Research Article

Cuestiones de Fisioterapia

Medicine

SPECTRUM OF MAGNETIC RESONANCE IMAGING FINDINGS IN PATIENTS PRESENTING WITH CHRONIC LOW BACK PAIN: A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE TEACHING HOSPITAL

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Abstract

Background: Chronic low back pain (CLBP) is one of the most frequent reasons for outpatient consultation and imaging referral in India. Magnetic resonance imaging (MRI) is the modality of choice for evaluating the lumbar spine because of its superior soft-tissue contrast and multiplanar capability, yet the spectrum of findings encountered in unselected patients from a South Indian tertiary care setting is incompletely characterised. Objective: To describe the spectrum, distribution and relative frequency of lumbar MRI findings in adults presenting with CLBP and to explore associations of degenerative changes with age, occupation and clinical features. Methods: This hospital-based cross-sectional, descriptive imaging study was conducted in the Department of Radiodiagnosis of a tertiary care teaching hospital in South India over the study period. Consecutive adults with CLBP of more than three months' duration referred for lumbar MRI were included. Imaging was performed on a 1.5 T (or [field strength]) scanner using a standard lumbar protocol, and findings were recorded per intervertebral level. Data were analysed descriptively; chi-square and t-tests were used for associations, with $p<0.05$ considered significant. Results: Among 300 patients (mean age 51.7 +/- 19.6 years; 173 women, 57.7%), degenerative changes dominated. Disc degeneration prevalence increased caudally, being maximal at L4-L5 (63.7%) and L5-S1 (59.0%). Disc bulge was the commonest morphology (55.0%), followed by protrusion (24.7%). Neural foraminal narrowing (37.0%), facet arthropathy (34.3%) and canal stenosis (22.3%) were frequent. Lumbar spondylosis/degenerative disc disease was the leading impression (75.3%). A small but important minority showed red-flag findings: vertebral compression fracture (2.7%), severe canal stenosis (2.7%) and suspected spondylodiscitis (0.7%). Multilevel degeneration and canal stenosis rose significantly with age ($p<0.001$). Conclusion: Degenerative disease, maximal at the lower lumbar levels, accounts for the overwhelming majority of MRI findings in South Indian patients with CLBP, while a clinically relevant minority harbour serious pathology. Given the well-recognised imperfect correlation between imaging and symptoms, MRI should be requested judiciously and interpreted alongside clinical findings.

Keywords: Chronic low back pain; magnetic resonance imaging; lumbar spine; intervertebral disc degeneration; spinal stenosis; South India

Introduction

Low back pain is the single leading cause of years lived with disability worldwide and imposes a substantial and rising burden on health systems in low- and middle-income countries, including India. Chronic low back pain (CLBP), conventionally defined as pain persisting for more than three months, affects a large proportion of the adult population and is a common reason for referral to radiology departments in tertiary care teaching hospitals across South India. The condition is frequently multifactorial, with contributions from intervertebral disc degeneration, facet joint arthropathy, ligamentous changes, spinal canal and foraminal compromise, and, less commonly, serious "red-flag" pathology such as fracture, infection or neoplasm.

Magnetic resonance imaging (MRI) has become the imaging modality of choice for the lumbar spine because of its excellent soft-tissue contrast, multiplanar acquisition and absence of ionising radiation. It permits detailed depiction of disc hydration and morphology, endplate (Modic) changes, the spinal canal and neural foramina, the facet joints and the paraspinal soft tissues [1,2]. The introduction of MRI has transformed the evaluation of degenerative disc disease, allowing distinct patterns of degeneration to be recognised and correlated with clinical presentations [1]. Upright and positional MRI techniques have further refined the assessment of dynamic morphological change in the symptomatic spine [3,13].

