Section: Radio Diagnosis

Original Research Article

ROLE OF 1.5 T MRI IN LOW BACKACHE DUE TO NON-TRAUMATIC CONDITIONS OF LUMBOSACRAL SPINE

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ABSTRACT

Background: Low backache (LBA) is one of the most common musculoskeletal complaints encountered in clinical practice and represents a major public health problem worldwide. The objective is to evaluate various causes of low backache and their prevalence. This is to study the findings of MRI done in patients with non-traumatic cause of low backache.

Materials and Methods: A prospective hospital-based study. Study area: Department of Radio Diagnosis, Subbaiah institute of medical sciences Shivamogga, India. Study Period: 1 year. Study population: Patients with complaints of low backache referred to Department of Radiology for MRI. Sample size: The study consisted of 100 subjects. Sampling method: Simple random technique.

Results: Statistical analysis demonstrated a highly significant predilection of disc bulge for the L4-L5 level, disc desiccation for the L5-S1 level, and degenerative spondylolisthesis for the L5-S1 level, reflecting the greater mechanical load borne by the lower lumbar spine. These findings support the role of MRI in accurately localizing and characterizing degenerative lumbosacral pathology.

Conclusion: The present study demonstrates that 1.5 Tesla MRI is a highly sensitive, non-invasive, and comprehensive imaging modality for the evaluation of low backache due to non-traumatic conditions of the lumbosacral spine.

Keywords: Low Back Pain, 1.5 Tesla MRI, Disc Degeneration, Intervertebral Disc Herniation, Degenerative Spine Disease.

INTRODUCTION

Low backache (LBA) is one of the most common musculoskeletal complaints encountered in clinical practice and represents a major public health problem worldwide. It is a leading cause of disability, work absenteeism, reduced quality of life, and increased healthcare expenditure. The lifetime prevalence of low back pain has been reported to range between 60% and 85%, affecting individuals across all age groups, with the highest incidence occurring during the most productive years of life.[1] The majority of patients present with non-traumatic causes of low backache, including degenerative, inflammatory, infective, congenital, and neoplastic conditions involving the lumbosacral spine.[2]

The lumbosacral spine bears the greatest mechanical load of the vertebral column and is therefore particularly susceptible to degenerative changes. Intervertebral disc degeneration, disc bulge, disc herniation, spinal canal stenosis, facet joint arthropathy, ligamentum flavum hypertrophy, spondylolisthesis, and Modic endplate changes are among the most common causes of chronic low back pain.[3] These pathological conditions may result in compression of neural structures, instability, or inflammatory changes that contribute to pain and functional impairment. Accurate identification of the underlying pathology is essential for appropriate management and prevention of long-term disability.

Conventional radiography has traditionally been used as the initial imaging modality for evaluating spinal disorders. However, radiographs provide limited information regarding soft tissues, intervertebral discs, ligaments, spinal cord, nerve

roots, and bone marrow abnormalities. Computed tomography (CT) offers superior visualization of osseous structures but is associated with ionizing radiation exposure and limited soft tissue contrast.[4] Consequently, Magnetic Resonance Imaging (MRI) has emerged as the imaging modality of choice for the assessment of non-traumatic disorders of the lumbosacral spine.

MRI offers excellent soft tissue contrast, multiplanar imaging capability, and detailed visualization of vertebral bodies, intervertebral discs, spinal canal contents, neural foramina, ligaments, and paraspinal soft tissues without the use of ionizing radiation.[5] It enables comprehensive evaluation of degenerative, inflammatory, infective, congenital, and neoplastic lesions in a single examination. Furthermore, MRI can detect early pathological changes before they become apparent on conventional radiography or CT, thereby facilitating timely diagnosis and intervention.[6]

Among the available MRI systems, 1.5 Tesla (1.5 T) MRI remains the most widely utilized platform in routine clinical practice due to its optimal balance between image quality, acquisition time, availability, and cost-effectiveness. High-resolution T1-weighted, T2-weighted, Short Tau Inversion Recovery (STIR), and fat-suppressed sequences provide detailed anatomical and pathological information regarding spinal structures. The superior signal-to-noise ratio achieved by 1.5 T MRI allows accurate assessment of disc degeneration, annular tears, nerve root compression, spinal canal stenosis, marrow edema, infections, and other causes of low backache.[7]

