

## Correlation of plain film radiography and magnetic resonance imaging in degenerative disease of spine: A cross-sectional study

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Received: 29-04-2024

Accepted: 15-05-2024

**How to cite this article:** Gangwar S, Agarwal M, Kumar P. Correlation of plain film radiography and magnetic resonance imaging in degenerative disease of spine: A cross-sectional study. Int J Adv Integ Med Sci 2024;9(1):33-38.

**Source of Support:** Nil,

**Conflicts of Interest:** None declared.

**Background:** In a symptomatic patient with a low back who has failed a non-operative conservative treatment and has normal X-ray findings, a magnetic resonance imaging (MRI) can be a very effective tool for further evaluation of a patient. Hence, the present study was undertaken to evaluate degenerative disease of the spine by plain film radiography and MRI and to correlate the findings of X-ray and MRI in degenerative disease of the spine. **Materials and Methods:** The present cross-sectional study evaluated 90 patients with back pain and neurological symptoms using X-ray and MRI at Rohilkhand Medical College and Hospital, Bareilly. The findings provided detailed insights into the prevalence and characteristics of degenerative spinal changes. **Results:** This study revealed significant findings in patients with degenerative spinal disease. The most common radiographic findings included osteophytes, end plate sclerosis, and decreased intervertebral disk height, present in 66%, 55%, and 53% of patients, respectively. MRI findings showed a high prevalence of osteophytes, endplate sclerosis, and Modic changes. Schmorl's nodes were more commonly detected on MRI than plain film. Protrusion was the most common type of disk herniation, while facet joint arthrosis was more commonly detected on MRI than plain film. Neural foraminal obliteration and spinal canal stenosis were significantly more prevalent on MRI. These findings highlight the importance of comprehensive imaging in diagnosing and managing degenerative spinal disease. **Conclusion:** Imaging features visible on both plain radiographs and MRI were more accurately assessed with MRI, thanks to its superior soft-tissue resolution and ability to examine a feature from multiple planes. The only exception to this was the detection of osteophytes, which did not show a statistically significant difference. Plain radiographs serve as a foundational imaging modality for baseline evaluation. However, in symptomatic patients with normal X-ray results who have not responded to non-operative treatment, MRI can provide a more detailed assessment and aid in further diagnosis.

**KEY WORDS:** Endplate sclerosis, Modic changes, magnetic resonance imaging, neural foraminal obliteration, osteophytes

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### INTRODUCTION

Degenerative disease of the spine is a wide spectrum of degenerative abnormalities. It involves changes of bone (spondylolysis, spondylosis, and spondylolisthesis), intervertebral disk (e.g., herniation and bulging), facet joint (e.g., joint effusion, osteoarthritis, synovitis, and synovial cysts),

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ligaments (interspinous, supraspinous, and ligamentum flavum) and muscles (interspinous and multifidus).<sup>[1]</sup>

Multiple factors are involved in the degeneration of the disk. It involves both intrinsic and extrinsic factors. Intrinsic factors are cell senescence, decreased cell nutrition, and changes in the matrix protein. Extrinsic factors are aging, occupation, smoking, atherosclerosis, and genetics. Genetic predisposition is a most important extrinsic factor.<sup>[2]</sup>

Lumbar spine is the most common site of involvement, and most patients are asymptomatic, among symptomatic individual back pain without radiating radicular pain syndrome (sciatica) is most commonly present. Among non-symptomatic patients, 35% come with degenerative disease findings such as – disk desiccation, Modic changes, facet joint arthropathy, disk bulges, disk herniation, and spinal canal stenosis.<sup>[3]</sup>

Degeneration is most commonly assessed on magnetic resonance imaging (MRI) and plain radiography. Plain radiography has advantages over MRI, such as simplicity and cost-effectiveness.<sup>[4]</sup> MRI is a non-invasive and radiation-free procedure. It is a most sensitive imaging modality in the initial stages of the disease. It may detect pathology in the asymptomatic patients. On X-ray, we cannot comment on intervertebral disk and marrow signal intensity.<sup>[1]</sup> MRI has additional benefit of allowing the direct assessment of the neural structures. In a symptomatic patient with a low back who has failed a non-operative conservative treatment and has normal X-ray findings, a MRI can be a very effective tool for further evaluation of a patient. Hence, the present study was undertaken to evaluate degenerative disease of spine by plain film radiography and MRI and to correlate the findings of X-ray and MRI in degenerative disease of the spine.