Despite these advantages, the relationship between MRI findings and clinical symptoms in CLBP remains complex and imperfect. Degenerative changes such as disc bulges and disc degeneration are highly prevalent even among asymptomatic individuals, and their mere presence on imaging does not establish them as the source of a given patient's pain [4,5]. Some authors have argued that canal narrowing predicts CLBP more reliably than disc degeneration alone [4], while others have shown that the statistical association between disc degeneration and pain weakens substantially once endplate changes and disc contour are taken into account [5]. Modic (vertebral endplate and marrow) changes and high-intensity zones within the disc have attracted particular interest as potentially more specific markers of a painful, discogenic process [6,7,11]. Careful clinical correlation, therefore, remains essential, and several investigators have emphasised the limitations of imaging as a stand-alone diagnostic test in lumbar spine disorders [8,9].

In the South Indian context, where CLBP contributes heavily to outpatient and imaging workloads and where access to advanced imaging is expanding rapidly, a clear description of the spectrum and relative frequency of lumbar MRI findings is valuable for both radiologists and referring clinicians. Such data can inform expectations at reporting, support judicious use of MRI, and highlight the minority of patients in whom imaging reveals serious pathology requiring prompt action. Against this background, the present study was undertaken to characterise the spectrum of MRI findings in adults presenting with CLBP at a tertiary care teaching hospital in South India, to describe the level-wise distribution of degenerative change, and to explore associations of degenerative and stenotic findings with age, occupation and selected clinical features.

MATERIALS AND METHODS

Study design and setting

This was a hospital-based, cross-sectional, descriptive imaging study carried out in the Department of Radiodiagnosis, tertiary care teaching hospital, India, over the study period six months. The department serves as a referral centre for a large urban and semi-urban catchment population in South India and receives lumbar MRI requests from orthopaedics, neurosurgery, general medicine, rheumatology and physical medicine services.

Study population

Consecutive adult patients (aged 18 years and above) presenting with chronic low back pain of more than three months' duration and referred for lumbar spine MRI during the study period were considered for inclusion. Patients with a history of prior lumbar spine surgery, spinal instrumentation, known primary or metastatic spinal malignancy under active treatment, or MRI of non-diagnostic quality, and those with absolute contraindications to MRI (for example, non-MRI-compatible cardiac devices), were excluded. Relevant demographic and clinical information -- age, sex, body mass index (BMI), occupational category, duration and severity of pain (recorded on a 0-10 visual analogue scale, VAS), and the presence of radicular pain -- was recorded at the time of imaging.

MRI protocol

All examinations were performed on a 1.5 T MRI scanner using a dedicated spine phased-array coil. A standard lumbar spine protocol was employed, comprising sagittal T1-weighted and T2-weighted sequences, axial T2-weighted sequences through the lower lumbar intervertebral levels, and a sagittal short-tau inversion recovery (STIR) or fat-suppressed sequence to assess marrow and soft-tissue oedema. Additional sequences and contrast administration were used at the discretion of the reporting radiologist when infection, tumour or other specific pathology was suspected. Images were interpreted by radiologists in the department, and findings were recorded systematically at each intervertebral level from L1-L2 to L5-S1.

Imaging variables

For each patient, the following were documented: presence of disc degeneration at each of the five lumbar levels (L1-L2, L2-L3, L3-L4, L4-L5, L5-S1); disc morphology (bulge, protrusion, extrusion, sequestration); the level(s) of disc herniation where present; spinal canal stenosis and its grade; neural foraminal narrowing; facet arthropathy; ligamentum flavum hypertrophy; spondylolisthesis; Modic (endplate) changes; Schmorl nodes; vertebral compression fracture; and features suggestive of infection or tumour. A single overall primary MRI impression was assigned for each patient.

Statistical analysis

Data were compiled in a spreadsheet and analysed using standard statistical software. Continuous variables were summarised as mean +/- standard deviation (SD) and categorical variables as frequencies and percentages. Level-wise prevalence of degeneration and the frequency of individual findings were tabulated and displayed graphically. Associations between categorical variables (for example, multilevel degeneration or canal stenosis by age group and occupation) were tested using the chi-square test; the Pearson correlation coefficient and t-tests were used for continuous comparisons. A two-sided p-value <0.05 was considered statistically significant.