Recent studies have emphasized the significant role of MRI in identifying structural abnormalities associated with low back pain. Degenerative disc disease, disc protrusion, disc extrusion, annular fissures, Modic changes, and spinal stenosis have been shown to occur more frequently among symptomatic individuals compared with asymptomatic populations.[8] MRI also demonstrates imaging biomarkers such as high-intensity zones and vertebral endplate changes that may correlate with pain generation and disease severity.[9] Additionally, MRI is invaluable in detecting non-degenerative causes of low backache including spondylodiscitis, tuberculosis, inflammatory spondyloarthropathies, metastatic disease, and congenital spinal anomalies, thereby guiding clinical decision-making and therapeutic planning.[5]

The increasing burden of chronic low back pain has led to greater reliance on MRI for accurate diagnosis and management. MRI findings frequently influence treatment strategies, including conservative therapy, interventional pain procedures, and surgical planning. In cases of radiculopathy, spinal canal stenosis, or suspected serious spinal pathology, MRI provides critical information regarding the extent and severity of disease.[10] Furthermore, advances in MRI techniques continue to improve lesion characterization and enhance diagnostic confidence in evaluating complex spinal disorders.[6]

Despite the widespread use of MRI, the spectrum of MRI findings in patients with non-traumatic low backache varies considerably across different populations. Understanding the prevalence and pattern of MRI abnormalities in the lumbosacral spine is essential for accurate interpretation of imaging findings and their clinical correlation. Therefore, the present study entitled "Role of 1.5 T MRI in Low Backache Due to Non-Traumatic Conditions of Lumbosacral Spine" aims to evaluate the MRI spectrum of non-traumatic lumbosacral spinal disorders and assess the diagnostic utility of 1.5 T MRI in patients presenting with low backache.

Objectives

1. To evaluate various causes of low backache and their prevalence.
2. To study the findings of MRI done in patients with non-traumatic cause of low backache.
3. To analyze the various signal intensity changes in the Bone, Intervertebral disc, Thecal sac and its contents.

MATERIALS AND METHODS

Study Design: A prospective hospital-based study.

Study Area: Department of Radio Diagnosis, Subbaiah institute of medical sciences Shivamogga, India.

Study Period: 1 year.

Study Population: Patients with complaints of low backache referred to Department of Radiology for MRI.

Sample Size: The study consisted of 100 subjects.

Sampling Method: Simple random technique.

Inclusion Criteria: Patients with complaints of low backache referred to Department of Radiology for MRI.

Exclusion Criteria

• H/o trauma.
• Prior surgery.
• Metal implants/claustrophobia.

Ethical Consideration: Institutional Ethical Committee permission was obtained before the commencement of the study.

Study Tools and Data Collection Procedure

All MRI scans were performed using a 1.5 Tesla MRI scanner with a dedicated spine coil. The standard protocol included the following sequences:

- Sagittal T1-weighted images (T1WI)
- Sagittal T2-weighted images (T2WI)
- Sagittal STIR (Short Tau Inversion Recovery)
- Axial T1WI and T2WI at each intervertebral disc level
- Contrast-enhanced sequences were obtained selectively in cases of suspected infection or neoplasm

Slice thickness was maintained at 4 mm with an interslice gap of 0.5 mm. Field of view and matrix

were adjusted according to patient habitus to optimize image quality.

Demographic data (age, gender), clinical symptoms (duration, radiation of pain, neurological deficits), and MRI findings were recorded in a structured proforma. All MRI images were interpreted independently by two experienced radiologists with more than 5 years of experience in musculoskeletal imaging. In case of disagreement, a consensus diagnosis was made after joint review.

