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Neha Singh,
Deepak Kumar Singh

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MRI spectrum and prevalence of lumbar spinal degenerative disease in patients with non-traumatic low back pain

Neha Singh[1], Deepak Kumar Singh[2]

[1] Department of Radiodiagnosis and Imaging, Dr. Ram Manohar, Lohia Institute of Medical Sciences, Lucknow, INDIA
[2] Department of Neurosurgery, Dr. Ram Manohar, Lohia Institute of Medical Sciences, Lucknow, INDIA

Keywords
degenerative changes,
disc bulge,
facet hypertrophy,
intervertebral disc,
low back pain,
sciatica

ABSTRACT

Background. Low back pain (LBP) is a frequent cause of global disability and activity limitation. In the majority of cases, LBP is nonspecific, yet diagnostic confirmation is required to rule out serious underlying pathologies such as infection, tumour, fracture or degenerative disease. It can be done by a number of imaging techniques. Of all available techniques, MRI is currently the imaging modality of choice owing to lack of radiation, multiplanar reformation capabilities and high contrast resolution.

Objectives. To determine various MRI patterns and the common sites of spinal degenerative lesions among patients with LBP.

Method. This study was conducted on 622 patients suffering from non-traumatic LBP, referred for MRI of the lumbar spine. MRI database of the study population were analysed using axial T2-weighted, sagittal STIR, T1and T2-weighted and coronal STIR images. After excluding patients with h/o prior surgery and MR findings suggesting infective or neoplastic etiologies, 598 patients constituted the sample size of our study.

Results. A review of 598 patients with LBP revealed that degenerative changes in intervertebral disc were the most common abnormality detected. Among these, Disc bulge was the most common abnormality followed by disc desiccation, protrusion, extrusion, HIZ/annular tear, reduced IVD space and Schmorl's nodes. Other non- disc degenerative findings were Modic endplate changes, facet joint arthropathy, osteophytes, Spinal canal stenosis and Ligamentum Flavum hypertrophy.

Conclusions. Results reported the common occurrence of lumbar disc degenerative disease in patients with low backache. Research efforts should attempt to trim down risk factors and perk up the quality of life.

Corresponding author:
Neha Singh

Department of Radiodiagnosis and Imaging, Dr. Ram Manohar, Lohia Institute of Medical Sciences, Lucknow, India

neha.singh.dr@gmail.com

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INTRODUCTION

Low Back Pain (LBP) is one of the most common causes of hospital visits and is the leading cause of activity limitations and work absences in many parts of the world.[1,25,9]In the 2016 Global Burden of Disease study, musculoskeletal conditions were the second highest contributor to global disability, and lower back pain remained the single leading cause of disability.[32] LBP poses a considerable monetary menace to

the individual, family, workplace and society. Patients presenting with LBP frequently need imaging investigations to determine the cause. Standard radiography isusually the first investigation to perform, with MRI or CT only usedfor further workup [10]. Despite technical advancements inimaging, the specificcause of the pain can only be determined in less than 50% of cases [7]. This study was conductedto determine various MRI patterns and the common sites of spinal degenerative lesions among patients with LBP.

Materials and Methods

This study was conducted on patients with LBP referred to Radiology department of Dr Ram Manohar Lohia Institute of Medical Sciences, Lucknow for MRI of lumbosacral spine. It was a cross sectional observational study conducted from June 2017 to May 2018. Permission for study was taken from the ethics committee of our Institute. Consent from all patients was taken before their enrolment in the study. Patients name, age, sex and detailed history were obtained. MRI of the lumbar spine was performed with a 3 T (GE) MR imager using spine phased array coils. The scans consisted of axial T2-weighted, sagittal STIR, T1and T2-weighted and coronal STIR images with slice thickness of 4.0mm for each plane. A field of view of 30x30mm for sagittal and coronal images and 18x18mm for axial images were used. The images were stored directly as DICOM files in the workstation.

Inclusion Criteria:
- All patients with non-traumatic LBP referred for MRI lumbosacral spine.

Exclusion Criteria:
- Patients with history of recent trauma;
- prior lumbar spine surgery;
- metallic implants and pacemakers; and
- cases with MR findings s/o infective or neoplastic etiology.

Statistical Analysis -Statistical analysis was done using SPSS 15 software. Percentages were calculated for the various categories.

Results

There were 622 patients of LBP referred for MRI to Radiodiagnosis department. Out of these 24 were excluded from the study as 18 had radiological diagnosis of infective pathology and 6 had neoplastic etiology. A total of 598 patients constituted the sample size of the study. Out of the total patients there were 278 males (46.49%) and 320 (53.51%) females. The age of the patients ranged from 18 years to 80 years. Most common age group was between 31 to 40 years (33.76%). Distribution of various degenerative spinal abnormalities detected on MRI is shown in Table 1.

