DOI: 10.7860/IJARS/2026/85105.3091

Original Article

Radiology Section

Degenerative Lumbar Spine Changes on MRI among Adult Patients with Chronic Low Back Pain: A Cross-sectional Study

M JANANI[1], R MITHUN RAJ[2], JOSEPH MANUEL[3], PALLE MANJUNATHA REDDY[4]

ABSTRACT

Introduction: Low Back Pain (LBP) is a prevalent condition worldwide and a major cause of disability, particularly when associated with degenerative lumbar disc disease. Magnetic Resonance Imaging (MRI) provides high sensitivity and specificity for detecting disc degeneration and related changes in the lumbar spine, including spondylolysis and other structural abnormalities. Although MRI is the preferred modality for evaluating lumbar degeneration, relatively few studies have focused specifically on MRI documented changes in patients with chronic LBP presenting to tertiary care centres.

Aim: To characterise and describe degenerative changes of the lumbar spine as seen on MRI among adult patients with chronic LBP evaluated at a tertiary care hospital in Puducherry, India.

Materials and Methods: The present cross-sectional study was conducted from May 2023 to May 2025 at a tertiary care hospital in Puducherry, India, equipped with a 1.5 Tesla MRI scanner. The study included 190 adults aged over 30 years who presented with persistent LBP. Patients referred for MRI of the lumbar spine were recruited, excluding those with pain secondary to prior surgery, pregnancy, trauma, or neoplasms. MRI findings and relevant clinical data were recorded using standardised data collection forms and analysed using Statistical Package for the Social Sciences (SPSS) software. Ethical standards were strictly followed, and written informed consent was obtained from all participants.

Results: Among the 190 participants, 59.47% (n=113) were females and 40.53% (n=77) were males. The majority of patients belonged to the 41-60 year age group. MRI most frequently revealed degenerative changes at the L4-L5 and L5-S1 intervertebral disc levels. Disc bulge was observed in 96% of cases at L4-L5 and 82.1% at L5-S1, while disc herniation was noted in 22.1% and 15.3% of cases at these levels, respectively. Other common findings included facet joint arthropathy, ligamentum flavum hypertrophy, lumbar canal stenosis, lateral recess compression, neural foraminal narrowing, and thecal sac indentation, all occurring predominantly at the lower lumbar levels. Degenerative changes were more common in females, and LBP without associated radiculopathy was relatively uncommon.

Conclusion: MRI findings demonstrated that degenerative alterations including disc bulge, osteophyte formation, spinal canal stenosis, neural foraminal narrowing, ligamentum flavum hypertrophy, and thecal sac indentation were most frequent at the L4-L5 and L5-S1 levels in patients with chronic LBP. Comprehensive MRI evaluation of these regions is recommended. Targeted therapeutic approaches addressing nerve compression and biomechanical stress may prove beneficial. Future research should focus on treatment efficacy and long-term outcomes.

Keywords: Disc herniation, Chronic low back ache, Degenerative changes, Low back pain, Magnetic resonance imaging

INTRODUCTION

LBP is highly prevalent worldwide, affecting nearly two-thirds of the adult population at some point in their lives [1]. Lumbar degenerative disc disease is recognised as one of the leading global causes of LBP [2-4] and represents the primary symptom associated with musculoskeletal disorders of the spine. Degenerative changes within the intervertebral discs can result in discogenic pain, contributing to impaired functional stability of spinal motion segments [5-8].

In India, the prevalence of low back pain has been reported as 48% (95% CI: 40-56%) at a point in time, 51% (95% CI: 45-58%) annually, and 66% (95% CI: 56-75%) over a lifetime. The highest pooled prevalence has been observed among rural populations, elementary school staff, and females [9].

MRI serves as the principal diagnostic imaging modality for evaluating disc degeneration [10,11]. It allows comprehensive assessment of lumbar spondylosis, neural structures, disc morphology, loss of water content, and vertebral endplate signal intensity changes [12]. MRI enables detailed evaluation of disc bulge, annular tears, protrusion, extrusion, sequestration, and their effects on adjacent structures such as the spinal canal, neural foramina, and nerve roots. Early degenerative changes typically begin at the vertebral endplates and are best detected using MRI [13,14].

The term "degeneration" on spine MRI encompasses findings such as disc desiccation, reduced disc height, diffuse bulging or prolapse, annular fissures, mucinous degeneration, Modic endplate changes, sclerosis, and osteophyte formation [13]. Despite the high prevalence of degenerative changes, relatively few studies have systematically evaluated MRI features in patients presenting with chronic LBP [15,16]. Therefore, the present study aimed to assess common MRI variables associated with lumbar spine degeneration in adults with chronic LBP.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Radiodiagnosis at Pondicherry Institute of Medical Sciences, Puducherry, India, between May 2023 and May 2025. Approval was obtained from the Institutional Research and Ethics Committee (IEC: RC/202326), and all procedures were conducted in accordance with the Indian Council of Medical Research (ICMR) ethical guidelines. Written informed consent was obtained from all participants prior to enrolment.

Inclusion and Exclusion criteria: The study population included patients aged over 30 years presenting with LBP persisting for more than six weeks. Eligible participants were those referred from clinical departments for MRI evaluation of chronic LBP. Patients with a history of spinal surgery, trauma, pregnancy, or benign or malignant spinal masses were excluded.

