MRI Evaluation of Lumbar Disc Degenerative Disease

POKHRAJ SUTHAR¹, RUPAL PATEL², CHETAN MEHTA¹, NARROTAM PATEL*¹

ABSTRACT
Introduction: 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 evaluate the characterization, extent, and changes associated with the degenerative lumbar disc disease by Magnetic Resonance Imaging.

Study Design: Cross-sectional and observational study.

Materials and Methods: A total 109 patients of the lumbar disc degeneration with age group between 17 to 80 y were diagnosed & studied on 1.5 Tesla Magnetic Resonance Imaging machine. MRI findings like lumbar lordosis, Schmorl’s nodes, decreased disc height, disc annular tear, disc herniation, disc bulge, disc protrusion and disc extrusion were observed. Narrowing of the spinal canal, lateral recess and neural foramen with compression of nerve roots observed. Ligamentum flavum thickening and facetal arthropathy was observed.

Result: Males were more commonly affected in Degenerative Spinal Disease & most of the patients show loss of lumbar lordosis. Decreased disc height was common at L5-S1 level. More than one disc involvement was seen per person. L4 – L5 disc was the most commonly involved. Annular disc tear, disc herniation, disc extrusion, narrowing of spinal canal, narrowing of lateral recess, compression of neural foramen, ligamentum flavum thickening and facetal arthropathy was common at the L4 – L5 disc level. Disc bulge was common at L3 – L4 & L4 – L5 disc level. Posterior osteophytes are common at L3 - L4 & L5 –S1 disc level. L1- L2 disc involvement and spondylolisthesis are less common.

Conclusion: Lumbar disc degeneration is the most common cause of low back pain. Plain radiograph can be helpful in visualizing gross anatomic changes in the intervertebral disc. But, 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.

INTRODUCTION
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. With respect to radiologic evidence of lumbar disc degenerative disease, the prevalence of disc degeneration increases with age, but degenerated discs are not necessarily painful. Low back pain secondary to degenerative disc disease affects men more than women. The main symptom of disc degeneration after low back pain is sciatica. Sciatica pain occurs mostly on one side of the body. It is a sharp shooting type of pain. Mild tingling sensation, dull ache, or burning sensation can occur. Pain may radiate to the calf or sole of the foot. Sciatic pain aggravates on standing, walking, bending, straining and coughing. In severe case, patient becomes unable to move around [1,2]. Patients with lumbar disc degenerative disease can be presented with sensory disturbances in legs, claudication and relief of pain with bending forwards.[3] There are many risk factors associated with the lumbar disc degenerative disease like advancing age, smoking, obesity, trauma, heavy weight lifting, height, genetic factors[4] and hereditary factors. Certain occupations like machine drivers, carpenters and office workers are also associated with it [5].

The basic purpose of conducting this study is to evaluate the relation between different aspects of lumbar degenerative disc disease and their MRI findings. Antero-posterior (AP) and lateral views of the plain X-ray can be helpful in visualizing gross anatomic changes in the intervertebral disc. It is best visualized on lateral view of X-ray. However, 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 [6,7].

AIMS AND OBJECTIVE
- MR Imaging characterization of the disc degenerative changes of the lumbar spine.
- To evaluate extent of the involvement of the degenerative disc disease and its sequel.
- To identify the changes associated with the degenerative disc disease.

MATERIALS AND METHODS
This was a cross-sectional and observational study. The duration of the study was 2 months from 1st November 2013 to 31st December 2013. A total 109 patients of lumbar disc degeneration were diagnosed on 1.5 Tesla MRI machine. All the observation was done by three Radiologists (Professor, Associate Professor and Resident). Patients between 17 to 80 y of the age with low back pain were included in the study after obtaining a verbal consent. Patients with the history of trauma, prior surgery, spinal infections, active malignancy, pregnancy, cervical spine involvement, age<17 y and > 80 y were excluded from the study. In the study 109 patients were enrolled and their demographic findings noted. The following MRI findings were noted: lumbar lordosis preserved or not [Table/Fig-1,2], Schmorl’s nodes present or not [Table/Fig-3], decreased disc height as compared to the upper and lower vertebral levels.

Disc desiccation: It is a common degenerative change of intervertebral discs. On MRI imaging, the disc loses its central high T2 signal [9] [Table/Fig-4]. Normally, central nucleus pulposus shows...
Degenerative disc disease, Intervertebral disc, Sciatica pain

High signal intensity on T2WI and peripheral annulus, low signal intensity on T2WI

Annular tear: It is also called annular fissure and is a separation between annular fibers, avulsion of fibers from vertebral body insertion or break through fibers involving one or more layer of the annular lamella. Tear in the disc is seen as hyperintese on T2 Weighted images. Annular tear is further classified according to axial location into: central/medial, paramedian/lateral recess, foraminal/subarticular and extra-foraminal. Foraminal or subarticular disc herniation often very troublesome for the patient because compression of a ‘Dorsal Root Ganglion’. Extra-foraminal is very rare.