Type of Abnormality	Frequency (%)
Disc Bulge	**72**
Disc dessication	**69.56**
Disc Protrusion	**27.42**
Disc extrusion	**4.34**
Disc sequestration	**0.83**
HIZ /Annular tear	**28.12**
Schmorl's nodes	**12.67**
Osteophytes	**51.83**
Facetal arthropathy	**30.43**
Modic changes	**23.21**
Flaval hypertrophy	**13.04**
Spinal stenosis	**53.54**
Vertebral collapse	**6.5**
Transitional vertebra	**6.8**
Spinal Listhesis	**5.2**

Table 1. Distribution of various degenerative spinal abnormalities detected on MRI.

Degenerative changes in intervertebral disc were the most common abnormality detected. Among these, Disc bulge was most common abnormality, constituting 72% of the total study population. It was followed by disc dessication (in 69.56%), disc protrusion (in 27.42%), disc extrusion (in 4.34%) (Fig-1), HIZ/annular tear (in 28.12%), reduced IVD space (in 20.54%) and Schmorl's nodes in 12.67% of the patients (Fig-2).

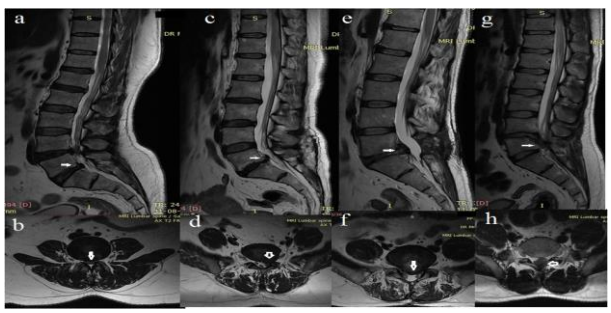

Figure 1. T2W sagittal and axial images of LS spine show disc bulge (a, b), disc protrusion (c, d), disc extrusion (e, f) and sequestration (g, h) marked by arrows.

Figure 2. T2W sagittal images show multiple level disc desiccation with grade 5 changes at L5/S1 level (arrow in fig a), multiple Schmorl nodes (b) and posterior high intensity zone at L3/4 level (c, d).

Other non- disc degenerative findings were Modic end plate changes (in 23.21%), facet joint arthropathy (in 30.43%), osteophytes (in 51.83%), (Fig-3).

Spinal canal stenosis in 53.54% and Ligamentum Flavum hypertrophy (in 13.04%) of patients (Fig-4).

Other less commonlyseen but important findings included: vertebral collapse (in 9.1%), transitional vertebral complex (in 6.8%) and spinal listhesis (in 5.2% of the population) (Fig-5).

In our study, disc bulge was the most common abnormality (72%) seen in patients with low back ache. It was most commonly seen at L4-L5 (in 39.30%) followed by L5-S1 (in 28.14%) and L3/4 (in 24.18%) levels. Single level bulge was seen in less than a quarter of patients, (in 24.18%) while multiple level involvement was a more frequent finding (in 75.82%). Posterocentral disc bulge was most commonly seen followed by paracentral, forminal and extraforaminal types.

Figure 3. a) Sagittal T1WI shows Modic 2 end plate changes. b) Sagittal T2WI shows marginal osteophytes. Axial T2WI show Ligamentumflavum hypertrophy (c) and facet joint hypertrophy (d).

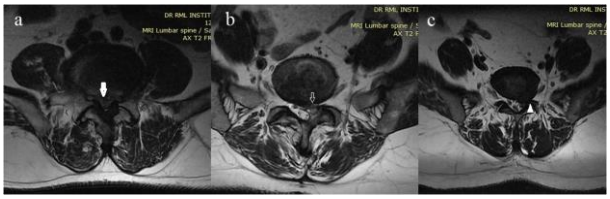

Figure 4. Axial T2WI show central canal stenosis (a), lateral recess stenosis (b) and neural foramina stenosis (c).

Disc dessication was the 2nd most common abnormality detected in 69.56% of total study population. Grade 3 degenerative changes were the most common pattern followed by grade 4 and 5 changes. All these changes were most commonly involving L4/5 and L5/S1 levels.

Figure 5. Sagittal T2WI show vertebral collapse (a), spondylolisthesis (b) and Transitional vertebral complex (c).

