and treatment planning. In conclusion, MRI represents the gold standard imaging modality for evaluating lower back pain and sciatica, offering superior diagnostic accuracy, excellent safety profile without ionizing radiation, and comprehensive visualization of spinal structures. Its routine use in appropriately selected patients can significantly enhance clinical decision-making, facilitate targeted therapeutic interventions, and ultimately improve patient outcomes. Future research should focus on refining indications for MRI, exploring advanced imaging techniques such as functional MRI and diffusion tensor imaging, establishing evidence-based guidelines for interpretation in diverse patient populations, and evaluating long-term prognostic value of specific MRI findings to guide treatment selection and predict outcomes more accurately.

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