



Evaluation Of Degenerative Changes Of Lumbo- Sacral Spine On MRI

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Abstract

Background and Aims:

Lower back pain secondary to degenerative disc disease is a condition that affects young to middle-aged persons with peak incidence at approximately 40 y. MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanar imaging capability, excellent spinal soft-tissue contrast and precise localization of intervertebral discs changes.

Aims and Objective: To describe various degenerative changes of lumbo-sacral spine on MRI and to illustrate various MR imaging features and grading of degenerative disc changes of the lumbo-sacral spine.

Study Design: Prospective, Cross-sectional and observational study.

Materials and Methods: A total 135 patients with history of lower backache of any age groups were evaluated on 1.5 Tesla Philips Magnetic Resonance Imaging machine. Different Images like T1 weighted, T2 weighted and STIR images wherever required were taken to evaluate all the patients.

Result: Males were more commonly affected with degenerative changes (83 out of 87). Above the age 49 years all patients (100%) presented degenerative changes. Vertebral body changes present in 88 (65.19%) patients. Disc changes present in 129 (95.56%) patients. Among these 129 patients

71 patients (55.04%) presented Disc buldge, 38 (29.46%) presented Disc protrusion, 6 (4.65%) presented Disc extrusion and 14 patients (10.85%) had annular tear. Among the all patients included in the study 83 (61.48%) patients showed degenerative changes in X -ray and 52 (38.52%) did not showed any changes in X- ray. Although all these undergone MRI evaluations and 129 (95.56%) patients showed degenerative changes on MRI and only 6 (4.44%) patients did not show any changes on MRI evaluation. Sensitivity of MRI was 64.34% and specificity was 100% in comparison to X-ray.

Conclusion: MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanar imaging capability, excellent bone to soft tissue differentiation, excellent spinal soft-tissue contrast and precise localization of intervertebral discs changes. It accurately detects, localize and characterize various degenerative pathologies of spine causing back pain and helps in arriving at a correct anatomical diagnosis there by guiding further management of the patient.

Keywords: Degenerative disc changes, lower back ache, intervertebral disc, T1 and T2 weighted images

Introduction

Low back pain is one of the most distressing for patients to take medical care in both primary care and emergency setting. [1] This is well known and documented fact that there is increasing trend of

lumbar disc disease with advancing age. [2,3] However, in the recent decades an increasing incidence of lumbar disc disease in young adults and

adolescents has also been reported by studies done in various populations world over. [4-6]

It is most important to find out the reason of back pain in patients of all ages with different presentations in these different populations. Knowledge about the different alarming or red flag sign of back pain like weakness, bowel or bladder incontinence, or pain that awakens patients from sleep in both children and adults can guide the provider to appropriate evaluation and treatment. Most of the time back pain will resolve with time and rest. [7]

Much of the time conservative management which includes over-the-counter pain medications such as acetaminophen or NSAIDs resolves the problem. But many patients require muscle relaxants, gabapentin, topical analgesics, and opioids for the management of back pain. [8] Back pain in majority of patients is mechanical in origin and respond to activity modification, rest, ice, and heat. Physiotherapy and muscle strengthening exercises also play a role. [9] All back pain does not resolve with physical therapy. Back pain of more than six weeks duration should be evaluated with X-ray and MRI to help identify possible disc herniation or spinal stenosis.

Due to its profound effect on patients' well-being, effect on day to day activities due to accommodate back pain and suffering of quality of life back pain is on most focus of many clinicians and researchers. In contrary to other injuries in the body, back pain (and axial skeletal injuries) affects almost every aspect of life like sleeping is disrupted, it is difficult to bend, reach or turn, it is hard to drive or go to work, lifting and exercise become strenuous, anxiety-provoking activity, walking to the bathroom becomes a difficult task, and so on.