## MATERIALS AND METHODS

The present cross-sectional study was conducted at the Department of Radiodiagnosis, Rohilkhand Medical College and Hospital, Bareilly, over a period of 1 year from November 01, 2022, to October 31, 2023. The study participants were selected from the outpatient department and inpatient wards, and informed consent was obtained from each patient who met

the inclusion criteria. A total of 90 patients were enrolled in the study, forming the sample size for this research.

Patients were included in the study if they presented with complaints of back pain, accompanied by neurological symptoms such as weakness, tingling sensations, numbness, or referred pain in the limbs. However, patients were excluded from the study if they had known contraindications to MRI, including a history of trauma, infective or inflammatory spondylitis, neoplastic involvement of the spine, bony dysplasia, connective tissue, metabolic, or endocrine-related disorders, or Paget's disease. In addition, patients with implants or other ferromagnetic external devices that were incompatible with MRI were also excluded from the study.

Study was conducted after taking informed consent from the patients and approval from the Institutional Ethics Committee, RMCH, Bareilly. Patients were selected from both outpatient and inpatient departments. A thorough medical history was taken, followed by a physical examination. For the spinal X-ray examination, patients were positioned on the X-ray table in supine and lateral positions. Radiographs were captured using conventional films with appropriate kV and mAs settings.

For MRI, the procedure was explained to patients. Patients were given a hospital gown so that any metallic object can be avoided. MRI was done in supine position and in quite respiration. The patient was instructed not to move during the investigation.

The study utilized advanced imaging equipment, including a 500Ma SIEMENS machine for X-ray examinations of the spine, and a 1.5 Tesla Magnetom Sempra-Siemens machine for MRI. The MRI protocol for evaluating patients with degenerative disease of the spine consisted of a series of standard sequences, including T1-weighted images (T1-WI) in both sagittal and axial planes, T2-WI in both sagittal and axial planes, and short-tau inversion recovery sequences in both coronal and sagittal planes. This comprehensive protocol provided detailed images of the spine, enabling the assessment of degenerative changes and accurate diagnosis.

## Statistical Analysis

Data were entered on Microsoft, excel software, and statistical analysis was done using a licensed version of Statistical

**Table 1:** Comparison of common imaging features assessed on both plain film and MRI

Features	Plain film (%) (n=90)	MRI (%) (n=90)	P-value
Decreased vertebral body Ht.	15 (16.6)	17 (18.3)	0.74
Osteophytes	60 (66.7)	50 (55)	0.45
Schmorl's nodes	18 (20)	33 (36.7)	0.06
Decreased IVD Ht.	48 (53.3)	55 (61.6)	0.58
Facet joint arthrosis	40 (45)	57 (63.3)	0.16
Neural foramina stenosis	24 (26.6)	48 (53.3)	0.01
Spinal canal stenosis	46 (51.6)	65 (71.6)	0.15

MRI: Magnetic resonance imaging

Package of the Social Sciences 23.0. Descriptive analysis was done by calculating proportions, means, and standard deviation. Appropriate statistical tests were applied depending on the distribution and type of data.  $P < 0.05$  was considered significant.