Sample size calculation: The sample size of 190 participants was calculated based on the study by Ravikanth R (2020), assuming a 41.2% prevalence of L4-L5 disc involvement, with an absolute precision of 7% and a 95% Confidence Interval (CI). Participants were selected using consecutive sampling [15].

Study Procedure

Following a detailed clinical assessment by the referring clinician and the radiologist, which included neurological examination of lower limb power, deep tendon reflexes (knee and ankle jerks), sensory testing along dermatomal distributions, and manoeuvres such as the straight leg raise test, all participants underwent MRI of the lumbar spine using a 1.5 Tesla scanner. The imaging protocol included T1-Weighted (T1W), T2-Weighted (T2W), and Short Tau Inversion Recovery (STIR) sagittal images; T1W and T2W axial images; and STIR coronal sections. MRI findings were documented using a standardised case report form and subsequently compiled into a master database for statistical analysis.

STATISTICAL ANALYSIS

Data were analysed using SPSS version 20. Results were expressed as frequencies and percentages with 95% confidence intervals. The Chi-square test was applied to assess associations between spinal level and the presence of degenerative MRI findings, including disc protrusion or extrusion, disc bulge, osteophyte formation, facet joint arthropathy, ligamentum flavum hypertrophy, lumbar canal stenosis, neural foraminal stenosis, and thecal sac indentation. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 190 patients with chronic LBP were included in the study, comprising 113 females (59.47%) and 77 males (40.53%). Age distribution analysis revealed that the majority of patients were in the 41-50 year (34.7%) and 51-60 year (30%) age groups, followed by those aged over 60 years (18.4%) and 30-40 years (16.8%). This distribution highlights that lumbar degenerative changes predominantly affect middle-aged and older adults, consistent with age-related disc dehydration and cumulative biomechanical stress [Table/Fig-1,2].

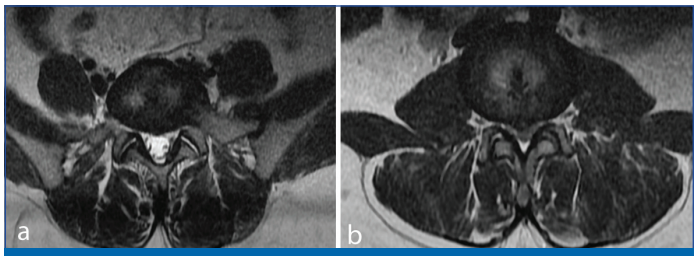
Gender	Frequency	Percentage
Male	77	40.53%
Female	113	59.47%
Total	190	100%

[Table/Fig-1]: Gender distribution of study participants.

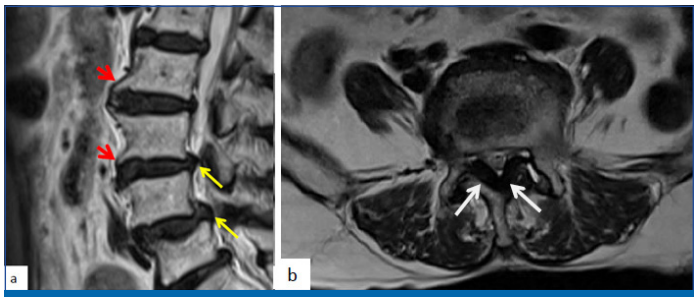
Age group (years)	Frequency	Percentage
30-40	32	16.84%
41-50	66	34.74%
51-60	57	30.00%
>60	35	18.42%

[Table/Fig-2]: Age distribution of study participants.

MRI evaluation demonstrated a high prevalence of degenerative changes in the lower lumbar spine, particularly at the L4-L5 and L5-S1 levels. These segments are subjected to the greatest biomechanical stress, explaining their frequent involvement. Disc bulge was the most common MRI finding, observed in 183 patients (96.3%) at L4-L5 and 156 patients (82.1%) at L5-S1. The strong statistical association (p<0.0001) indicates that disc bulging is a hallmark feature of chronic degenerative lumbar spine disease. Disc herniation was also frequently noted at these levels, occurring in 42 cases (22.1%) at L4-L5 and 29 cases (15.26%) at L5-S1. Higher lumbar levels (D12-L1 to L2-L3) demonstrated minimal involvement [Table/Fig-3,4].



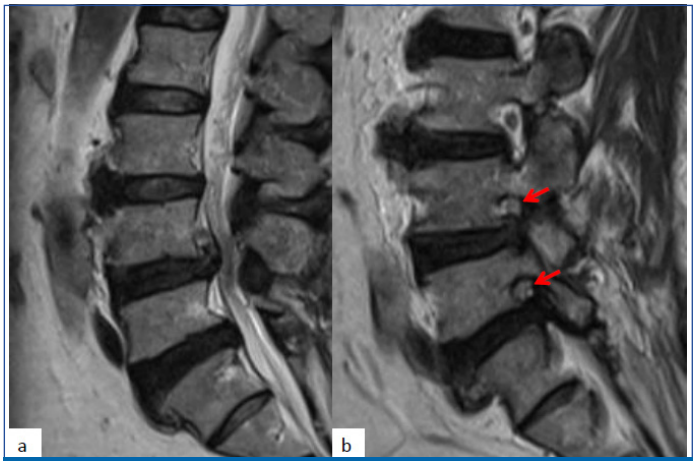
[Table/Fig-3]: A 33-year-old female came with the complaints of low back ache: a) This is an axial T2W image showing disc bulge indenting the anterior thecal sac at L4-L5 level; (b) Axial T2W image of lumbar spine at L3-L4 level showing central disc protrusion causing severe anterior thecal sac indentation, bilateral lateral recess compression and spinal canal narrowing.