Variety of factors contributing to this degeneration are aging, axial loading of disc, abnormal posturing, vascular in growth, and abnormalities in collagen and proteoglycan all contribute to disc degeneration. Disc herniation with radiculopathy and chronic discogenic LBP are the result of this degenerative process.[10]

MRI has become the initial imaging technique of choice in evaluation of cases having lower back pain or radicular pain for demonstration of objective

evidence of pathology in a location consistent with clinical findings.[11]

MRI demonstrates the lumbar spine in multiple planes and extradural soft tissues (including intervertebral discs), paravertebral musculature, the exiting nerve roots and intradural structures (spinal cord, conus medullaris, and intrathecal roots).

The various causes of LBP include: Degenerative (Intervertebral disc abnormalities, lumbar canal stenosis associated nerve compression, spondylolisthesis, facetar arthropathy, Schmorl's nodes), Infections (Tuberculosis), Inflammation (Sacroiliitis in young females), Developmental and congenital abnormalities (Transition vertebra, scoliosis, Scheuermann's disease) [12], Neoplastic (Primary/metastatic bone disease), Lumbosacral muscle and soft tissue related disorders (Muscle sprain and strains) and Osteopenia/ Osteomalacia/ Osteoporosis and non-spinal causes such as renal calculi, pancreatitis, abdominal aortic aneurysm, and gynecological disorders like endometriosis.

Thus, we conducted this study to describe various degenerative changes of lumbo-sacral spine on MRI and to illustrate various MR imaging features and grading of degenerative disc changes of the lumbo-sacral spine among the different age group patients.

Material And Methods

This was a prospective, cross-sectional and observational study conducted at department of radiodiagnosis, JLN medical college and hospital, Ajmer (INDIA). The duration of the study was 24 months from 1st October 2020 to 31st October 2022. A total 135 patients who were referred to our department with low backpain and suspected degenerative disease of the lumbosacral spine for MRI were included for the study.

Inclusion Criteria:

1. Patients presenting with lower back pain.
2. Patients with suspected degenerative disease of the lumbosacral spine.
3. Patients presenting with spinal deficit. Exclusion criteria
4. Patients with history of acute trauma, surgical intervention, infection, tumors and tumor like conditions.

5. Patients with pacemakers and ferromagnetic metallic implants (allowed only on doctors' advice)
6. Recent H/o spinal epidural anesthesia

All patients who were meet the inclusion criteria with known history of backpain and suspected degenerative disease of lumbosacral spine were subjected to an MRI scan. MRI examinations was performed by using closed type 1.5 Tesla Philips MR scanner with the study subject in the supine position. T1 weighted images in axial and sagittal plane, T2 weighted images in axial coronal and sagittal plane, STIR images where ever required was taken.

On MRI Examination Areas covered were as follows:

Sagittal (cord, disc signal, height, vertebral bodies, spinous process, nerve roots, neural

foramina, central canal, ligaments, epidural space)

Axial (nerve roots, cord, disc contour, vertebral bodies, neural foramina, central canal, lateral recesses, ligaments, epidural space, facet joints).

Osseous changes related to disc degeneration

Vertebral Bodies

Osteophytes

1. Endplate & Marrow Changes. (no disc changes)
2. Type1: Decreased signal on T1 WI, increased signal on T2 WI (inflammatory tissue)
3. Type2: Increased signal on T1 WI, follows fat on T2 WI (fatty marrow changes)
4. Type3: Decreased signal on T1 and T2 WI (osteosclerosis)

Facet Joints

1. Subchondral sclerosis with cartilage loss and cyst formation
2. Osteophyte formation with hypertrophy of articular processes
3. Vacuum joint phenomenon and joint effusion
4. Hypertrophy and calcification of ligamentum flavum

Breakdown Of Interspinous Ligaments

1. Bursae form between spinous processes (High signal on T2 WI)
2. Decreased space between spinous processes

3. Subcortical sclerosis and faceted appearance
4. Osteophytes and enthesophytes

Descriptive statistics was used such as mean, SD and proportion. The Chi- Square test procedure tabulates a variable into categories for comparison between two categorical variables. A p-value less than 0.05 considered as significant and 0.01 as highly significant. All the statistical operations were done using SPSS v21.0 software. The other parameters employed during the statistical analysis such as, sensitivity, specificity, Positive predictive value (PPV) and Negative predictive value (NPV).