## RESULTS

Table 1 shows the comparison between prevalence of degenerative features on both imaging. MRI shows a higher prevalence of facet joint arthrosis (63.3%), neural foraminal obliteration (53.3%), and spinal canal stenosis (71.6%) as compared to plain film radiography with the incidence of 45%, 26.6%, and 51.6% respectively. Neural foraminal obliteration and spinal canal stenosis were observed in a significantly larger proportion of patients on MRI than plain film ( $P = 0.01$  and  $0.15$ , respectively). Osteophytes were seen in 66.7% of patients on plain film which was higher than 55% of patients as seen on MRI, the difference was however not statistically significant ( $P = 0.45$ ). Decreased vertebral height was comparable on both imaging 15 (16.6%) patients on plain film and 17 (18.3%) patients on MRI showed decreased vertebral body height. Plain film demonstrated schmorl's nodes in 18 (20%) patients with a higher number of patients 33 (36.7%) showing the same on MRI ( $P = 0.06$ ). Decreased intervertebral disk height was seen in 48 patients on plain film and 55 patients on MRI.

Table 2 shows the incidence of degenerative radiological features on both plain film and MRI in different age groups. In 20–29 years, age group, two patients on X-ray and three patients on MRI (out of 4 patients) had schmorl's nodes and one patient had decreased intervertebral disk height on MRI, no other abnormality was seen in this group. In 30–39 years, age group 25% had osteophytes on X-ray; however, none of

the patients had osteophytes on MRI. About 16% and 33% had Schmorl's nodes on plain film and MRI, respectively. Decreased intervertebral disk height was seen in 8.3% and 25% of patients on X-ray and MRI. Most common finding in this age group was spinal canal stenosis on plain film and neural foraminal obliteration and spinal canal stenosis on MRI. In 40–49 years, age group, 22 patients were present, osteophytes (46%), decreased intervertebral disk height (26%), and spinal canal stenosis (26%) were the most common features on plain film and facet joint arthrosis (46.6%), neural foramina obliteration (33.3%) and spinal canal stenosis (60%) on MRI. In the 50–59 years, age group, nine patients were present. All of them had osteophytes on both imaging. Other common findings in this group were decreased intervertebral disk height and spinal canal stenosis. In above 60 years patients, all patients had osteophytes on both imaging. All of them had facet joint arthrosis and spinal canal stenosis in involved spinal levels on MRI. Whereas, the plain film showed facet joint arthrosis in 84.6% and 81.8% in 60–69 and 70–80 years age group. Spinal canal stenosis was seen in 84.6% of 60–69 years patients and 100% of patients in 70–80 years age group. The majority of differences in imaging findings were in younger age groups. Osteophytes were more common on plain film than MRI in the younger age group but were seen in all patients in above 50 years age group patients irrespective of imaging technique.

Out of 60 patients with osteophytes on plain film, 6.7% patients were in 30–39 years age group, 18.3% were in 40–49 years age group, 15% in 50–59 years, 42% were in 60–69 years and 18% in 70–80 years as compared to 10% patients in 40–49 years, 18% patients in 50–59 years, 40% in 60–69 years patients, and 32% patients in 70–80 years age group patients on MRI [Table 3]. The difference was not statistically significant in any age group.