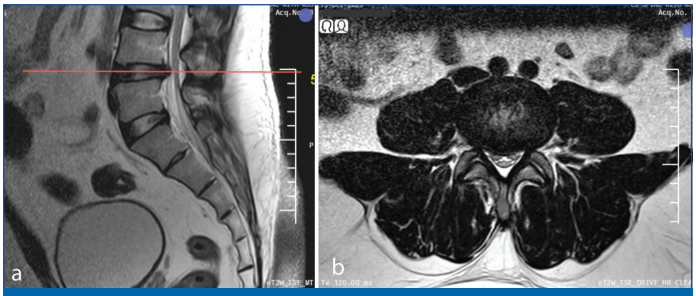
[Table/Fig-4]: A 63-year-old female came with the complaints of chronic low back ache: a) This is a T2W sagittal image showing anterior marginal osteophytes (red arrow) and multilevel disc bulges (yellow arrows) causing spinal canal stenosis involving the lumbar spine; b) This is a T2W image in axial section showing thickened ligamentum flavum (white arrows) at L4-L5 level.

Disc protrusion was identified in 39 patients (20.53%) at L4-L5 and 27 patients (14.21%) at L5-S1, whereas disc extrusion was relatively uncommon, occurring in only 2.11% of cases at both L4-L5 and L5-S1 levels. Osteophyte formation demonstrated a progressive increase from higher to lower lumbar segments, peaking at 188 patients (98.9%) at L4-L5 and 159 patients (83.7%) at L5-S1, underscoring the chronicity of degeneration and mechanical overload at these segments.

Facet joint arthropathy was observed in 59 patients (31.05%) at L4-L5 and 63 patients (33.16%) at L5-S1. Ligamentum flavum hypertrophy was another prominent finding, present in 53 patients (27.89%) at L4-L5 and 39 patients (20.53%) at L5-S1. Lumbar canal stenosis was most pronounced at the L4-L5 level, affecting 51 patients (26.84%), followed by 35 patients (18.42%) at L5-S1. These findings reflect the combined effect of disc bulge, ligamentum flavum hypertrophy, and facet joint arthropathy [Table/Fig-5,6].

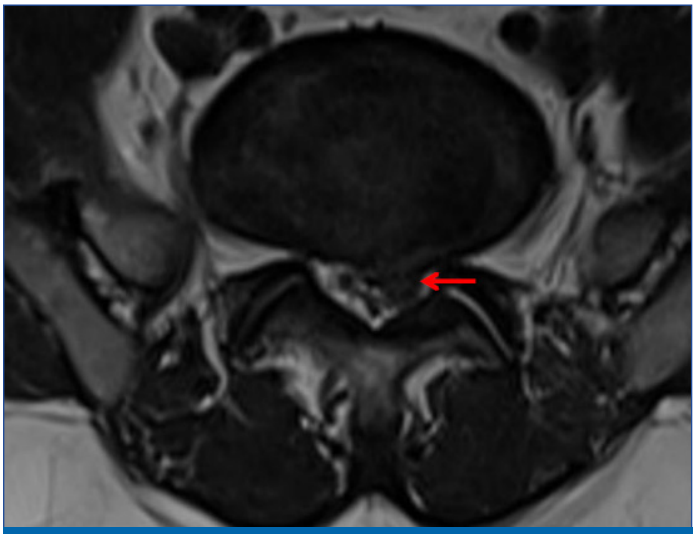


[Table/Fig-5]: A 54-year-old male came with the complaints of low back ache with the pain radiating to the left lower limb: a) T2W sagittal image shows disc bulge causing severe anterior thecal sac indentation and spinal canal stenosis at L4-L5 level; b) T2W sagittal images show left-sided severe neural foramen narrowing, impinging the exiting nerve roots (red arrows).



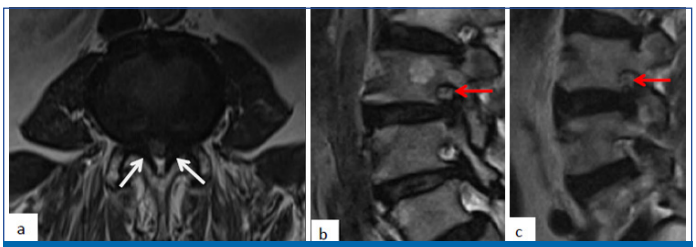
[Table/Fig-6]: A 39-year-old male who presented with low back ache after lifting heavy weight: a) This is an sagittal T2W image showing disc bulge indenting the anterior thecal sac at L4-L5 level; b) Axial T2W image of lumbar spine at L4-L5 level showing symmetrical disc bulge causing severe anterior thecal sac indentation, bi-lateral lateral recess compression, impinging bilateral exiting nerve roots and spinal canal narrowing.