Results

Total 135 patients who met the inclusion criteria were studied in the evaluation of MRI appearance of degenerative spinal disease. From total 109 patients, 87 (64.44%) patients were male and 48 (35.56%) patients were female. Most of the patients belongs to 40-49 year age group (42 patients) followed by 34 patients (25.19%) in the age group 50-59 years and 43 patients (31.85%) were in the age group 60 and above.

Vertebral body changes present in 88 (65.19%) patients. Disc changes present in 129 (95.56%) patients. Among these 129 patients 71 patients (55.04%) presented Disc buldge, 38

(29.46%) presented Disc protrusion, 6 (4.65%) presented Disc extrusion and 14 patients (10.85%) had annular tear. Postero lateral was the most common location of disc changes found in 101 patients (78.29%) followed by postero central in 25 patients (19.38%) and foraminal in 3 patients (2.33%). L4-L5 was the most common vertebral level of degenerative changes found in 58 patients (44.96%) followed by L5-S1 in 34 (26.36%), L3-L4 in 27 (20.93%) and L2-L3 in 10 (7.75%).

83 patients (95.40%) out of 87 males and 46 (95.83%) out of 48 females had degenerative changes (Table-1). According to age distribution 11 (68.75%) patients out of 16 in the age group 20-39 years, 41 (97.92%) out of 42 patients in 40-49 years and 100% patients in the all age group above 49 years had degenerative changes (Table-2).

Thecal sac changes was present in 112 patients (82.96%) out of 135 patients. Spinal cord changes

were seen in 62 patients (45.93%) out of 135 patients. Among these 62 patients presentation of cord changes was mild in 33 patients (53.23%), moderate in 18 patients (29.03%) and severe in 11 patients (17.74%).

Posterior element changes were seen in 26 patients (19.26%) out of all 135 patients. 4 patients had paravertebral structure involvement.

Among the all patients included in the study 83 (61.48%) patients showed degenerative changes in X

-ray and 52 (38.52%) did not showed any changes in X- ray. (Figure-1) Although all these undergone MRI evaluations and 129 (95.56%) patients showed degenerative changes on MRI and only 6 (4.44%) patients did not show any changes on MRI evaluation. (Figure-2)

Sensitivity of MRI was 64.34% and specificity was 100% in comparison to X-ray. (Table- 3 & Figure-3).

Table 1: Gender wise incidence of degenerative changes

MRI findings	Male (n=87)		Female (n=48)		Total
	Number	%	Number	%	
Degenerative changes present	83	95.40	46	95.83	129
Normal MRI	4	4.60	2	4.17	6

Table 2: Age group wise incidence of degenerative changes

Age group	Degenerative changes present		Normal MRI		Total
	Number	%	Number	%	
20 – 39	11	68.75	5	31.25	16
40 – 49	41	97.92	1	2.08	42
50 – 59	34	100.00	0	0	34
60 – 69	24	100.00	0	0	24
≥ 70	19	100.00	0	0	19
Total	129	95.56	6	4.44	135

Table 3: MRI and X ray findings in total study group

X-ray changes	MRI changes		Total	Chi square value	P value
	Yes	No			
Yes	83	0	83	10.022	0.0015