**Table 2: Age distribution of degenerative features assessed on both plain film and MRI**

Features	Age G p- no. of pt	20–29 (n=4)	30–39 (n=18)	40–49 (n=22)	50–59 (n=9)	60–69 (n=20)	70–80 (n=17)	Total (n=90)
Decreased vertebral body Ht.	X-ray	0	0	3 (13.3)	0	4 (23.1)	8 (45.4)	15 (16.6)
	MRI	0	0	4 (20)	0	5 (23.1)	8 (45.4)	17 (18.3)
Osteophytes	X-ray	0	4 (25)	11 (46.6)	9 (100)	20 (100)	16 (100)	60 (66.7)
	MRI	0	0	4 (20)	10 (100)	20 (100)	16 (100)	50 (55)
Schmorl's nodes	X-ray	2 (33.3)	3 (16.6)	4 (20)	1 (16.6)	2 (7.7)	6 (36.3)	18 (20)
	MRI	3 (66.6)	6 (33.2)	8 (33.3)	3 (33.2)	5 (23.1)	8 (45.4)	33 (36.7)
Decreased IVD height	X-ray	0	1 (8.3)	6 (26.6)	8 (83.3)	20 (100)	13 (81.8)	48 (53.3)
	MRI	1 (33.3)	5 (25)	8 (33.3)	7 (83.3)	20 (100)	14 (90.9)	55 (61.6)
Facet joint arthrosis	X-ray	0	3 (16.6)	4 (20)	3 (33.2)	16 (84.6)	14 (81.8)	40 (45)
	MRI	0	6 (33.2)	11 (46.6)	4 (50)	20 (100)	16 (100)	57 (63.3)
Neural foraminal obliteration	X-ray	0	1 (8.3)	0	0	11 (53.8)	12 (72.7)	24 (26.6)
	MRI	0	8 (41.6)	7 (33.3)	6 (66.6)	13 (69.1)	14 (81.8)	48 (53.3)
Spinal canal stenosis	X-ray	0	4 (25)	6 (26.6)	3 (33.2)	16 (84.6)	17 (100)	46 (51.6)
	MRI	0	10 (50)		13 (60)	20 (100)	16 (100)	65 (71.6)

MRI: Magnetic resonance imaging, IVD: Intervertebral disk

**Table 3: Patients showing osteophytic changes in different age group**

Age in years	X-ray (n=90) (%)	MRI (n=90) (%)	P-value
20–29	0 (0)	0 (0)	-
30–39	4 (6.7)	0 (0)	0.06
40–49	11 (18.3)	4 (10)	0.08
50–59	9 (15)	10 (18)	0.83
60–69	20 (42)	20 (40)	1
70–80	16 (18)	16 (32)	1
Total	60 (100)	50 (100)	0.45

MRI: Magnetic resonance imaging

**Table 4: Percentage distribution of degenerative imaging findings on MRI in both sexes (% in parenthesis)**

Findings	Males (52)	Females (38)	Total (90)	P-value
Decreased vertebral body Ht.	7 (13.4)	10 (26)	17 (18.8)	0.22
Osteophytes	33 (62.8)	17 (44)	50 (55)	0.34
Modic changes	15 (28.5)	18 (48)	33 (36.7)	0.23
Schmorl's nodes	16 (31.4)	17 (44)	33 (36.7)	0.36
Decreased IVD Ht	34 (65.7)	21 (56)	55 (61.6)	0.63
Disk desiccation	47 (91.4)	29 (76)	76 (85)	0.60
Disk bulge	31 (60)	29 (76)	60 (66.7)	0.46
Disk herniation	12 (22.8)	10 (28)	22 (25)	0.78
Facet joint arthrosis	31 (60)	26 (68)	57 (63.3)	0.68
Ligt. flavum hypertrophy	13 (25.7)	11 (28)	24 (26.7)	0.75
Neural foraminal obliteration	27 (51.4)	21 (56)	48 (53.3)	0.86
Spinal canal stenosis	35 (67)	30 (80)	65 (71.6)	0.63

MRI: Magnetic resonance imaging, IVD: Intervertebral disk

Table 4 shows the distribution of MRI features of degenerative spine disease in males and females. Disk desiccation was the most common finding seen in 91.4% of male patients and 76% of female patients. Spinal canal stenosis was seen in 65 patients, 67% of male patients and 80% of female patients had spinal canal stenosis. Sixty patients had intervertebral disk bulge, 60% of male patients and 76% of female patients showed disk bulge. About 57 (63.3%) patients had facet joint arthrosis with 60% of male patients and 68% of female patients. Decreased intervertebral disk height was present in 55 (61.6%) patients with 65.7% of male patients and 56% of female patients had decreased intervertebral disk height. About 33 (62.8%) of male patients and 17 (44%) of female patients had osteophytes on MRI with a total of 50 (55%) patients. Forty-eight patients had neural foraminal obliteration, with 51.4% of male patients and 56% of female patients. 25.7% of male patients and 28% of female patients showed ligamentum flavum hypertrophy with a total of 24 patients. About 22% of males and 28% of females had disk herniation with a total of 22 patients. About 31.4% of male patients and 44% of female patients had Schmorl's nodes. About 15 (28.5%) male patients and 18 (48%) females had evidence of Modic changes with a total of 33 (36.7%). Decreased vertebral body height was present in 17 patients with 13.4% of males and 26% of females. There was no statistically significant difference of MRI findings in both sexes.