Neural foraminal compression, a clinically significant finding associated with radiculopathy, was identified in 176 patients (92.63%) at L4-L5 and 136 patients (71.58%) at L5-S1, representing the most common cause of radiating pain in this study population. Thecal sac indentation was observed in 187 patients (98.42%) at L4-L5 and 155 patients (81.58%) at L5-S1, indicating significant space-occupying pathology in the lower lumbar canal. Only a small subset of 2 patients (1.05%) presented with chronic LBP without associated radiculopathy [Table/Fig-7].

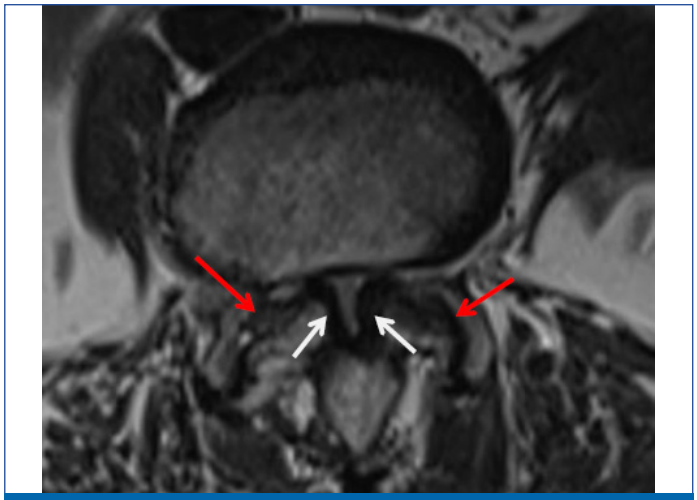


[Table/Fig-7]: A 56-year-old male who presented with low back ache for 3 months. This is an sagittal T2W image showing disc bulge with left paracentral protrusion (red arrow) indenting the anterior thecal sac and causing lumbar canal stenosis at L4-L5 level.

Overall, the L4-L5 and L5-S1 levels were the most frequently affected sites across all degenerative parameters, including disc pathology, osteophyte formation, and canal or foraminal narrowing. These associations were statistically significant ($p<0.0001$), confirming that degenerative lumbar spine disease in chronic LBP is predominantly localised to the lower lumbar segments [Table/Fig-8-10].



[Table/Fig-8]: A 75-year-old female came with the complaints of chronic low back ache: a) This is a T2W axial image showing diffuse symmetrical L4-L5 disc bulge causing severe anterior thecal sac indentation and lumbar canal stenosis along with bilateral lateral recess compression. Bilateral Ligamentum flavum thickening (white arrows) is noted in the same section; b) This is a T2W image in sagittal section at L3-L4 level showing severe right-sided neural foramen narrowing (red arrow); c) This is a T2W image in sagittal section at L3-L4 level showing severe left-sided neural foramen narrowing (red arrow).



[Table/Fig-9]: A 62-year-old female who presented with low back ache for 6 months. This is an axial T2-weighted image showing symmetrical disc bulge indenting the anterior thecal sac and causing lumbar canal stenosis at L4-L5 level. Bilateral facet joint arthropathy (red arrows) is noted along with ligamentum flavum hypertrophy (white arrows).

DISCUSSION

The present study demonstrated that degenerative changes were most prevalent at the L4-L5 and L5-S1 levels, with disc bulge being the most common MRI finding, followed by disc herniation and osteophyte formation. These findings were statistically significant ($p<0.0001$), reinforcing the concept that the lower lumbar segments bear the greatest biomechanical load and are therefore most susceptible to degenerative changes.

With increasing life expectancy and an ageing population, the prevalence and associated disability related to degenerative disc disease are rising. Lumbar disc degeneration remains the leading cause of LBP globally, with disc herniation constituting a major component of this degenerative process. Advances in MRI technology now provide a superior, non invasive modality for evaluating the entire lumbar spine, offering high-contrast, sensitive, and multiplanar images that clearly delineate disc morphology and its relationship with surrounding spinal structures [17].

In the present study, most patients with chronic LBP were middle-aged, particularly in the 41-50 and 51-60 year age groups. This finding is consistent with global data demonstrating that lumbar degenerative changes increase with age due to cumulative biomechanical stress and progressive disc dehydration, as reported by Wu A et al., and Zhang C et al., [18,19]. A higher proportion of females (59%) was also observed, in line with previous reports indicating a greater prevalence of LBP among women, potentially related to hormonal influences, differences in bone density, and lifestyle factors. These findings highlight age and female sex as important determinants of lumbar degenerative disease and chronic LBP [20,21].

The present study demonstrated that degenerative changes were most prevalent at the L4-L5 and L5-S1 levels, with disc bulge and disc herniation occurring most frequently at these segments. This distribution corresponds with the well-established understanding that the lower lumbar spine bears the greatest mechanical stress, predisposing these levels to accelerated degeneration. Similar findings have been reported by Ravikanth R (2020) and Iida T et al., (2024), who also observed a higher incidence of disc pathology and degenerative alterations at these levels due to their pivotal role in load transmission and mobility within the lumbar spine [15,22].

