Original Research Article

Diagnostic Performance of Magnetic Resonance Imaging in Lumbar Disc Prolapse With Focal Neurological Deficits

Girendra Shankar[1], Rudra Narayan Dash[2*], Kamal Kumar Sen[3], Shubhankar[1]

[1]Postgraduate resident, Department of Radiodiagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India
[2]Associate Professor, Department of Radiodiagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India
[3]Professor and Head of the Department, Department of Radiodiagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

Received: 14-11-2020 / Revised: 17-12-2020 / Accepted: 16-01-2021

Abstract

Introduction: A magnetic resonance imaging (MRI) scan is now theaccepted gold standard for the diagnosing a lumbar disc prolapse. In this study, we aimed to determine the degree to which a 1.5 Tesla MRI corresponds with the clinical features and findings in cases of lumbar disc prolapse with focal neurological deficits. **Materials and methods**: A prospective cohort study was conducted at PBM Hospital, a tertiary-care institution between July 2018 and July 2020. Over a two-year period, 150 consecutively sampled patients with lumbar disc prolapse were included in this study. All the patients were subjected to a 1.5 Tesla MRI scan. **Observations**: Out of the total 150 referred patients for low back ache with neurological deficits, 135 (90%) patients were diagnosed with disc prolapse by our reference standard, of which 128 patients (85.33%) were positively diagnosed by magnetic resonance imaging. The calculated sensitivity was 94.81% and specificity was 80.00% with an accuracy of 90.37% .**Results**: All of the patients referred to us with chronic low back ache and focal neurological deficits had degenerative findings at various lumbar spinal levels. 1.5 T MRI for patients with low back ache with focal neurological deficits has high accuracy and can be used for detailed evaluation of the etiology of the symptoms, for precise clinical management decisions and for preoperative surgical planning.

Keywords : Disc Prolapse, Degenerative disease of spine, MRI spine

Introduction

Low back ache is a common condition from which every individual has suffered at some point of their life. It can range from mild pain to most debilitating pains associated with neurological deficits. It is also touted to be one of the most common cause of disability-adjusted life years due to impaired physical function and sub-optimal quality of life[1]. The etiology of the low back ache has been under extensive study. In the adult population, most common cause of low back ache is degenerative disc disease(42%) followed by facetal arthropathy (31%) and sacroiliac (SI) joint disease (18%)[1]. Although it has been also found that asymptomatic adults have a high per However, asymptomatic adults also have a high prevalence of degenerative lumbar spine imaging findings[2].One of the most commonly associated findings seen with low back ache is intervertebral disc herniation. There is also a noted variation in the presentation of symptoms with herniated discs, a same sized disc may be asymptomatic in one patient or may cause severe compressive myelopathy[3]. Often the diagnosis is complicatedas both symptoms and signs have to be correlated with the image findinga[4]. MRI is the Investigation of choice for the diagnosis of lumbar disc diseases with better discrimination of disc tissue and neural tissues[5].Though MRI is best modality for morphologic classification of the disc prolapse, only a moderate correlation is noted between the imaging and the corresponding symptoms[6]. Therefore, to assess the clinical significance of anatomical anomalies found by the MRI technique, a correlation between the clinical features of disc prolapse and MRI is required.It is difficult to verify the relationship between DD and LBP among adults, since degeneration progresses with age, and changes in temporal order are therefore difficult to detect without long follow-up[7].The present research examined the prevalence of lumbar spine degenerative findings and their correlations with sciatica-associated clinical signs. Our hypotheses were that there is direct correlation between MRI findings in lumbar disc prolapse and straight leg raising test as well as sciatic stretch test.

**Correspondence*
Dr. Rudra Narayan Dash
Associate Professor, Department of Radiodiagnosis, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India
E-mail: dr.r.n.dash2011@gmail.com

Materials and methods

A prospective cross-sectional study was conducted in the Pradyumna Bal memorial hospital, a tertiary-care level institute between August 2018 and August 2020. The sample size of this study was 150 patients.

Inclusion criteria

1. Adult patients with persistent low backache radiating to the lower limb with associated neurological symptoms and signs referred to department of Radiodiagnosis for MRI lumbosacral spine.
2. Patients who underwent surgery after MRI were undertaken for evaluation of our study.

Exclusion criteria

1. Patients with history of trauma or operative intervention for low backache.

2. Patients of age less than 20 years.
3. Cases in which MRI was contraindicated, in patients with implanted medical devices containing ferromagnetic object like cardiac pacemakers, internal defibrillator devices, orthopedics implants, bone growth stimulators, etc.
4. Claustrophobic patient.

