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Comparative Evaluation of Magnetic Resonance Imaging and Plain Radiography in the Assessment of Lumbar Disc Degeneration

Dr. Aman Kumar[1], Dr. Shruti Sharma[2], Dr Shreya Khandelwal[3], Dr. Shivani Dhaka[4]

[1]Assistant Professor, MD, Department of Radiology, Mata Gujri Medical College and LSK Hospital, Kishanganj, Bihar, India
[2]Assistant Professor, DNB, Department of Radiology, Mata Gujri Medical College and LSK Hospital, Kishanganj, Bihar, India
[3]2nd Year PG Resident, Mata Gujri Medical College and LSK Hospital, Kishanganj, Bihar, India
[4]3rd Year PG Resident, Department of Radiology, SGT University, Budhera, Gurugram, Haryana, India

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Corresponding Author:

Dr. Shreya Khandelwal
MBBS, Mata Gujri Medical College and LSK Hospital, Kishanganj, Bihar, India
Email:
drshreyakhandelwal1@gmail.com

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ABSTRACT

Background: Lumbar disc degeneration is a major contributor to chronic low back pain and disability worldwide. While magnetic resonance imaging (MRI) is regarded as the imaging modality of choice for evaluating degenerative changes of the lumbar spine, plain radiography remains widely used because of its accessibility, low cost, and rapid acquisition. This study aimed to systematically compare the diagnostic utility of plain radiography and MRI in the evaluation of lumbar spine degeneration.

Methods: This hospital-based cross-sectional study included patients with clinical suspicion of lumbar degenerative disease. All participants underwent plain radiography of the lumbar spine in anteroposterior, lateral, and oblique projections, and imaging findings were recorded using a structured proforma. Subsequently, MRI of the lumbar spine was performed according to a standardized imaging protocol. Data were entered into Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) version 20.0. Pearson's chi-square test was employed, where appropriate, to evaluate associations and determine statistical significance between categorical variables.

Results: A total of 90 patients were evaluated using both plain radiography and MRI. The most frequently observed radiographic finding was osteophyte formation, identified in 43 patients (47.8%), followed by spondylolisthesis in 11 patients (12.2%). Osteophytes were more readily detected on plain radiographs than on MRI, whereas spondylolisthesis was identified with comparable frequency on both modalities. Conversely, MRI demonstrated superior detection of Modic endplate changes, intervertebral disc height loss, and facet joint hypertrophy compared with plain radiography.

Conclusion: Plain radiography of the lumbar spine remains a valuable initial imaging modality in the assessment of chronic low back pain associated with suspected lumbar disc degeneration. Given its cost-effectiveness, widespread availability, low radiation burden, and ability to identify several clinically relevant degenerative changes, radiography should be considered as the first-line imaging investigation before MRI. MRI, however, provides greater sensitivity for detecting early and complex degenerative changes and serves as an important complementary tool when further diagnostic evaluation is required.

Keywords: *Lumbar disc degeneration; Magnetic resonance imaging; Plain radiography; Chronic low back pain; Osteophytes; Modic changes; Degenerative spine disease.*

INTRODUCTION

Degenerative disorders of the lumbar spine are among the most common causes of chronic low back pain and represent a significant source of disability and healthcare utilization worldwide. Diagnostic imaging plays a central role in the

evaluation of these conditions by facilitating the assessment of structural abnormalities, identifying potential neural compromise, and guiding clinical management and therapeutic decision-making (1).

Several imaging modalities are available for the assessment of lumbar degenerative disease, including conventional radiography, computed tomography (CT), CT myelography, discography, and magnetic resonance imaging (MRI). Among these, plain radiography has traditionally served as the initial imaging modality because of its widespread availability, low cost, rapid acquisition, and relatively low radiation exposure. Standard lumbar spine radiographs, including anteroposterior, lateral, and oblique projections, provide valuable information regarding disc space narrowing, vertebral alignment, endplate sclerosis, osteophyte formation, facet joint arthropathy, and spondylolisthesis (2).

With advances in imaging technology, MRI has emerged as the preferred modality for evaluating patients with low back pain owing to its superior soft-tissue contrast and multiplanar imaging capabilities (3). MRI enables detailed assessment of the intervertebral discs, vertebral marrow, spinal ligaments, neural foramina, spinal canal, and adjacent neural structures, allowing earlier detection and more comprehensive characterization of degenerative changes than conventional radiography. Furthermore, MRI can directly visualize pathological processes that are not appreciable on plain radiographs, including disc degeneration, annular tears, nerve root compression, and vertebral marrow abnormalities.

Despite these advantages, the increasing utilization of advanced imaging raises important questions regarding its clinical value in routine evaluation of lumbar degenerative disease. Although MRI offers greater anatomical detail and diagnostic sensitivity, improved detection of imaging abnormalities does not necessarily translate into superior clinical outcomes or altered patient management (4). Many degenerative findings identified on MRI are also frequently observed in asymptomatic individuals and may have limited clinical significance when interpreted in isolation.