In the present study, disc protrusion was observed in 20.5% of patients at L4-L5 and 14.2% at L5-S1, while disc extrusion was relatively rare. These findings are consistent with large MRI-based cohort studies reporting that disc protrusions occur far more frequently than extrusions in symptomatic populations. Similarly, the observation of osteophyte formation peaking at the lower

Parameters	D12-L1	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1	p-value
Disc bulge	0	29 (15.26%)	54 (28.42%)	119 (62.63%)	183 (96.32%)	156 (82.11%)	<0.0001
Disc herniation	0	5 (2.63%)	10 (5.26%)	17 (8.95%)	42 (22.11%)	29 (15.26%)	<0.0001
Disc protrusion	0	7 (3.68%)	2 (1.05%)	15 (7.89%)	39 (20.53%)	27 (14.21%)	<0.0001
Disc extrusion	0	0	0	3 (1.58%)	4 (2.11%)	4 (2.11%)	<0.0001
Osteophyte formation	10 (5.26%) (est.)	23 (12.11%)	40 (21.05%)	86 (45.36%)	188 (98.95%)	159 (83.68%)	<0.0001
Facet arthropathy	6 (3.16%)	14 (7.37%)	30 (15.79%)	48 (25.26%)	59 (31.05%)	63 (33.16%)	<0.0001
Ligamentum flavum thickening	3 (1.58%)	12 (6.3%)	20 (10.53%)	31 (16.32%)	53 (27.89%)	39 (20.53%)	<0.0001
Lumbar canal stenosis	0	6 (3.16%)	16 (8.42%)	28 (14.74%)	51 (26.84%)	35 (18.42%)	<0.0001
Neural foraminal compression	5 (2.63%)	19 (10.0%)	49 (25.79%)	78 (41.08%)	176 (92.63%)	136 (71.58%)	<0.0001
Thecal sac indentation	3 (1.58%)	10 (5.26%)	23 (12.11%)	79 (41.58%)	187 (98.42%)	155 (81.58%)	<0.0001

[Table/Fig-10]: Association between lumbar level and degenerative MRI findings.

lumbar levels in this study is in agreement with previous studies demonstrating increased osteophytic changes at L4-L5 and L5-S1, further supporting the role of increased mechanical burden at these junctions [15,17].

Facet joint arthropathy was observed in 31.1% of patients at L4-L5 and 33.2% at L5-S1 in the present study. This lower-lumbar predominance is consistent with multiple imaging studies identifying the L4-L5 level as the most commonly affected site for facet osteoarthritic changes. Kalichman L et al., reported the highest prevalence of facet joint arthropathy at L4-L5, with substantial involvement also noted at L5-S1 [23]. Similarly, Eubanks JD et al., documented peak facet arthropathy at L4-L5, supporting the current findings that posterior element degeneration is concentrated at these functionally critical segments [24].

Ligamentum flavum hypertrophy in the present study was observed in 27.9% of patients at L4-L5 and 20.5% at L5-S1. Lumbar canal stenosis was most pronounced at L4-L5 (26.8%), followed by L5-S1 (18.4%). These observations align with multiple studies identifying ligamentum flavum hypertrophy and facet joint arthropathy as major contributors to lumbar canal compromise at the L4-L5 level. Several studies have demonstrated that ligamentum flavum thickness is greatest at L4-L5 and that hypertrophy frequently coexists with disc bulge and facet arthropathy in stenotic segments [25-27].

The reported prevalence of facet arthropathy, ligamentum flavum hypertrophy, and lumbar canal stenosis varies widely across studies, likely due to differences in age distribution, population characteristics, and imaging methodologies [6,24,28]. Higher prevalence rates are generally observed in older populations or surgically selected cohorts, whereas community-based MRI studies tend to report lower values [29,30]. These variations emphasise the importance of interpreting degenerative MRI findings in relation to patient demographics and clinical context [6,24].

Although the prevalence of neural foraminal compression in the present study was substantially higher than that reported in large-scale imaging analyses- such as the study by Travis Caton M et al., (2021), which reported rates of 16% at L4-L5 and 14.8% at L5-S1 in an analysis of 43,255 MRI scans using natural language processing the trend of decreasing prevalence beyond the L5-S1 level remained consistent with existing literature [28]. The higher prevalence observed in this study aligns more closely with reports focusing on symptomatic populations. For instance, Norisyam Y et al., reported moderate-to-severe foraminal stenosis in 77.7% of patients at the lower lumbar levels [31].

Similarly, the finding of significant thecal sac deformation and reduced lumbar canal dimensions in this study corresponds with cross-sectional studies demonstrating reduced thecal sac area and narrower canal diameters in symptomatic individuals with LBP compared to asymptomatic controls [32]. Comparable studies from the literature are summarised in [Table/Fig-11] [6,15-17,28,31,32].

Overall, the results of the present study are consistent with previous MRI based investigations demonstrating that degenerative changes predominantly affect the lower lumbar segments [16,33,34]. Large imaging cohorts have likewise reported the highest prevalence of degeneration at the L4-L5 and L5-S1 levels, confirming that mechanical stress and load concentration render these segments particularly susceptible to chronic degenerative changes [16,33,34].