MRI evaluation

The selected patients underwent an MRI scan (1.5T) of lumbo-sacral spine with *GE Signa HDx T 1.5 Tesla MRI*. Standard protocol for LS spine was done for all cases using a polarized spine array coil (HD 8Ch CTL spine array coil) which was positioned below the lumbosacral spine. The planes used for scanning were axial and sagittal with oblique sections taken for evaluating sacroiliac joints and scoliotic spine. The axial sections were obtained parallel through the lumbar discs including superior and inferior endplates using a slice thickness of 4 mm. The sequences obtained included T1, T2 STIR in the sagittal plane, T1 and T2 in the axial plane, HFS in both sagittal and coronal plane. Gradient and Diffusion weighted sequences were acquired as per requirement. Interpretation of the MR images was performed by two evaluators. Initially, all images were screened for evidence of neoplastic, inflammatory infectious disorders or surgical scars and if any, the patient was excluded from the study.

Clinical evaluation

The LDH with Radiculopathy Work Group of the North American Spine Society's (NASS) Evidence-Based Guideline Development Committee recommendedin 2014,manual muscle testing, sensory testing, and supine SLR test (and its crossed leg variant) as the gold standard for clinical diagnosis of LDH[8]. A meta-analysis in 2017 concluded that initial screening by the SLR test in conjunction with three of the following four symptoms in a nerve root distribution is sufficient for clinical diagnosis of LDH with radiculopathy: dermatomal pain, sensory deficits, reflex deficits, and/or motor weakness[9]. Therefore, a combination of clinical examination for muscle weakness, sensory impairment, supine SLRT and deep tendon reflexes findings was considered as a reference standard.

Data Analysis

Data was analyzed using GraphPad Prism 8. The tabulation of master-chart was done and the obtained information was analyzed using the Chi-Square test. The prevalence of low backache was taken as 70% according to the WHO background paper. P-value of 0.05 was considered to indicate statistically significant difference.

Results

Among the patient studied, half belonged to the middle age group i.e. 40 to 60 years of age. And least belonged to the younger population signifying the increase in degenerative changes in the older age group. Patients with focal deficits tend to present earlier than the older age group. One patient belonging to age group above 80 was also included in our study. The study included 150 patients; the age range was from 23 to 81 years (mean 50.78 ±1.07 years) whereby sixty-three (42%) of them were females.It is observed that in our study the referred patients were of 23 to 81 years of age(mean 50.78 ±1.07 years) whereby 63(42%) of them were females.Prevalence of various degenerative imaging findings were more common among males, only disc bulges were common among females, though the differences were not statistically significant (p-value ≥0.05)

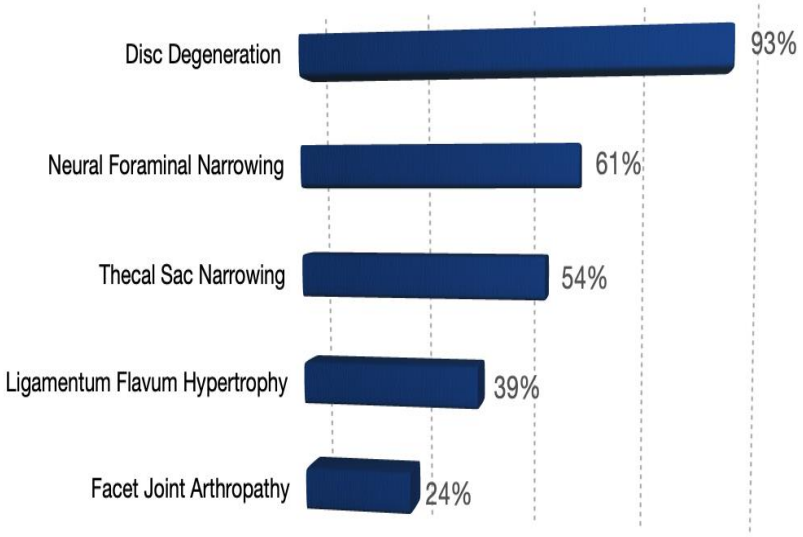

Figure 1:Frequency distribution of MRI features in lumbar disc prolapse with focal neurological deficits

Diagnostic Accuracy of Magnetic resonance imaging for lumbar disc prolapse with neurological deficits

Table 1:Diagnostic Accuracy of Magnetic resonance imaging for lumbar disc prolapse with neurological deficits (*With respect to prevalence according to WHO background paper)

Statistic	Value	95% CI
Sensitivity	94.81%	89.61% to 97.89%
Specificity	80.00%	51.91% to 95.67%
Positive Likelihood Ratio	4.74	1.72 to 13.05
Negative Likelihood Ratio	0.06	0.03 to 0.14
Disease prevalence (*)	70.00%	84.04% to 94.29%
Positive Predictive Value (*)	91.71%	80.07% to 96.82%
Negative Predictive Value (*)	86.86%	75.48% to 93.42%
Accuracy (*)	90.37%	84.48% to 94.58%