No sex predilection was noted in cases of disc prolapse. Most common age of presentation for both protruded and extruded disc was 31-40 years. Disc protrusion was seen in 27.42% of total sample size, most commonly identified at L4-L5 (48%) and L5-S1 (29%) levels. Posterocentral disc protrusion (68.2%) was most common type followed by paracentral and forminal protrusions. Disc extrusion was demonstrated in 4.34% of the population, most common level being L4/5 followed by L5/S1.Posterocentral type extrusion was most frequently seen. Disc sequestration was seen in only 5 patients constituting 0.83% of total study population.

Annular tear is characterised by T2W Focal hyperintensity, described as High Intensity Zone (HIZ) in posterior annulus of the disc. It was noted in 28.12% of the total study population and was most prevalent at L4/5 and L5/S1 levels. These changes were most commonly seen between 60-80-year age group. Schmorl's nodes were seen in 12.67% of the cases and were most commonly involving 21-40yr age group males.

Lumbar canal stenosis was noted in 53.54% of the study population without any sex predilection. Multilevel involvement and bi-laterality was the most common presentation in this study. Bilateral lateral recess stenosis was most common pattern (in 58.68%) followed by bilateral foraminal stenosis in 23.24% and central stenosis in 18.08%. These patterns can be seen unaccompanied or in amalgamation.

Spondylolisthesis was demonstrated in 5.2% of population. Most common level involved was L4 over L5 and L5 over S1. Vertebral collapse was noted in 6.5% of the cases with anterior wedge collapsebeing the most common type. Lumbosacral transitional vertebral complex (LSTV) was detected in 6.8% of the population. Majority of the cases were showing sacralization of L5 vertebra with occasional occurrence of Lumbarization of S1.

Our study demonstrated vertebral end plate changes in 23.21% of cases. Modic type I and type II changes were seen in 3.16% and 20.05% of the population respectively. These changes were most commonly seen after age of 50 years. Marginal osteophytes were reported in 51.83% of our study population.

Facetal arthropathy was seen in 30.43% of cases and was more common in elderly patients. Most common vertebral level involved was L4/5 followed by L5/S1. Ligamentumflavum hypertrophy was noted in 13.04 % of the study population.

Discussion

Low back pain (LBP) is an important public health problem with many possible etiologies and uneven distribution. As a result, the existingenormous literature on LBP is not only heterogeneous but also conflicting. According to a global review published in 2012, point prevalence of LBP was 11.9%+2.0%, overall mean prevalence was 31.0%+ 0.6%, and the lifetime prevalence was 39.9% +24.3%.[12] Studies on Indian population have shown the prevalence ranging between 6.2% in general population to 92% in heavy physical workers. Such great variation can be attributed to the heterogeneity of the population.[4] The diagnostic accuracy of MRI for degenerative conditions of spine is high. MRI is 75% sensitive and 77% specific in diagnosing nucleus pulposus herniation, resulting in a positive predictive value of 84% and a negative predictive value of 64%.[30] Similar studies have shown high sensitivity of 96% coupled with lower specificity of 75% in the identificationof spinal stenosis[2] and sensitivity of 92% tied with higher specificity of 100% in evaluation of nerve root compression [6].

Our study demonstrated female predilection for LBP seen in 53.51% females and 46.49% males. It was in accordance with systematic review of the global prevalence of low back pain [12]and studies conducted on Indian population [23,26].

Most common age group who presented with LBP was 31-40 years (33.76%), an age group that is usually involved in strenuous physical activity. These

results were in accordance with those found by Kopec [17].

In our study, disc bulge was the most common pathology seen in 72% of cases which correlated well with previous studies [34]. It was seen most commonly at L4-5 level followed by L5-S1 and L3-4 levels respectively. These findings correlated well with study by Ma D et al [20]. In our study, single level bulge was seen in less than a quarter of patients with multiple level involvements being a more frequent finding. This finding was in accordance with studies by Pokhraj Suthar et al [28] and Osman et al [24]. Posterocentral disc bulge was most common type followed by paracentral and forminal bulge. These findings were well supported by Pintu et al [5].

Disc desiccation was the 2nd most common abnormality detected in 69.56% of total study population with the last two lumbar levels clearly predominating.These findings were supported by study done by Jarvik JG et al [15].While the gradesof disc degeneration are not much taken into account in the literature, so-called 'discreet or grade 3' changes seem to be more common than 'moderate to severe (grade 4/5)' changes [31].