Results

Demographic and clinical characteristics

A total of 300 adults with CLBP were analysed. The mean age was 51.7 +/- 19.6 years, and women constituted the majority (173, 57.7%) compared with men (127, 42.3%). The mean BMI was 25.9 +/- 4.3 kg/m^2. Sedentary occupation was the commonest occupational category (138, 46.0%), followed by moderate physical work (113, 37.7%) and heavy physical work (49, 16.3%). The mean duration of pain was 60.4 +/- 34.4 months and the mean VAS score was 5.7 +/- 1.5, indicating moderate pain intensity. Radicular pain was present in 128 patients (42.7%) and absent in 172 (57.3%). These characteristics are summarised in Table 1.

Table 1. Demographic and clinical characteristics of the study population (N=300)

Characteristic	Value
Age, years (mean +/- SD)	51.7 +/- 19.6
Female, n (%)	173 (57.7)
Male, n (%)	127 (42.3)
BMI, kg/m^2 (mean +/- SD)	25.9 +/- 4.3
Occupation -- Sedentary, n (%)	138 (46.0)
Occupation -- Moderate physical work, n (%)	113 (37.7)
Occupation -- Heavy physical work, n (%)	49 (16.3)
Pain duration, months (mean +/- SD)	60.4 +/- 34.4
Pain severity, VAS 0-10 (mean +/- SD)	5.7 +/- 1.5
Radicular pain present, n (%)	128 (42.7)
Radicular pain absent, n (%)	172 (57.3)

Level-wise distribution of disc degeneration

Disc degeneration showed a clear caudal predominance. Prevalence rose progressively from the upper to the lower lumbar spine: L1-L2 18.0%, L2-L3 28.3%, L3-L4 43.0%, L4-L5 63.7% and L5-S1 59.0% (Figure 1, Table 2). The two lowest mobile segments, L4-L5 and L5-S1, were the most frequently affected, consistent with the greater biomechanical loading at these levels. Overall, at least one level of degeneration was demonstrable in the large majority of patients, and multilevel involvement was common.

Figure 1. Prevalence of disc degeneration by lumbar level (N=300)

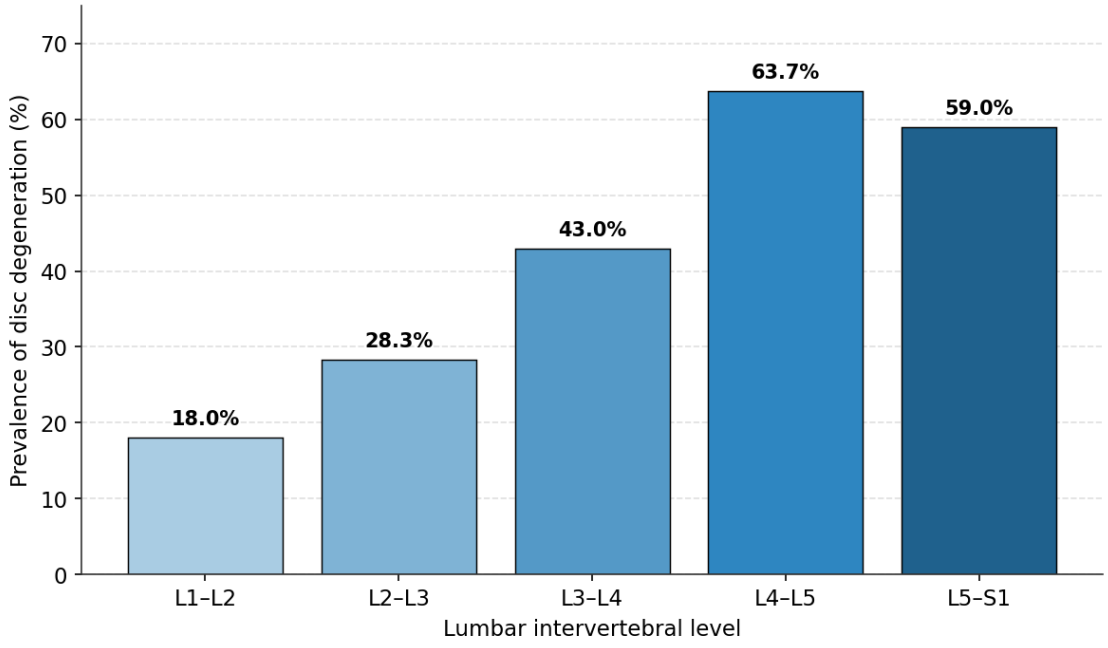

Figure 1. Prevalence of disc degeneration by lumbar intervertebral level (N=300), showing a caudal predominance maximal at L4-L5 and L5-S1.