No	46	6	52
Total	129	6	135

Figure1: Percentage showing X-ray changes in total study subjects

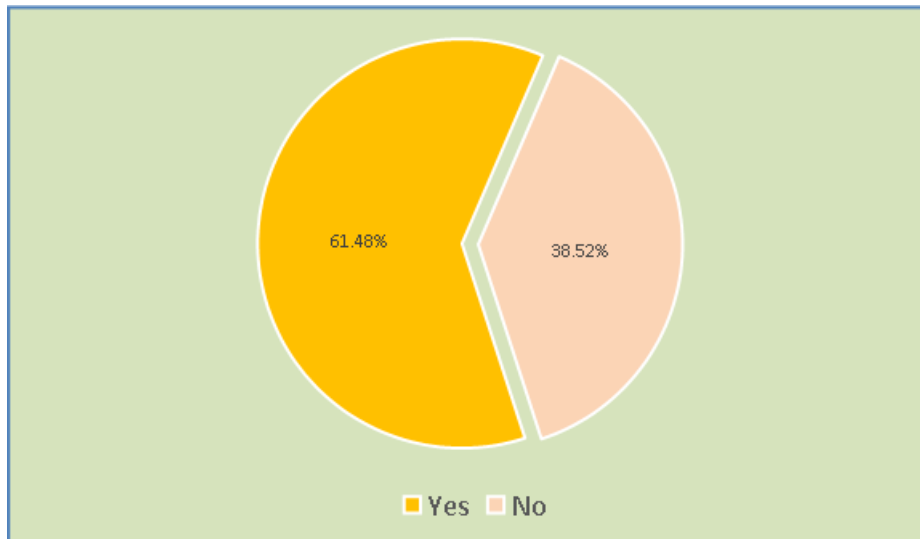


Figure2: Percentage showing MRI changes in total study subjects

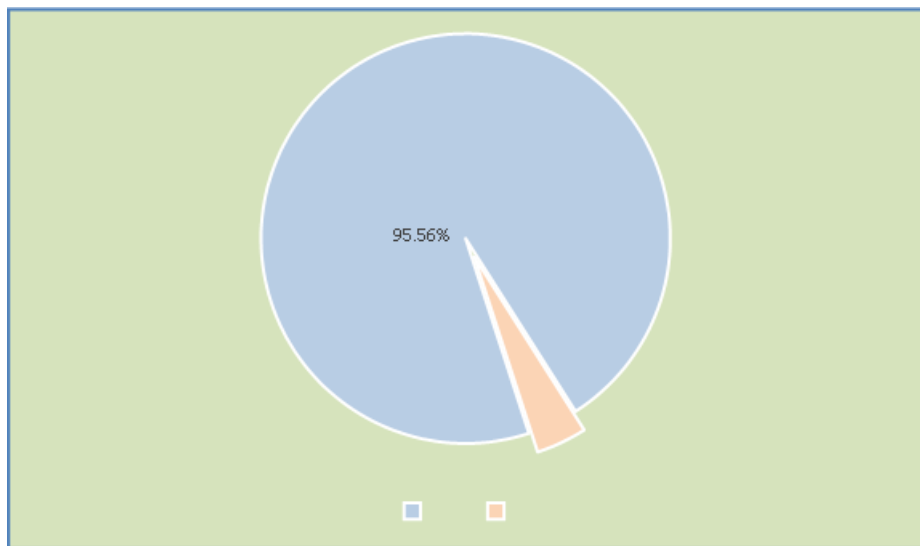


Figure-3: Comparison of X-ray and MRI findings

Statistic	Value	95% CI
Sensitivity	64.34%	55.43% to 72.58%
Specificity	100.00%	54.07% to 100.00%
Positive Likelihood Ratio		
Negative Likelihood Ratio	0.36	0.28 to 0.45
Disease prevalence (*)	95.56%	90.58% to 98.35%
Positive Predictive Value (*)	100.00%	
Negative Predictive Value (*)	11.54%	9.37% to 14.12%
Accuracy (*)	65.93%	57.28% to 73.86%

Discussion

Lumbar disc degeneration is the most common cause of low back pain around the world and majority due to the disc herniation. Due to development of MRI, noninvasive excellent imaging of spine is possible. [13,14]

The role of diagnostic imaging is to provide accurate anatomic information and to affect the management decision making.[9] This cross-sectional hospital-based study used MRI to diagnose spine degenerative changes as it has better tissue segregation and it can show degenerative changes at an early stage as compared to other imaging techniques (such as X-ray and CT scan). [15] Other advantages of MRI include having no known side effects or morbidity, no radiation exposure and is non-invasive. [16,17] Despite its high sensitivity, degenerative changes are observed on many MRI scans in asymptomatic subjects, thus questioning its specificity. [16] That’s why MRI is only beneficial to patients with chronic disease, symptomatic lower backache and those who are being planned for spine surgery.