Disc herniation: Whenever the displacement of disc material beyond the limits of the intervertebral disc space is called as a disc herniation. A herniated disc may or may not be covered by annulus fibroses. Herniation can be focal or bulging. When herniation is less than 180° disc circumference it is called a focal disc herniation and when it is 180° to 360° beyond the edges of the ring apophyses it is called disc buldge. If herniation & buldge was present, it was marked with a “Y”.

Disc protrusion & extrusion: Disc protrusion indicates that the distance between the edges of the disc herniation is less than the distance between the edges of the base. If disc protrusion was present it was marked with “Y”. Whenever the distance between the edges of the disc material is greater than the distance at the base is called as disc extrusion.
Migration: Whenever displacement of disc material is away from the site of extrusion it is called migration. Migration can occur either in cranial or caudal directions [Table/Fig-15,16].

Sequestration: When the displaced disc material has completely lost any continuity with the parent disc it is called sequestration.

Ligamentum flavum thickening: Ligamentum flavum thickening was measured on the axial image, perpendicular to the spinal canal axis and parallel to the lamina, where ligamentum flavum were seen along their entire length & measurement were taken at the half length of ligamentum flavum. According to Park et al., a mean thickness of the ligamentum flavum of 4.44 mm in the patients with the spinal canal stenosis labeled as thickened and 2.44 mm thickness in the control group. So, we had labeled a >4 mm ligamentum flavum thickening as thickened [9] [Table/Fig-17].

Facetal arthropathy: Facetal arthropathy was noted as reduction in synovial facetal joint space with loss of high signal intensity on T2WI [Table/Fig-18].

Narrowing of the spinal canal: In the mid sagittal T2 Weighted images spinal canal diameter was measured. Spinal canal diameter less than 12 mm, indicates narrowing of the canal [Table/Fig-19].

Narrowing of lateral recess: A lateral recess is the space which is bounded ventrally by the posterior surface of the vertebral body, dorsally by the superior articular facet, and laterally by the pedicle.
Medially, it is open toward the spinal canal. It is measured at the level of the pedicle in axial section as the distance between the post aspect of the vertebral body and superior articular facet. If it is less than 4 mm it is considered abnormal [Table/Fig-20,21].

Compression of neural foramen was observed in T2W Sagittal image [Table/Fig-22].

Abnormal hyper signal intensity in the spinal cord on T2 weighted images were evaluated for the spinal cord edema. Pre and Para vertebral soft tissue involvement [Table/Fig-23,24], vertebrectal hemangioma [Table/Fig-25,26], sacroilitis, lumbarization and sacralization of the vertebra were observed.

Spondylolysis is seen as low signal on T1WI in pars interarticularis [Table/Fig-27]. Spondylolisthesis was measured and diagnosed by the methods of Meyerding. Antero-posterior diameter of the superior surface of the lower vertebral body is divided into four equal parts and is Graded as I, II, III and IV if there is a corresponding slip of <25%, 25-50%, 50-75% and >75%. But we could not divide our data according to the grades of the spondylolisthesis, we simply noted that whether spondylolisthesis were present or not & anterolisthesis or posterolisthesis were present or not [Table/Fig-28,29].

RESULTS
Total 109 patients were studied in the evaluation of MRI appearance of Degenerative Spinal Disease. Sixteen patients were excluded from the study as they had history of prior surgery, spinal infections, and active malignancy. From total 109 patients, 60 patients (i.e.55.04% of total patients) were male and 49 patients (i.e.44.95% of total patients) were female. Lumbar lordosis was preserved in 51 (i.e.46.79% of total patients) and loss of the lumbar lordosis was seen in 58 (i.e. 53.21% of total patients) patients. Conus end at
As seen in [Table/Fig–30,31] there were a total 241 disc involvements, so per patients average 2.21 disc involvements were found. L4 – L5 disc involvement was common & seen in 93 discs (i.e. 38.59% of the disc involvement). Decrease disc heights were seen in 31 disc levels, from which decreased disc height common at L5-S1 level 10(i.e. 32.26% of decreased disc height). Two patients (1.83%) showed changes of disdiscs. Fifty five patients (i.e. 50.45% of total patients) showed medi annular disc tear. In medial annular disc tear L4 – L5 disc were common seen (i.e. 38.18% of medial annular disc tear). Forty three patients (i.e. 39% of total patients) show changes of discitis. Fifty five patients (i.e. 50.45% of total patients) show changes of discitis.