## DISCUSSION

A total of 90 patients were assessed using plain radiography, followed by further evaluation with MRI. The mean age of the patients was 51.63 years, ranging from 24 to 79 years. Of the 90 patients, 52 (57.8%) were male, and 38 (42.2%) were female, indicating a male predominance in the study. This observation is consistent with findings by Vroomen *et al.*,<sup>[5]</sup> where the mean age was  $46 \pm 11.2$  years, with 53% male and 48% female participants. Similar results were reported by Pople and Griffith<sup>[6]</sup> and Carragee and Kim,<sup>[7]</sup> with mean ages of 42 and 42.8 years, respectively, also showing male predominance.

Plain radiography is useful in evaluating factors such as osteophytes, spinal alignment, degenerative spondylolisthesis, and facet joint arthrosis contributing to canal stenosis. MRI, on the other hand, is a non-invasive, radiation-free technique that provides detailed imaging of the spinal cord and subarachnoid space. It is highly sensitive in identifying extradural pathologies and offers multiplanar views and excellent neural element visualization, making it more accurate in diagnosing intrinsic cord diseases. MRI may also detect pathology in asymptomatic patients or conditions unrelated to the presenting symptoms. In one study, which was also demonstrated by Luoma *et al* in their study on lumbar disc degeneration, 57% of patients over

64 years of age showed disk bulging, and 26% had signs of cord compression on MRI.<sup>[8]</sup> However, certain spondylotic changes, such as small lateral osteophytes and midbody calcific densities, may be missed on MRI.

Despite its limitations, MRI's advantages significantly outweigh its drawbacks, making it the gold standard for diagnosing spondylotic disease and a highly accurate imaging tool.

Vertebral osteophytes are bony outgrowths that form along the margins of the vertebral body. As age advances, osteophytes become more prevalent due to the altered stress on the anterior longitudinal ligament. On plain radiographs, they are assessed on anteroposterior and lateral views, while on MRI; they are evaluated using sagittal T1-WI. In this study, osteophytes were observed in 60% of patients on plain radiographs and 50% on MRI. The highest incidence of osteophytes, 42% on plain film and 40% on MRI occurred in the 60–70 years age group. Among patients with low back pain, 46.6% on plain film and 41.6% on MRI had osteophytes, while in those with radiculopathy, 43.3% on plain film and 36.6% on MRI showed osteophytes. These findings align with the study by Frymoyer *et al.*, which also found a strong association between osteophytes and lower back pain, as well as lower limb symptoms.<sup>[9]</sup>

In this study, Schmorl's nodes were identified in 20% of patients on plain radiographs, with 50% located in the dorsolumbar region. MRI revealed Schmorl's nodes in 36% of patients, with the highest incidence (54%) occurring in the dorsolumbar region (D10-L2). These results are consistent with the study by Hilton *et al.*, which reported a higher frequency of Schmorl's nodes in the dorsolumbar region compared to the mid and lower lumbar spine, with a predominance in male patients. Kjaer *et al.* found Schmorl's nodes in 29.8% of cases, most commonly at the L4-S1 vertebral levels in the lumbar spine.<sup>[10]</sup>