Majority of the disease processes were diagnosed on MRI which often go undetected on conventional radiography. Multiplanar MRI provides remarkable aid in the assessment of spinal and paraspinal structures.

All recruited patients underwent MRI of the lumbar spine and both sagittal and axial views of all images were interpreted to locate the degenerative findings.

Males are more commonly affected to the disc degeneration than females. It is most likely due to the increased mechanical stress and injury. In our study 87 patients (64.44%) were male and 48 patients (35.56%) were females.

Similar findings were also found in study done by Suthar P et al (2015) [18] where they see that out of total 109 patients, 60 patients (55.04% of total patients) were male and 49 patients (44.95% of total patients) were female. In another study done by Jacob M et al (2010) [19] they found that Disc degeneration was slightly more frequent among males 67 (85.9%) as compared to females 70(80.5%), though the variation observed was not statistically significant.

Degenerative changes were observed in majority 129 (95.56%) of patients examined. Most of these degenerative findings were seen at L4/L5 (44.96%) and L5/S1 (26.36%). Though a degenerative change of the disc begins early in life and is partly a consequence of aging, the actual cause is not known but many factors (autoimmune, genetic, reabsorption and biochemical) have been implicated in accelerating the process. Since lumbar spine is subjected to heavy mechanical stress, it is a common area affected by degenerative changes [20] this could partly explain such observation in this study group. The mean age of this study group is 53.50 ± 14.26 years, could be another explanation, as degenerative changes is common in individuals above 40 years of age and its prevalence increases progressively up to 100% by 50 years of age. [21,22]

MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanar imaging capability, excellent spinal soft tissue contrast and precise localization of intervertebral discs changes. It is also being used for pre- and post-operative evaluation.

Majority of the disease processes were diagnosed on MRI which often go undetected on conventional radiography. Multiplanar MRI provides remarkable aid in the assessment of spinal and paraspinal structures.

In our study the comparison of findings of X-ray and MRI shows $\chi^2 = 10.022$, $df=1$, $p = 0.0015$, Significant. Sensitivity and specificity Variable Value % at 95% Confidence Interval: Sensitivity 64.34% (55.43% - 72.58%), Specificity 100% (54.07% - 100%), Positive Predictive

Value 100% (93.74% - 100%) and Negative Predictive Value 11.54% (9.37% - 14.12%).

Sensitivity- if MRI shows truly positive result, the chance of getting positive result in X- ray is 64.34%. Though we obtained an estimate of sensitivity as 64.34%, it could vary between 55.43% – 72.58%.

Specificity- if MRI shows truly negative result, the chance of getting negative result in X- ray is 100 %. Though we obtained an estimate of specificity as 100%, it could be 54.07% - 100%. In our study degenerative disc pathology was the most common finding affecting 129 patients (95.56%) with age predilection in the 40 – 59 years age group seen in (75 patients, 58.13%). The study also saw sex predilection of males 83 (64.34%) to females 46 (35.66%) seen as 1.8: 1 ratio. These findings are consistent with previous studies.

Degenerative disc changes are predominant at L4 – 5 level (58 patients,44.96%) and L5 – S1 level (34 patients,26.36%) probably due to increased mechanical stress at the lumbosacral curvature. L2 – L3 & L3 – L4 level was least common. This Cranio-caudal direction pattern is also followed by disc herniation. [102] It also observed that lower the lumbar level the higher is the prevalence of disc herniation. Multiplicity in the disc level involvement is common as compare to the single disc involvement. All these findings are in concordance

with previous studies. [23,24] Variation in spinal anatomy like transitional vertebrae and malalignment of the vertebra as in spondylolisthesis is seen to hasten the process of degeneration seen in form of secondary changes like facet arthropathy and ligamentum flava hypertrophy at adjacent level. Spondylolisthesis was most commonly present at L4 – L5 disc level. This finding is in concordance with a previous study. Vertebral changes: In our study vertebral changes were seen in 88 patients (65.19%) against normal vertebrae in 47 patients (34.81%).