S. no.	Author, year	Place of study	Sample size	Objective	Parameters assessed	Key conclusion and comparison with present study
1	Cheung KMC et al., 2009 [6]	Hong Kong, community population	1,043	To describe prevalence and pattern of lumbar MRI changes in a general population	Disc degeneration grades, disc bulge/herniation, Modic changes across lumbar levels	Reported high prevalence of age-related degeneration, with lower lumbar levels (L4-L5, L5-S1) most frequently involved, consistent with predominant lower lumbar involvement in the present hospital-based symptomatic cohort.
2	Ravikanth R 2020 [15]	India, tertiary care hospital	1000 MRI lumbar and whole spine studies	To evaluate MRI features of lumbar disc degenerative disease in patients with LBP	Disc bulge, protrusion, extrusion, osteophytes, canal and foraminal stenosis at each lumbar level	Found maximal degenerative changes at L4-L5 and L5-S1 with disc bulge more common than extrusion, closely mirroring the current study where disc bulge and herniation peak at these levels in chronic LBP patients.
3	Ruangchainikom M et al., 2021 [16]	Japan/USA collaborative, symptomatic subjects	1095, MRI cohort of adults with lumbar symptoms	To characterise patterns of lumbar disc degeneration on MRI in symptomatic individuals	Disc degeneration grades, distribution by level, associated Modic and facet changes	Demonstrated that degeneration clusters at lower lumbar segments, particularly L4-L5 and L5-S1, supporting the present study's finding that mechanical load concentrates degeneration at these motion segments.
4	Saleem S et al., 2013 [17]	Pakistan, hospital-based	163 patients with lumbar degenerative disease	To correlate symptoms with MRI findings of lumbar disc degenerative disease	Disc desiccation, bulge, protrusion, extrusion, canal compromise	Reported disc bulge and protrusion as the most frequent MRI abnormalities, predominantly at L4-L5 and L5-S1, comparable with the present study where disc bulge is the commonest lesion at these levels in chronic LBP
5	Badaam AM et al., 2023 [32]	India, cross-sectional MRI study	200, Out of which 100 with LBP and 100 subjects with no pain	To assess lumbar vertebral canal dimensions on MRI in LBP	Thecal sac area, canal diameter, presence of canal stenosis at each level	Observed reduced thecal sac area and highest frequency of canal compromise at lower lumbar levels, aligning with the present study's documentation of pronounced canal stenosis and thecal sac indentation at L4-L5 and L5-S1

6	Travis Caton M et al., 2021 [28]	USA, multicentre MRI report database	43,255 MRI reports	To analyse age and sex related distribution of lumbar spinal and foraminal stenosis	Radiology reported central and foraminal stenosis by level	Large Natural Language Processing (NLP)-based series showed peak foraminal stenosis at L4-L5 and L5-S1, consistent with the very high frequency of neural foraminal compression at these levels in the present symptomatic Indian cohort, although absolute percentages are higher in the current study
7	Norisyam Y et al., 2023 [31]	Malaysia, tertiary centre	121 Symptomatic patients	To study lateral lumbar spinal stenosis and its clinical correlations	Lateral recess and foraminal stenosis severity at lower lumbar levels	Reported high rates of moderate-severe foraminal stenosis in lower lumbar segments, comparable to the present study's finding of frequent neural foraminal compression at L4-L5 and L5-S1 in patients with chronic LBP
8	Present study, 2025	Puducherry, India, tertiary hospital	190 adults with chronic LBP	To describe degenerative lumbar spine changes on MRI in adults with chronic LBP	Disc bulge, herniation, protrusion, extrusion, osteophytes, facet arthropathy, ligamentum flavum hypertrophy, canal stenosis, foraminal compression, thecal sac indentation by level	Demonstrates that degenerative changes are most frequent at L4-L5 and L5-S1, with disc bulge as the dominant finding and high rates of foraminal compression and thecal sac indentation, corroborating national and international data that lower lumbar segments bear maximal mechanical load and degeneration

[Table/Fig-11]: Comparison of present study with other studies on MRI degenerative changes of lumbar spine [6,15-17,28,31,32].

Limitation(s)

As the present study was conducted at a single centre, the findings may not be generalisable to the broader population. A multicentre study design would have enhanced the external validity and robustness of the results.

CONCLUSION(S)

MRI plays a pivotal role in the detection and characterisation of degenerative changes of the lumbar spine in patients with chronic LBP. The present study demonstrated that the L4-L5 and L5-S1 levels are the most frequently affected sites across all degenerative parameters, including disc pathology, osteophyte formation, and canal or foraminal narrowing. These findings reinforce the influence of mechanical stress and load concentration at the lower lumbar segments as key contributors to degeneration. The predominance of disc bulge and facet joint arthropathy, along with associated ligamentum flavum hypertrophy and neural foraminal compression, underscores the multifactorial nature of chronic LBP. Recognition of these characteristic MRI patterns may facilitate early diagnosis, improved risk stratification, and the development of targeted therapeutic interventions.

REFERENCES

[1] Jarvik JG, Deyo RA. Diagnostic evaluation of low back pain with emphasis on imaging. Ann Intern Med. 2002;137(7):586-97. Doi: 10.7326/0003-4819-137-7-200210010-00010.