Table 2. Prevalence of disc degeneration by lumbar level (N=300)

Lumbar level	Degeneration present, %
L1-L2	18.0
L2-L3	28.3
L3-L4	43.0
L4-L5	63.7
L5-S1	59.0

Spectrum and frequency of MRI findings

The overall spectrum of findings was dominated by degenerative changes (Figure 2, Table 3). Disc bulge was the commonest morphological abnormality, seen in 55.0% of patients, followed by disc protrusion (24.7%), disc extrusion (7.0%) and disc sequestration (1.0%). Among the other degenerative features, neural foraminal narrowing (37.0%) and facet arthropathy (34.3%) were the most frequent, followed by canal stenosis (22.3%), Modic changes (20.3%), ligamentum flavum hypertrophy (18.3%), Schmorl nodes (11.3%) and spondylolisthesis (11.0%). Vertebral compression fracture was uncommon (2.7%).

Figure 2. Frequency of key MRI findings in chronic low back pain (N=300)

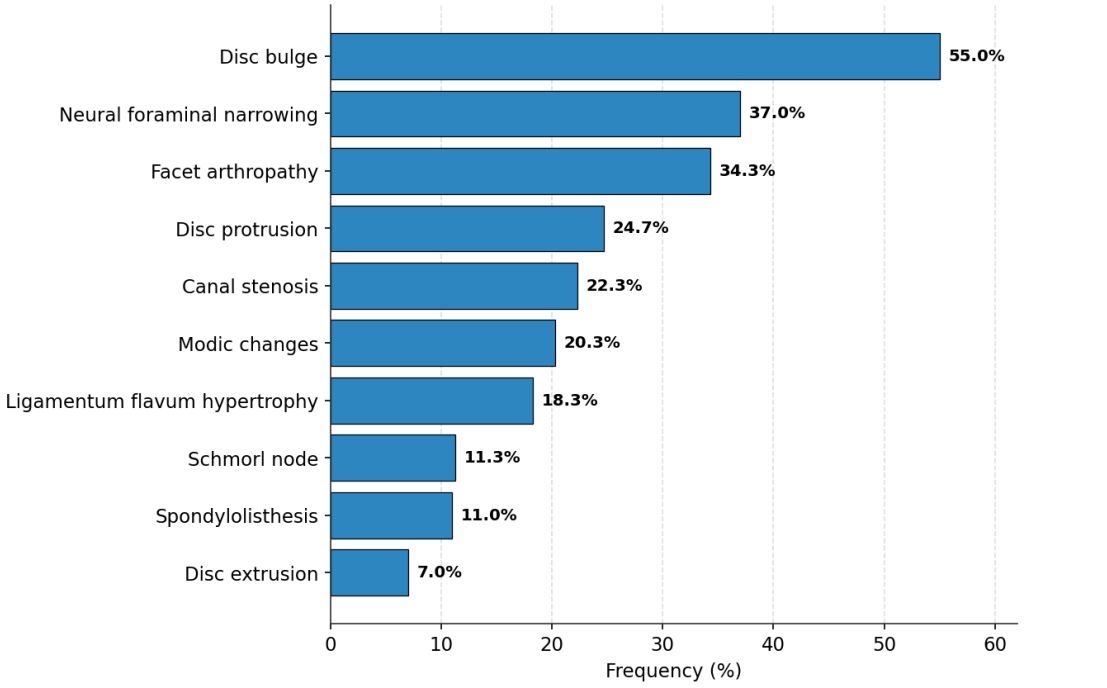

Figure 2. Frequency (%) of key MRI findings in patients with chronic low back pain (N=300).