Consequently, the role of conventional radiography in the contemporary evaluation of lumbar degenerative disease remains relevant. As a readily available and cost-effective imaging modality, radiography continues to provide important diagnostic information regarding structural degenerative changes and spinal alignment while reducing the need for more expensive investigations in selected patients. Given the growing emphasis on value-based healthcare and judicious utilization of diagnostic resources, a critical comparison of radiographic and MRI findings is warranted.

The present study was undertaken to compare the diagnostic findings of plain radiography and MRI in patients with suspected lumbar disc degeneration and to evaluate the continuing role of conventional radiography in the assessment of degenerative lumbar spine disease.

METHODS AND MATERIALS

Study Design and Setting

This hospital-based cross-sectional observational study was conducted in the Department of Radio-Diagnosis of a tertiary care center over a one-year period from August 2015 to August 2016. The study protocol was approved by the Institutional Review Board (IRB), and written informed consent was obtained from all participants prior to enrollment.

Study Population

All consecutive patients referred to the Department of Radio-Diagnosis with clinical suspicion of degenerative lumbar spine disease during the study period were screened for eligibility. A total of 90 patients were included in the study.

Inclusion Criteria

Patients meeting any of the following criteria were included:

- Patients presenting with low back pain, with or without radiculopathy.
- Patients referred by clinicians with a clinical suspicion of degenerative disease of the lumbar spine.

Exclusion Criteria

The following patients were excluded from the study:

- Patients with a history of acute spinal trauma.
- Patients with prior spinal surgery.
- Patients with spinal infections, tumors, or tumor-like lesions.
- Patients with metallic implants contraindicating MRI examination.
- Patients younger than 18 years of age.

No control group was included.

Imaging Protocol

All enrolled patients underwent both plain radiography and MRI evaluation of the lumbar spine. Conventional radiographs were obtained in anteroposterior, lateral, and oblique projections. Radiographic findings were documented using a structured data collection proforma.

MRI examinations were performed using a 0.35-Tesla open magnet system (MAGNETOM C! SYNGO, Siemens, Germany). Imaging was performed from the L1 to S1 vertebral levels using a standardized lumbar spine protocol. The protocol included non-contrast T1-weighted sequences in axial and sagittal planes, T2-weighted sequences in axial, sagittal, and coronal planes, and short tau inversion recovery (STIR) sequences in the sagittal plane. Images were acquired with a slice thickness of 5 mm or less. Intravenous contrast-enhanced T1-weighted imaging in axial and sagittal planes was performed whenever clinically indicated. MRI findings were recorded using the same structured proforma and subsequently compared with radiographic findings.

Data Collection and Statistical Analysis

Clinical information, radiographic findings, and MRI findings were systematically recorded and entered into a Microsoft Excel database. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 20.0 (IBM Corp., Armonk, NY, USA).

Descriptive statistics were used to summarize demographic and imaging findings. Associations between categorical variables and differences in imaging findings between radiography and MRI were evaluated using Pearson's chi-square test, where appropriate. A two-tailed p-value of <0.05 was considered statistically significant. Statistical significance was assessed at a 95% confidence level.

RESULTS

A total of 90 patients with clinically suspected degenerative disease of the lumbar spine underwent evaluation with both plain radiography and MRI.

The most common degenerative finding detected on plain radiography was osteophyte formation, observed in 43 patients (47.8%), followed by spondylolisthesis in 11 patients (12.2%). On MRI, the most frequently identified abnormality was Modic endplate change, which was present in 34 patients (37.8%), followed by osteophyte formation in 30 patients (33.3%) (Table 1).

Table 1. Comparison of degenerative lumbar spine findings detected on plain radiography and MRI (n = 90).

Imaging Findings	X-ray n (%)	MRI n (%)	P-value
Osteophytes	43 (47.8)	30 (33.3)	0.048
Modic changes	7 (7.8)	34 (37.8)	< 0.001
Disc height reduction	6 (6.7)	8 (8.9)	0.578
Spondylolisthesis	11 (12.2)	11 (12.2)	1
Facet joint hypertrophy	2 (2.2)	6 (6.7)	0.148

Comparison of findings between the two imaging modalities demonstrated that osteophytes were detected significantly more frequently on plain radiographs than on MRI (47.8% vs. 33.3%; $p = 0.048$). In contrast, Modic changes were identified significantly more often on MRI than on plain radiography (37.8% vs. 7.8%; $p < 0.001$). Disc height reduction was observed in 8 patients (8.9%) on MRI and 6 patients (6.7%) on radiography, with no statistically significant difference between the modalities ($p = 0.578$).

Spondylolisthesis was detected in 11 patients (12.2%) on both radiography and MRI, demonstrating complete agreement between the two modalities ($p = 1.000$). A representative case of grade II spondylolisthesis with anterior displacement of the L5 vertebral body over S1 on lateral radiography is shown in Figure 1.