In this study, facet joint degeneration was observed in 45% of patients on plain radiographs and 63% on MRI, with the most commonly affected levels being L4/L5 and L5/S1, followed by C5/C6 on both imaging modalities. These findings align with the study by Jarvik and Deyo who also reported facet joint degeneration most frequently at the L4-L5 level, followed by L5-S1.<sup>[11]</sup> Similarly, Kjaer *et al.* found facet joint degeneration at L4-5 and L5-S1 in 36.2% of cases.<sup>[10]</sup>

In this study, the ligamentum flavum appeared normal in 66 patients, while 24 cases showed hypertrophy. This result is comparable to the findings of Peter *et al.*, who noted that isolated thickening of the ligamentum flavum is uncommon, but frequently occurs in conjunction with facet joint degeneration or lamina shortening due to degenerative changes. They concluded that under such conditions, the hypertrophied ligamentum flavum may significantly encroach on the neural foramen or spinal canal.<sup>[12]</sup> Park *et al.* also found that the ligamentum flavum was notably thicker in patients with spinal stenosis.<sup>[13]</sup>

Overall, disk bulging or degeneration is the most common cause of neural foramina narrowing. On plain radiographs, posterior osteophytes are the most frequent cause and are more easily visualized, with facet joint hypertrophy being the second most common contributor.

On plain radiographs, foraminal stenosis was diagnosed by the encroachment of posterior osteophytes and degenerated facet joints into the neural foramina. In contrast, on MRI, foraminal stenosis was evaluated and diagnosed when the hyperintense epidural fat was obliterated by disk material of intermediate signal intensity or osseous material of low signal intensity on axial T2WI. In this study, neural foraminal stenosis was observed in 24 patients (26%) on plain film and in 48 patients (53%) on MRI, with the L4-L5 level being the most commonly affected on both modalities. MRI proved superior to plain radiographs in detecting neural foraminal stenosis, as it could assess both discal, ligamentous, and bony degenerative changes ( $P = 0.03$ ).

In terms of spinal canal stenosis, it was identified in 46 patients (51.6%) on plain radiographs, most frequently at the L4-L5 level in 22 patients, followed by L5-S1 in 13 patients. In the cervical region, the C5-C6 level was the most commonly affected, with 10 patients. On MRI, spinal stenosis was found in 65 patients (71%), with L4-L5 being the most frequently involved level in 35 patients, followed by L5-S1 in 24 patients. Similarly, in the cervical spine, the C5-C6 level was the most commonly involved, with 11 patients. These findings are consistent with Kjaer *et al.*, who also reported spinal stenosis most frequently at the L4-L5-S1 levels.<sup>[10]</sup> MRI detected a higher percentage of spinal stenosis cases, as it allows for the assessment of disk bulging, herniation, ligamentum flavum hypertrophy, and osteophytic and facet joint changes ( $P = 0.03$ ).

## CONCLUSION

This study revealed significant findings in patients with degenerative spinal disease. The most common radiographic findings included osteophytes, end plate sclerosis, and decreased intervertebral disk height, present in 66%, 55%, and 53% of patients, respectively. MRI findings showed a high prevalence of osteophytes, endplate sclerosis, and Modic changes. Schmorl's nodes were more commonly detected on MRI than plain film. Protrusion was the most common type of disk herniation, while facet joint arthrosis was more commonly detected on MRI than plain film. Neural foraminal obliteration and spinal canal stenosis were significantly more prevalent on MRI. These findings highlight the importance of comprehensive imaging in diagnosing and managing degenerative spinal disease.

Imaging features visible on both plain radiographs and MRI were more accurately assessed on MRI due to its superior soft-tissue resolution and the ability to examine features from multiple planes. The only exception to this was the detection of osteophytes, which did not show a statistically significant

difference between the two modalities. Plain radiographs serve as a basic imaging tool and are useful for baseline evaluation. However, in symptomatic patients who do not respond to non-operative conservative treatment and have normal X-ray findings, MRI can provide valuable additional insights for more thorough evaluation.

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