Disc protrusion was next most common abnormality detected in 27.42% of population. This is unlike the findings of Pokhraj et al [28] who found disc protrusions in 62.24% and disc bulges in 27.39% of population. This discrepancy could be owing to preponderance of younger individuals in our study. Study by Pintu Biswas demonstrated high incidence of disc bulge (71.59%) as compared to protrusions (8.8%). [5) Disc protrusions were mostly seen in 60-80-year-old individuals, most common level being L4-L5 (48%) and L5-S1 (29%).

Disc extrusion was seen in 4.34% of the population, most common level being L4/5 followed by L5/S1. These findings correlated well with study by Jacob et al [13]. Disc sequestration was seen in only 5 patients constituting 0.83% of total study population.

Annular tear was noted in 28.12% of the total study population. It corresponds to a previous study by Aprill and Bogduk, which reported 28% prevalence of annular tear in patients with back pain. This study also concluded that HIZ was highly specific and strongly predictive of a painful disc. [3]

Schmorl's nodes were seen in 12.67% of the cases and were most commonly involving 21-40yr age group males. These findings correlated well with study by Jagannath D et al who reported the prevalence of 9.2% and these features being most common in 4th decade. [14]

Lumbar canal stenosis was noted in 53.54% of the study population whereas study by Shobeiri E et al revealed lower number of cases seen only in 37% of the cases.[27] Bilateralism and multilevel involvementwas mostcommon presentation in our study. Spinal stenosis can be central, lateral recess or foraminal. Central stenosis is a result of hypertrophy of the inferior facet articular process of cephalic vertebra. Lateral recess and foraminal stenosis occurs due to hypertrophy of the superior facet articular process of caudal vertebra.[19] Bilateral lateral recess stenosis was most common pattern (in 58.68%) followed by bilateral foraminal stenosis in 23.24% and central stenosis in 18.08%. These patterns can be seen unaccompanied or in amalgamation.

Spondylolisthesis was found in 5.2% of study population, with obvious female predilection. In a study performed by Frennered et al. the prevalence of spondylolisthesis in patients with LBP was estimated to be 2.5% which is less than that in present study. [8] Recent studies like He et al. and Layegh M, Hejazian E. estimated higher prevalence [13%] than what was approved in our study [11,18]. Most common level involved was L4 over L5 followed by L5 over S1which correlated well with previous studies. [18]

Vertebral collapse was noted in 6.5% of the cases with anterior wedge collapse being the most common type seen in approximately 80% cases. It was higher as compared to the study byMustapha et al who found wedge collapse in just 1.97% of the cases. It can be explained by higher number of female patients in our study whereas the previous study was a male predominant study [22].

Lumbosacral transitional vertebral complex was seen in 6.8% of the population. Majority of the cases had sacralized L5 vertebra and only few cases had Lumbarized S1. Study by Layegh on Iranian population found the prevalence of LSTV to be 9.8%. Of all patients, 8.2% had sacralisation of L5 and 1.6% had lumbarisation of S1 [18].

Our study demonstrated vertebral end plate changes in 23.21% of cases. Systemic review by Tue Secher documented that median prevalence of end plate changes is 43% in patients with non-specific LBP [29]. Type I and type II changes were seen in

3.16% and 20.05% of the population respectively. These findings correlated well with the original study of Modic et al which demonstrated that type 2 changes were the most frequent and may account for up to 90% of Modic changes.[21]

Marginal osteophytes were reported in 51.83% of our study population. Nemoto found osteophytes in 46% of patients and there was no difference between patients with and without back pain. [24] Facetal arthropathy was seen in 30.43% of cases and was more common in elderly patients. Although study done by P Y Yong et al was correlating with our study as the prevalence was 29.8%. [33] Study by A.K. Kohat et al had shown very high prevalence (75%) of facet joint arthropathy in chronic low backache patients. [16] Most common vertebral level involved was L4/5 followed by L5/S1which is supported by both the previously mentioned studies.

Ligamentum flavum hypertrophy was noted in 13.04 % of our study population. It was in accordance with study by PY Yong et al (prevalence 14.0%) but very low as compared to study by Kohat (prevalence 70.8%). It was predominantly seen at lower lumbar levels (L4/L5 and L5/S1).

Conclusion

Degenerative disease of the lumbar spine is a common condition that radiologists will come across frequently. Role of diagnostic imaging in patients with low back pain is to provide precise anatomic information which in turn affects the management. MRI is a mainstay in the evaluation of low back pain and degenerative disease of the lumbar spine. This paper highlights a variety of degenerative patterns affecting the vertebral bodies, intervertebral discs, facet joints, and ligamentum flava, as well as the collective effects of these changes on the spinal canal and neural foramina.

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