Figure 1. Lateral radiograph of the lumbar spine demonstrating anterior displacement of the L5 vertebral body relative to S1, consistent with grade II spondylolisthesis.

Facet joint hypertrophy was identified in 6 patients (6.7%) on MRI compared with 2 patients (2.2%) on plain radiography; however, this difference did not reach statistical significance ($p = 0.148$).

Representative imaging findings are illustrated in Figures 1–4. Figure 2 demonstrates multilevel osteophyte formation and endplate sclerosis on lateral lumbar spine radiography. Reduction in intervertebral disc height at the L3–L4, L4–L5, and L5–S1 levels is demonstrated on both plain radiography (Figure 3) and sagittal T2-weighted MRI (Figure 4).

Figure 2. Lateral radiograph of the lumbar spine showing multilevel anterior osteophyte formation and vertebral endplate sclerosis, indicative of degenerative spondylotic changes

Figure 3. Lateral radiographs of the lumbar spine demonstrating reduction in intervertebral disc height at the L3–L4, L4–L5, and L5–S1 levels.

Figure 4. Sagittal T2-weighted magnetic resonance image of the lumbar spine demonstrating reduced intervertebral disc height at the L3–L4, L4–L5, and L5–S1 levels, consistent with degenerative disc disease.

DISCUSSION

Comparison of imaging findings in patients with low back pain revealed that spondylolisthesis was detected with similar frequency on both plain radiography and MRI ($P > 0.05$). This observation is consistent with the findings of Yong et al. (5), who reported comparable detection rates of spondylolisthesis on radiographs and MRI.

On MRI, Modic type 1 changes were characterized by low signal intensity on T1-weighted images and high signal intensity on T2-weighted images, whereas Modic type 2 changes demonstrated signal characteristics consistent with fatty marrow replacement on both T1- and T2-weighted sequences. Modic type 3 changes appeared as low signal intensity on both T1- and T2-weighted images, reflecting subchondral sclerosis. On plain radiographs, endplate changes were identified as focal areas of sclerosis adjacent to the vertebral endplates. However, the marrow alterations associated with Modic type 1 and type 2 changes are not appreciable on radiography, limiting its ability to detect early endplate degeneration. Consequently, only advanced Modic type 3 changes, characterized by dense sclerotic bone, were readily visualized on plain radiographs. In the present study, endplate sclerosis was identified in 7.8% of patients on radiography compared with 37.8% on MRI. These findings corroborate the observations of Yong et al. (5), who demonstrated that MRI is superior to plain radiography in detecting early vertebral endplate and marrow degenerative changes.

Reduction in intervertebral disc height was more frequently detected on MRI than on plain radiography. This finding is in agreement with Yong et al. (5), who reported that radiographically apparent posterior disc height loss often reflects advanced disc degeneration, frequently associated with significant disc herniation, spinal canal stenosis, and/or nerve root compression.

Osteophyte formation was identified more frequently on plain radiographs (47.8%) than on MRI (33.3%), with the difference reaching statistical significance ($P = 0.048$). This finding is consistent with previous reports indicating that plain radiography is highly sensitive for the detection of osteophytic changes, although its specificity for determining the underlying cause of low back pain remains limited (5).

Although MRI provides superior soft-tissue contrast and spatial resolution, allowing more detailed visualization of spinal anatomy and degenerative changes, the additional abnormalities detected may not always translate into clinically meaningful information or influence patient management (6). Furthermore, evidence from a randomized controlled trial demonstrated that patients undergoing early lumbar spine MRI were more likely to undergo surgical intervention and incur higher healthcare costs than those initially evaluated with plain radiography, without corresponding improvements in clinical outcomes (7).

Similarly, Chou et al. (8) reported that there is insufficient evidence to suggest that treatment strategies directed by common imaging findings, such as degenerative disc disease, facet joint arthropathy, or disc bulges in the absence of nerve root compression, result in superior outcomes compared with a more conservative, symptom-based approach. These findings underscore the importance of correlating imaging abnormalities with clinical presentation and support the judicious use of advanced imaging in the evaluation of chronic low back pain.

CONCLUSION

This study demonstrates that plain radiography and MRI provide complementary information in the evaluation of lumbar degenerative disease. While MRI remains superior for detecting soft-tissue abnormalities and early degenerative changes, including Modic endplate changes, disc height loss, and facet joint hypertrophy, plain radiography reliably identifies several clinically relevant structural abnormalities, particularly osteophyte formation and spondylolisthesis. Given its widespread availability, low cost, and rapid acquisition, plain radiography continues to serve as a valuable first-line imaging modality in the assessment of patients with chronic low back pain and suspected lumbar degeneration. A stepwise imaging approach, reserving MRI for patients with persistent symptoms, neurological deficits, or inconclusive radiographic findings, may optimize resource utilization while maintaining diagnostic accuracy. These findings support the continued role of plain radiography in routine clinical practice and highlight the complementary value of MRI in the comprehensive evaluation of lumbar degenerative disorders.

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