### Table/Fig-28:

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<th>Intervertebral Disc Level</th>
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### Table/Fig-27:

[Table/Fig-27]: Sagittal T1 Weighted MR Image: Linear low signal intensity in pars interarticularis of L4 and L5 vertebra (solid white arrow) represent spondylolysis without spondylolisthesis. [Table/Fig-28]: Sagittal T2 Weighted MR Image: Posterior annular tear in L3-L4 and L5-S1 disc with herniation & spinal canal narrowing. Grade – I antrololisthesis of L5 over S1 vertebral body is seen (solid white arrow) [Table/Fig-29]: Sagittal T2 Weighted MR Image: L5- S1 posterior disc herniation with spinal canal narrowing. Grade – I retrololisthesis of L5 over S1 vertebral body is seen (open white arrow)
paramedian annular tear. In paramedian annular disc tear L4 – L5 disc were commonly seen 21 (i.e. 48.84% of paramedian annular tear). Left paramedian tear were seen in 22 patients and right paramedian tear were seen in 21 patients. So, left paramedian tear was common as compared to the right side. 41 patients (i.e. 37% of total patients) showed foraminal annular tear. In foraminal annular disc tear L4 – L5 disc were common 24 (i.e. 58.54% of foraminal annular tear). Left foraminal tear were seen in 25 patients and right foraminal tear were seen in 16 patients. So, left foraminal tear was common as compare to the right side. Herniation in 150 discs (i.e. 62.24% of disc involvement), extrusion in 42 discs (i.e. 17.43% of disc involvement) and disc bulge in 66 disc (i.e. 27.30% of disc involvement). Herniation was common at L4 – L5 disc level 68 (i.e. 45.33% of herniation). Extrusion was common at L4 – L5 disc level 18 (i.e. 42.86% of extrusion). Disc bulge was common at L3 – L4 17 (i.e. 25.76% disc bulge) & L4 – L5 disc level 17 (i.e. 25.76% disc bulge). L3 – L4 & L5 – S1 level shows maximum osteophytes 5 (i.e. 29.41% osteophytes). Spinal canal narrowing was seen in 56 discs (i.e. 23.24% of disc involvement). Spinal canal narrowing was common in L4 – L5 disc 25 (i.e. 44.64% of spinal canal narrowing). Narrowing of lateral recess and compression of neural foramen were seen in 127 discs (i.e. 52.70% of disc involvement) and both were common at L4 – L5 disc 60 (i.e. 47.24% of involvement). Facetal arthropathy and ligamentum flavum thickening was seen in 209 disc levels (i.e. 86.72% of the disc involvement) & both were common at the L4 – L5 disc level. Six patients (i.e. 5.5% of total patients) showed wedging in vertebral body and were equally common at L1, L4 & L5 vertebral body (i.e. 33% each). Fifteen patients (i.e. 13.76% of total patients) showed listhesis in the spine in the form of anterolisthesis or retrolisthesis. Anterolisthesis (i.e. 10.09% of spondylolisthesis) is common as compare to retrolisthesis (i.e. 3.67% of spondylolisthesis). L5 vertebral body listhesis over S1 vertebral body was common in both anterolisthesis & retrolisthesis. As incidental findings vertebral hemangioma in 12 patients (i.e. 11.01% of total patients), marrow edema in 2 patients (i.e. 1.83% of total patients), partial fusion of vertebral body in 1 patient (i.e. 0.92% of total patients), paraspinal muscles fatty infiltration and edema in 3 patients (i.e. 2.75% of total patients) and spinal cord syrinx in 1 patient (i.e. 0.92% of total patients) were found.

**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. Men are more commonly affected to the disc degeneration than women. It is most likely due to the increased mechanical stress and injury [10]. The findings of our study were consistent with other studies [11]. Most common cause of disc degeneration was observed in 4th and 5th decade of life in our study, which was comparable with other studies [11]. Disc desiccation is a common degenerative change of intervertebral discs. It results from the replacement of the glycosaminoglycans within the nucleus pulposus with fibrocartilage which leads to reduced disc height due to reduction in nucleus pulposus volume [12]. Disc degeneration with diffuse disc changes are more commonly found at L4 - L5 and L5 – S1 level [11] and L1 – L2 is least common. This Crani-caudal direction pattern is also followed by disc herniation. It also can be deduced 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; which is also concordance with past studies [13]. The lower back pain and sciatica were due to nerve root compression, which was significantly associated with disc degeneration [14]. Spondylolisthesis was more commonly found in the patients of lumbar stenosis as compare to disc herniation, reflecting the fact that during stenosis, laxity of capsule and ligament may result in the development of spondylolisthesis. Spondylolisthesis was most commonly present at L5 – S1 disc level. This findings is inconcordance with a previous study where spondylolisthesis was common at L4 – L5 disc level [3].

**CONCLUSION**

Lumbar disc degeneration is the most common cause of low back pain. Men are more frequently affected to the disc degeneration than women. Multiple levels of the disc involvement are seen per person. Annular disc tear, disc herniation, disc extrusion, narrowing of spinal canal, narrowing of lateral recess, compression of neural foramen, facetal arthropathy and ligamentum flavum thickening is common at the L4 – L5 disc level. L1- L2 disc involvement and spondylolisthesis are less common. 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.

**REFERENCES**


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