Table 3. Spectrum and frequency of MRI findings (N=300)

MRI finding	Frequency, n (%)
Disc bulge	165 (55.0)
Disc protrusion	74 (24.7)
Disc extrusion	21 (7.0)

Disc sequestration	3 (1.0)
Canal stenosis	67 (22.3)
Neural foraminal narrowing	111 (37.0)
Facet arthropathy	103 (34.3)
Ligamentum flavum hypertrophy	55 (18.3)
Spondylolisthesis	33 (11.0)
Modic changes	61 (20.3)
Schmorl node	34 (11.3)
Vertebral compression fracture	8 (2.7)

Disc herniation was identified in 198 patients (102 had no herniation). The level distribution of herniation mirrored the degeneration pattern, with the lower lumbar levels most often involved: L4-L5 (87), L5-S1 (53), L3-L4 (32), L2-L3 (18) and L1-L2 (8).

Primary MRI impression

The single most common primary MRI impression was lumbar spondylosis/degenerative disc disease, assigned in 226 patients (75.3%). Moderate lumbar canal stenosis was the impression in 22 patients (7.3%) and no significant abnormality in 18 (6.0%). Lumbar disc herniation with nerve-root compression accounted for 16 patients (5.3%). A small but clinically important minority carried serious impressions: vertebral compression fracture in 8 (2.7%), severe lumbar canal stenosis in 8 (2.7%) and suspected infective spondylodiscitis in 2 (0.7%) (Table 4).

Table 4. Primary MRI impression and selected associations (N=300)

Primary MRI impression	n (%)
Lumbar spondylosis / degenerative disc disease	226 (75.3)
Moderate lumbar canal stenosis	22 (7.3)
No significant abnormality	18 (6.0)
Lumbar disc herniation with nerve-root compression	16 (5.3)
Vertebral compression fracture	8 (2.7)
Severe lumbar canal stenosis	8 (2.7)
Infective spondylodiscitis suspected	2 (0.7)
Selected associations (age group)	**Value**
Multilevel degeneration, <40 y / 40-60 y / >60 y	54.3% / 64.0% / 84.9% (p<0.001)
Canal stenosis, <40 y / 40-60 y / >60 y	15.2% / 14.6% / 35.8% (p<0.001)

Associations

The burden of degenerative change increased markedly with age. Multilevel disc degeneration (two or more levels) was present in 54.3% of patients under 40 years, 64.0% of those aged 40-60 years and 84.9% of those older than 60 years (chi-square = 23.6, p<0.001). Similarly, canal stenosis rose from 15.2% and 14.6% in the younger age bands to 35.8% in patients over 60 years (chi-square = 17.3, p<0.001). By contrast, multilevel degeneration did not differ significantly across occupational categories (sedentary 67.4%, moderate physical work 68.1%, heavy physical work 69.4%; p=0.97).

Pain severity showed only a weak, non-significant positive relationship with the number of degenerated levels (Pearson r = 0.11, p=0.06), underscoring the limited correlation between the anatomical extent of degeneration and reported pain intensity. Radicular pain was more frequent among patients with disc herniation (48.0%) than among those without herniation (32.4%), and this difference was statistically significant (chi-square = 6.1, p=0.014), consistent with the expected clinical-radiological link between herniation and nerve-root symptoms.

Discussion

This cross-sectional study of 300 adults with CLBP referred for lumbar MRI at a tertiary care teaching hospital in South India confirms that degenerative disease, maximal at the lower lumbar levels, accounts for the overwhelming majority of imaging findings, while a small but clinically significant minority harbour serious pathology. Disc degeneration prevalence increased in a caudal gradient, peaking at L4-L5 (63.7%) and L5-S1 (59.0%), and disc herniation followed the same distribution. These patterns are consistent with the greater axial load, range of motion and shear forces borne by the lowest mobile lumbar segments, and they accord with prior MRI analyses that have delineated distinct patterns of lumbar disc degeneration in degenerative disc disease and disc prolapse [1,2].

Disc bulge was the commonest morphological abnormality (55.0%), a finding in keeping with the high background prevalence of bulges reported in both symptomatic and asymptomatic populations. Neural foraminal narrowing, facet arthropathy, canal stenosis, Modic changes and ligamentum flavum hypertrophy were each encountered in a substantial fraction of patients, reflecting the multifactorial and whole-motion-segment nature of lumbar degeneration rather than isolated disc pathology [2]. The overall primary impression of lumbar spondylosis/degenerative disc disease in three-quarters of patients (75.3%) mirrors everyday radiological experience in South Indian tertiary practice, where degenerative change is by far the dominant substrate of CLBP.