In our study of 150 patients, the sensitivity was 94.81%, specificity was 80.00%, Accuracy of 90.37%, positive predictive value of 91.71% and negative predictive value of 86.86%. These findings are comparable to previous study conducted by Boos et al with sensitivity of 82.61% and specificity of 89.13%, the overall diagnostic accuracy was 85.87%[10].On lumbar MRI of patients with disc prolapse associated with clinical neurological deficits, all selected cases showed lumbar disc prolapse, likely due to our inclusion criteria. Disc degeneration (sign of reduced disc signal intensity) being the most frequent finding seen in 139 (92.6%) patients, followed by ligamentum flavum hypertrophy in 104 (69.3%) patients, spinal canal narrowing in 94 (62.6%) patients, neural foraminal narrowing in 92 (61.3%) patients and modic changes in 55 (36.6%) patients. The least common finding was facet joint arthropathy which was seen in 36 patients (24%). None of the participants had normal lumbar MRI findings.The prevalence of disc degeneration in the form of disc desiccation was highest at L4-L5 in 128 levels (40.25%) followed by L5-S1 level, which was 89 levels (27.98%). Disc degeneration was least common at L1-L2 level. (4.7%)Disc prolapse was seen to occur maximum at L4-L5 level, summing up to be 43.50% of the total prolapsed discs. Successively, L5-S1 level emerged to be the second most common site of involvement contributing ~33% of the total diseased discs. L1-L2 Level was the least affected level, accounting for 3.5% of the total.Most of the disc degenerative findings were seen at lower lumbar levels i.e. L4-L5 and L5-S1, 43.5% and 32.9% respectively.Annular tears were most commonly noted at L4-L5 levels followed by L3-L4 and L5-S1 levels. They were least noted at L1-L2 and L2-L3 levels.Modic changes were seen at a total of 82-disc levels, most of which were identified at L4-L5 and L5-S1 levels which were 32.92% and 25.60% respectively. Least end plate changes were identified at L1-L2 level (4.87%).Most common Modic change was type 2 which was seen at 68 levels in the sample population, amounting to 82.9% of the same. Type 3 modic change was seen at 5 levels only (~6%)

Discussion

The main aim of diagnostic imaging is to form an accurate anatomic data which ultimately affects the final therapeutic decision making. Our tertiary level hospital based prospective cross-sectional study used 1.5 T MRI for diagnosis of degenerative changes in spine. Since there is higher tissue differentiation with diagnosis of early degenerative changes when compared against other imaging modalities like computed tomography. Other than higher accuracy for spinal degenerative changes MRI also is superlative as it has no known adverse effects or associated morbidity, there is no risk of radiation exposure and non-invasive in nature[11].Even though there is documented evidence of higher diagnostic performance for degenerative diseases, many of the asymptomatic patients show degenerative changes[12]. This is primary reason why MRI is of more value in patients with chronic low back ache and for pre-operative planning.All the patients who underwent magnetic resonance imaging of lumbar spine were primarily evaluated for degenerative disease. The degenerative changes were detected in all of 150 of patients evaluated. Highest number of findings were localised to be at L4-L5 (43.50%) and L5-S1 (32.98%) IVD levels. The degenerative changes start at an early age in life, that is in second and third decade and are directly considered to be a part of normal aging process, still the primary cause is not known. The various aetiologies that could be at play could be immunological, hereditary, bio-chemical and resorption basis which can lead to accelerated aging. Sincelumbar spine is subjected to mechanical stress due to vertical transmission of body weight, it becomes the focus of load bearing due to degenerative changes. This partially explains the predilection found in our observations. The mean age of our study is calculated to be 50.78 ±1.07 years. This is comparable to the findings of previous studies showing high prevalence in patients above 40 years of age which increases progressively to over 90% by 50 to 55 years of age[7,13]. The most frequent finding encountered was disc degeneration observed in 137 (83%) patients in current study. The disc degeneration increased in prevalence with progressing age (In 60 to 80 years of age prevalence was 99.3%, whereas in the age group 40 to 59 years and 20 to 39 years, prevalence came out to be 72.7% and 22.7% respectively). The calculated difference noted between the age groups was significant(p-value 0.000) , this observation was corresponding to those obtained in previous studies[7,13,14]. The variation encountered within the young and the aged population can be due to age related degenerative processes. We observed that the disc degeneration was more commonly encountered among males 66 (82%) when compared with females 67 (77%), although the variation was not statistically significant. This is similar to the findings reported by Suthar et al. and Saleem et al[14,15].The degenerated discs increased in number going down the lower spinal levels, as described by Suthar et al. and Saleem et al., most commonly L4-L5 and L5-S1 levels spinal levels were involved which was similar to our observations. L1-L2 level showed approximately ~95% of the IV discs of normal signal intensity, which decreased to approximately 60% in the lower lumbar levels (L4-L5 and L5-S1)[14,15]. Cheung et al. reported that a significant association was present between lumbar disc degenerative changes on the magnetic resonance imaging and the symptoms of low back ache. Our study showed