[2] Weiler C, Lopez-Ramos M, Mayer HM, Korge A, Siepe CJ, Wuertz K, et al. Histological analysis of surgical lumbar intervertebral disc tissue provides evidence for an association between disc degeneration and increased body mass index. BMC Research Notes. 2011;4:497. Doi: 10.1186/1756-0500-4-497.

[3] Choi YS. Pathophysiology of degenerative disc disease. Asian Spine J. 2009;3(1):39-44. Doi: 10.4184/asj.2009.3.1.39. Cited: in: PMID: 20404946.

[4] Quint U, Wilke HJ. Grading of degenerative disk disease and functional impairment: Imaging versus patho-anatomical findings. European Spine Journal. 2008;17(12):1705-13. Doi: 10.1007/s00586-008-0787-6.

[5] Mostagi FQRC, Dias JM, Pereira LM, Obara K, Mazuquin BF, Silva MF, et al. Pilates versus general exercise effectiveness on pain and functionality in non-specific chronic low back pain subjects. Journal of Bodywork and Movement Therapies. 2015;19(4):636-45. Doi: 10.1016/j.jbmt.2014.11.009.

[6] Cheung KMC, Karppinen J, Chan D, Ho DWH, Song YQ, Sham P, et al. Prevalence and pattern of lumbar magnetic resonance imaging changes in a population study of one thousand forty-three individuals: Spine. 2009;34(9):934-40. Doi: 10.1097/BRS.0b013e3181a01b3f.

[7] Ito K, Creemers L. Mechanisms of intervertebral disk degeneration/injury and pain: A review. Global Spine Journal. 2013;3(3):145–152. Doi: 10.1055/s-0033-1347300.

[8] DePalma MJ, Ketchum JM, Saullo T. What is the source of chronic low back pain and does age play a role? Pain Med. 2011;12(2):224-33. Doi: 10.1111/j.1526-4637.2010.01045.x.

[9] Shetty GM, Jain S, Thakur H, Khanna K. Prevalence of low back pain in India: A systematic review and meta-analysis. Work. 2022;73(2):429-452. Doi: 10.3233/WOR-205300.

[10] Taher F, Essig D, Lebl DR, Hughes AP, Sama AA, Cammisa FP, et al. Lumbar degenerative disc disease: current and future concepts of diagnosis and management. Advances in Orthopedics. 2012;2012:970752. Doi: 10.1155/2012/970752.

[11] Tertti M, Paajanen H, Laato M, Aho H, Komu M, Kormano M. Disc degeneration in magnetic resonance imaging. A comparative biochemical, histologic, and radiologic study in cadaver spines. Spine (Phila Pa 1976). 1991;16(6):629-34. Doi: 10.1097/00007632-199106000-00006.

[12] Bhalla A, Schoenfeld AJ, George J, Moghimi M, Bono CM. The influence of subgroup diagnosis on radiographic and clinical outcomes after lumbar fusion for degenerative disc disorders revisited: a systematic review of the literature. The Spine Journal. 2017;17(1):143-149.

[13] Modic MT, Ross JS. Lumbar degenerative disk disease. Radiology. 2007;245(1):43-61. Doi: 10.1148/radiol.2451051706.

[14] Maravilla KR, Lesh P, Weinreb JC, Selby DK, Mooney V. Magnetic resonance imaging of the lumbar spine with CT correlation. Am J Neuroradiol. 1985;6(2):237-45..

[15] Ravikanth R. Magnetic resonance evaluation of lumbar disc degenerative disease as an implication of low back pain: a prospective analysis. Neurology India [Internet]. 2020;68(6):1378-84.

[16] Ruangchainikom M, Daubs MD, Suzuki A, Xiong C, Hayashi T, Scott TP, et al. Patterns of lumbar disc degeneration: magnetic resonance imaging analysis in symptomatic subjects. Asian Spine J. 2021;15(6):799-807.

[17] Saleem S, Aslam HM, Rehmani MAK, Raees A, Alvi AA, Ashraf J. Lumbar disc degenerative disease: disc degeneration symptoms and magnetic resonance image findings. Asian Spine J. 2013;7(4):322-34. Doi: 10.4184/asj.2013.7.4.322.

[18] Wu A, March L, Zheng X, Huang J, Wang X, Zhao J, et al. Global low back pain prevalence and years lived with disability from 1990 to 2017: estimates from the Global Burden of Disease Study 2017. Ann Transl Med. 2020;8:299-99. Doi: 10.21037/atm.2020.02.175.

[19] Zhang C, Qin L, Yin F, Chen Q, Zhang S. Global, regional, and national burden and trends of Low back pain in middle-aged adults: analysis of GBD 1990-2021 with projections to 2050. BMC Musculoskeletal Disorders. 2024;25(1):886. Doi: 10.1186/s12891-024-08002-y.

[20] Calais-Ferreira L, Pozzobon D, Pinheiro MB, Blyth FM, Ordoñana JR, Duncan GE, et al. Sex differences in lifetime prevalence of low back pain: A multinational study of opposite-sex twin pairs. European Journal of Pain. 2023;27(10):1150-1160. Doi: 10.1002/ejp.2146.