A central and clinically important theme of this study is the imperfect correlation between MRI degenerative findings and symptoms. Pain severity correlated only weakly and non-significantly with the number of degenerated levels (r = 0.11, p=0.06), and 6.0% of symptomatic patients had no significant abnormality on imaging. These observations echo a substantial body of literature demonstrating that degenerative changes are common in asymptomatic individuals and that their presence alone does not establish causation [4,5]. Visuri and colleagues found that narrowing of the lumbar spinal canal predicted CLBP more accurately than disc degeneration in young conscripts [4], while Kovacs et al. showed that the association between disc degeneration and CLBP became non-significant once endplate changes and disc contour were accounted for [5]. Modic changes and high-intensity zones have been proposed as more specific markers of a genuinely painful, discogenic process, and their pathophysiology and relationship to pain remain areas of active investigation [6,7,11]. In our cohort, Modic changes were present in one-fifth of patients (20.3%), a proportion broadly in line with these reports. The consistent message from this

literature, and from studies applying formal principles of diagnostic testing to the lumbar spine, is that imaging must be interpreted in the light of the clinical picture rather than in isolation [8,9].

The finding that radicular pain was significantly more frequent in patients with disc herniation (48.0% versus 32.4%; p=0.014) provides reassurance that, at the level of nerve-root compression, imaging and symptoms do align in a clinically coherent way, as observed in cross-sectional clinical-radiological correlation studies of prolapsed intervertebral disc disease [8]. The strong, graded increase in multilevel degeneration and canal stenosis with advancing age (both $p<0.001$) is expected and highlights that, in older South Indian patients, degenerative and stenotic change is almost ubiquitous -- a consideration that should temper the diagnostic weight placed on such findings when they are encountered incidentally.

While degenerative disease predominated, this study also underscores the importance of vigilance for red-flag pathology. A small proportion of patients had vertebral compression fracture (2.7%), severe canal stenosis (2.7%) or suspected infective spondylodiscitis (0.7%). Although individually uncommon, these conditions carry major implications for management and prognosis, and their detection is one of the principal justifications for MRI in the CLBP pathway. Spondylolisthesis (11.0%) and spondylolysis-related change are additional structural contributors that must be systematically sought and reported, as reviewed in detail elsewhere [10]. The paraspinal musculature, increasingly recognised as relevant to lumbar degenerative disease, may also merit attention on routine sequences [12].

These findings carry practical implications for the judicious use of MRI in South India. Given the very high prevalence of degenerative change, particularly in older patients, and its imperfect correlation with symptoms, indiscriminate imaging risks generating incidental findings that may drive unnecessary anxiety, further investigation and intervention. A rational approach -- reserving early MRI for patients with clinical red flags, progressive neurological deficit or features suggesting specific treatable pathology, while managing uncomplicated mechanical CLBP conservatively in the first instance -- is likely to improve the value of imaging and optimise the use of scarce resources in busy South Indian tertiary care teaching hospitals. Structured, level-wise reporting that distinguishes clinically actionable findings from ubiquitous age-related change would further support referring clinicians.

Conclusion

In this cross-sectional study of adults with chronic low back pain referred for lumbar MRI at a tertiary care teaching hospital in South India, degenerative changes dominated the imaging spectrum, with disc degeneration and herniation maximal at the L4-L5 and L5-S1 levels and lumbar spondylosis/degenerative disc disease as the leading impression in three-quarters of patients. Degenerative and stenotic changes increased strongly with age, yet correlated only weakly with pain severity, reaffirming the well-recognised imperfect relationship between MRI findings and symptoms. A small but clinically important minority showed serious "red-flag" pathology, including fracture, severe canal stenosis and suspected infection. These findings support the judicious, clinically guided use of lumbar MRI and careful, structured interpretation in South Indian practice, so that ubiquitous age-related change is not over-attributed while genuinely serious disease is reliably detected.

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