similar findings and association[7]. In our study the prevalence of end plate Modic changes was 54.67%, which was relatively more comparable to prevalence of 43% found by Jensen et al[16].Our observations were somewhat higher to the 27% prevalence studied by Rai GS et al[17]and 24.3% by Osman et al[18], on detailed evaluation of modic changes, Type II Modic changes were observed to be more frequent than the type I with prevalence of 82.9% and 10% of each type respectively, these findings are consistent with results derived by Kuisma et al[19] In our evaluation, it was also found that the proportion of their occurrence increased with lower spinal levels. The most common locations for modic changes were L4-L5 and L5-S1 IVD levels. Suthar et al. and Saleem found similar results and observations[14,15]

We studied the Disc Displacement and disc contour anomalies in detail which are also common findings of lumbar spine degenerative disease. The disc displacement can be in the form of diffuse circumferential bulge, or herniation. Herniation of the disc is further described, on the basis of morphology as protrusion, extrusion or sequestration. Our study showed disc herniation more commonly occurring when compared with focal bulges (63.33% and 33.11% respectively). The prevalence of disc herniation was comparable to the data reported by Rai et al[17], however it was lower than the observations of Suthar et al., Saleem et al. and Iyidobi et al[14,15,20] The majority of the herniation (Approximately 49%) were classified as postero central and least common were neural foraminal. In this study, two disc sequestrations were seen. the reduced prevalence of sequestration could be attributed to the skipping of axial at non symptomatic level section.Different studies have reported that disc herniations are more common at L4-L5 and L5-S1 levels which was also seen in our study. These findings were reflected in our study as 76.48% cases showed herniation at L4-L5 and L5-S1. These herniations could be due to the heavy mechanical stress seen at the lower lumbar levels on spine. The prevalence of disc herniation at the highest two levels, i.e., L3-L4 and L1-L2 was seen to be 14.03% and 3.50% respectively. (result similar to this was found in previous studies[14,15,18,21].The maximum occurrence of disc herniation was at the postero-central location, which was seen in 49.26% of the cases. Other locations viz. postero lateral and foraminal locations showed 45.59%, 5.15% occurrence respectively. (similar findings were reported by Suthar et al. and Saleem et al.[14,15]. Among the study population ninety-four (62.6%) patients were observed to have thecal sac narrowing. This finding was comparable to the spinal canal narrowing in the studies done by Iyidobi et al. and Saleem et al[15,21].which is comparatively more than that described by Suthar et al. and Hazra et al[20]. This variation can be attributed to the more older population undertaken when compared to the other two studies. Since the neurological symptoms and the examination findings with focus on the focal neurological deficits pertain more to the thecal sac narrowing than the spinal canal narrowing, as per our evaluation of the thecal sac antero-posterior diameter. The clinical presentation with sciatica with low backache is more commonly seen in degenerative spinal canal stenosis[3].

Suthar et al., Saleem et al. and Rai et al.have previously reported that the neural foraminal narrowing is more frequent at L5-S1 level, which is different from our study, we found it to be more commonly occurring at the L4-L5 IVD level. L1-L2 IVD level was seen to be least affected[14,15,17]

The sensitivity and specificity for diagnosis of lumbar disc prolapse in patients with focal neurological deficitswere 94.81% and 80.00% respectively, with an accuracy of 90.37%.These findings are comparable to a similar previous study conducted by Boos et al[10].

Conclusion

- All of the patients referred to us with chronic low back ache and focal neurological deficits had degenerative findings at various lumbar spinal levels.
- All the MRI features are more commonly seen at the lowest two lumbar levels i.e. L4-L5 and L5-S1 level.
- Features like disc herniation and neural foramina narrowing along with thecal sac indentation were common in patients with neurological deficits with chronic low back ache. Therefore, signifying a relation between their presence and the neurological deficits.
- Of the clinical tests studied by us, both sciatic stretch test and straight leg raising test have shown positive, although moderate correlation with the focal neurological deficits. Both tests had almost equal strength of association and can be used to identify patients with focal neurological deficits who should undergo MRI study.

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Conflict of Interest: Nil
Source of support:Nil