[21] Bizzoca D, Solarino G, Pulcrano A, Brunetti G, Moretti AM, Moretti L, et al. Gender-related issues in the management of low-back pain: a current concepts review. Clinics and Practice. 2023;13(6):1360-1368. Doi: 10.3390/clinpract13060122.

[22] Iida T, Takano M, Hikata T. Risk factors and frequency of occurrence of lumbar spine disease in young male American football players - A 6-year cohort study using lumbar spine MRI and X-rays. North American Spine Society Journal (NASSJ). 2024;18:100341.

[23] Kalichman L, Li L, Kim DH, Guermazi A, Berkin V, O'Donnell CJ, et al. Facet joint osteoarthritis and low back pain in the community-based population. Spine (Phila Pa 1976). 2008;33(23):2560-5. Doi: 10.1097/BRS.0b013e318184ef95. Cited in: PMID: 18923337.

[24] Eubanks JD, Lee MJ, Cassinelli E, Ahn NU. Prevalence of lumbar facet arthrosis and its relationship to age, sex, and race: an anatomic study of cadaveric specimens. Spine. 2007;32(19):2058-62. Doi: 10.1097/BRS.0b013e318145a3a9.

[25] Kolte VS, Khambatta S, Ambiye MV. Thickness of the ligamentum flavum: correlation with age and its asymmetry-an magnetic resonance imaging study. Asian Spine J. 2015;9(2):245-53. Doi: 10.4184/asj.2015.9.2.245. Cited: in: PMID: 25901237.

[26] Saadeddin M. Incidence of ligamentum flavum hypertrophy in patients with spinal stenosis. The Egyptian Orthopaedic Journal [Internet]. 2017;52(2):150-52.

[27] Kim YU, Park JY, Kim DH, Karm MH, Lee JY, Yoo JI, et al. The role of the ligamentum flavum area as a morphological parameter of lumbar central spinal stenosis. Pain Physician. 2017;20:E419-E424.

[28] Travis Caton M, Wiggins WF, Pomerantz SR, Andriole KP. Effects of age and sex on the distribution and symmetry of lumbar spinal and neural foraminal stenosis: a natural language processing analysis of 43,255 lumbar MRI reports. Neuroradiology. 2021;63(6):959-66. Doi: 10.1007/s00234-021-02670-6.

[29] Jensen RK, Jensen TS, Koes B, Hartvigsen J. Prevalence of lumbar spinal stenosis in general and clinical populations: a systematic review and meta-analysis. Eur Spine J. 2020;29(2):2143-63. Doi: 10.1007/s00586-020-06339-1.

[30] Munns JJ, Lee JYB, Espinoza Orías AA, Takatori R, Andersson GBJ, An HS, et al. Ligamentum flavum hypertrophy in asymptomatic and chronic low back pain subjects. PLoS ONE. 2015;10(5):e0128321. Doi: 10.1371/journal.pone.0128321.

[31] Norisyam Y, Salim AA, Bahrin Z, Yusof MI, Paiman M, Nadarajan C. Lateral lumbar spinal stenosis: Associations with the oswestry disability index, visual analogue scale, and magnetic resonance imaging. Cureus. 2023;15(12):e50475. [cited 2025 Oct 8]; Doi: 10.7759/cureus.50475.
[32] Badaam AM, Sukre SB, Hashmi SSA, Hasham Shaikh SA, Dadarao Hiware S, Moizuddin Jawaduddin K, et al. The MRI of lumbar vertebral canal in low back pain: A cross-sectional study. Cureus. 2023;15(12):e51407 [cited 2025 Oct 8].
[33] Teichtahl AJ, Urquhart DM, Wang Y, Wluka AE, O'Sullivan R, Jones G, et al. Lumbar disc degeneration is associated with modic change and high paraspinal fat content- A 3.0T magnetic resonance imaging study. BMC Musculoskeletal Disorders. 2016;17:439. Doi: 10.1186/s12891-016-1297-z.
[34] Harshith R, Ray J. Role of magnetic resonance imaging in the low back pain in young adults at a tertiary care hospital in Northeast India. Indian Journal of Physical Medicine & Rehabilitation. 2025;35(1):21-26.

PARTICULARS OF CONTRIBUTORS:
1. Junior Resident, Department of Radiodiagnosis, Pondicherry Institute of Medical Sciences, Puducherry, India.
2. Associate Professor, Department of Radiodiagnosis, Pondicherry Institute of Medical Sciences, Puducherry, India.
3. Associate Professor, Department of Radiodiagnosis, Pondicherry Institute of Medical Sciences, Puducherry, India.
4. Senior Resident, Department of Radiodiagnosis, Pondicherry Institute of Medical Sciences, Puducherry, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
R Mithun Raj,
Pondicherry Institute of Medical Sciences, Ganapathychettykulam, Kalapet, Puducherry, India.
E-mail: dr.muthu1211@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Nov 03, 2025
- Manual Googling: Dec 22, 2025
- iThenticate Software: Dec 31, 2025 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Oct 27, 2025**
Date of Peer Review: **Nov 24, 2025**
Date of Acceptance: **Jan 01, 2026**
Date of Publishing: **Mar 01, 2026**