Disc changes: In our study, disc changes were seen in 129 patients (95.56%) against normal discs in 6 patients (4.44%).

In disc changes, majority of types of herniation were disc buldge (63.57%), Disc desiccation (34.11%), Disc protrusion (1.55%) and only 1% discs were extrusion. In this study, no disc sequestration was seen. This can be due to the skip scanning technique used at MRI center of our institute, whereby only intervertebral spaces where scanned, leaving vertebral body areas uncovered. Disc bulges were more common among young individuals aged 20 to 49 years (40%) as compared to individuals aged 60 to 80 years (32%), unlike disc herniation which was higher among older individuals. Though these findings were not statistically significant (p -value >0.05). In this study, no significant difference in sex was found in the prevalence of disc bulges and herniations.

Various studies have reported that disc herniation is common at L4 – L5 and L5 – S1 and the frequency at these levels is ranging from 30% to over 90%. [17,25-27] This was also reflected in this study as 71.32% of the herniated discs were at L4 – L5 and L5 – S1, this can be due to the large work load causing stress at these lower lumbar levels of the spine. Disc herniation at L2 – L3 and L3 – L4 was observed in 7.75% and 20.93% respectively, this trend is similar to previous reports.[27]

The most location for disc herniation was posterolateral, seen in 78.29%, followed by posterocentral and foraminal 19.38%, 2.33% respectively, this finding is similar to previous report.[25] The intraspinal disc herniation (postcentral & posterolateral) were the most common (97.67%),

and this is similar to the findings seen by Takarad et al (2008). [28]

Disc displacement is also a common finding in lumbar spine degenerative disease. The displaced disc can be just a simple bulge or herniation, herniated discs can be protrusion, extrusion or sequestration. In this study disc herniations were more common than bulges (63% and 39% respectively); and this is different to the findings reported by Sivas et al (2009) [16] and Ong et al (2003) [25]. This difference could be due to young study population (individuals below 30 years) included in these studies. The prevalence of disc herniation is similar to the findings reported by Modic et al (2005) [15], but lower than what was reported by Shobeir et al (2009) [17] and Siddique et al (2005) [29].

Thecal sac changes: In our study, thecal sac changes were seen in 112 patients (82.96%) as indentation or compression, with normal thecal sacs in 23 patients (17.04%).

Spinal cord changes: In our study spinal cord involvement was seen in 62 patients (45.93%) and no cord changes were seen in 73 patients (54.07%).

Posterior elements involvement: In this study posterior elements involvement was seen in 26 patients (19.26%) of the 135 cases against normal posterior elements in 109 patients (80.74%).

Paravertebral structure involvement: In our study paravertebral structure involvement was seen in 4 patients (2.96%) and no changes were seen in 131 patients (97.04%).

In our study we found, if MRI shows truly positive result, the chance of getting positive result in X-ray is 64.34%. and that if MRI shows truly negative result, the chance of getting negative result in X-ray is 100%.

We also found that if X-ray has a positive result; the chance of having MRI positive is 100%. And X-ray has a negative result; the chance of having MRI negative is 11.54%.

Similar findings were found in study done by Gupta N (2022) [30] where they found that If MRI shows truly positive result, then chance of getting positive

result in X-ray is 20.88% (with the range of 16.23% - 26.23%) and If MRI shows truly negative result, then chance of getting negative result in X-ray is 100% (with the range of 87.24% - 100%).

Our study revealed the superiority of MRI in evaluation of various degenerative spine changes including the detection, localization, characterization and assessing the extent of disability. Strength of correlation between MRI and X-Ray findings confirms the value of MRI in assessment of degenerative changes of the lumbosacral spine.

Conclusion

From our study we concluded that Perfusion Index (PI) can be used as a tool for predicting hypotension in patients undergoing elective lower segment cesarean section under subarachnoid block. Patients with baseline PI >3.5 are at higher risk of developing hypotension following SAB compared to those with baseline PI ≤3.5.

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