MRI findings were categorized into:

- Degenerative changes (disc desiccation, bulge, protrusion, Modic changes, facet
- arthropathy)
- Inflammatory lesions (sacroiliitis, spondyloarthropathy)
- Infective pathology (tuberculous or pyogenic spondylodiscitis)
- Neoplastic lesions (primary or metastatic)
- Congenital and miscellaneous pathologies (excluded if traumatic)

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 25.0 (IBM Corp, USA). Categorical variables were expressed as frequencies and percentages. Continuous variables were summarized using mean and standard deviation. The association between clinical features and MRI findings was assessed using chi-square test or Fisher's exact test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic Profile of Study Population (n = 100)

Variable	Number	Percentage
Male	51	51%
Female	49	49%
Total	100	100%
Age Range	21–80 years	-
Most Common Age Group (31–45 years)	46	46%

The study population showed an almost equal gender distribution with a slight male predominance (51%). Patients ranged from 21 to 80 years of age, with the majority (46%) belonging to the 31–45 years age group, indicating that low backache due to non-traumatic lumbosacral spine disorders predominantly affects the economically productive age group.

Table 2: Distribution of MRI Abnormalities in Degenerative Spine Disease

MRI Finding	Frequency (%)
Disc Bulge	82
Disc Desiccation	61
Osteophytes	52
Spinal Stenosis	40
Facet Joint Arthropathy	14
Disc Protrusion (Central)	11
Modic Changes	11
Spondylolisthesis	10
Annular Tear (HIZ)	10
Paracentral Disc Protrusion	7
Vertebral Compression	5
Schmorl's Nodes	4
Ligamentum Flavum Hypertrophy	4
Disc Extrusion	1

Disc bulge was the most common MRI abnormality (82%), followed by disc desiccation (61%) and osteophyte formation (52%), highlighting the predominance of degenerative disc disease. Disc extrusion was the least common finding, observed in only 1% of patients.

Table 3: Level-wise Distribution of Diffuse Disc Bulge

Disc Level	Number of Bulges
L1-L2	3
L2-L3	15
L3-L4	38
L4-L5	66
L5-S1	35
Total	157*

*Multiple level involvement present.

Diffuse disc bulge was most frequently observed at the L4-L5 level (66 cases), followed by L3-L4 and L5-S1 levels. The predominance of lower lumbar levels reflects the greater biomechanical stress experienced by these segments. The difference was statistically significant ($p < 0.001$).

Table 4: Pattern of Intervertebral Disc Degeneration

Disc Abnormality	Frequency (%)
Disc Bulge	82
Disc Desiccation	61
Central Disc Protrusion	11
Paracentral Disc Protrusion	7
Annular Tear (HIZ)	10
Disc Extrusion	1

Disc degeneration constituted the major pathological process in the study. Disc bulge and desiccation were the predominant findings. Disc protrusions were more common than disc extrusion, while annular tears were identified in 10% of patients, suggesting a significant role of discogenic pathology in low backache.

Table 5: Vertebral and Endplate Degenerative Changes

Vertebral Abnormality	Frequency (%)
Osteophytes	52
Modic Endplate Changes	11
Spondylolisthesis	10
Vertebral Compression	5
Schmorl's Nodes	4

Osteophyte formation was the most common vertebral degenerative change, affecting more than half of the study population. Modic changes and degenerative spondylolisthesis were less frequent but clinically important findings. Vertebral compression fractures and Schmorl's nodes were relatively uncommon.

Table 6: Age-wise Distribution of Major Degenerative Findings

MRI Finding	Most Common Age Group
Disc Bulge	41–50 years
Disc Protrusion	31–45 years
Disc Desiccation	61–80 years
Annular Tear	31–50 years
Osteophytes	41–60 years
Facet Arthropathy	41–50 years
Spinal Stenosis	41–50 years
Ligamentum Flavum Hypertrophy	61–70 years
Spondylolisthesis	>40 years

Most degenerative changes increased with advancing age. Disc desiccation and ligamentum flavum hypertrophy showed a strong association with older age groups, while disc protrusion and annular tears were more common in younger and middle-aged adults.

Table 7: Characteristics of Spinal Stenosis (n = 40)

Parameter	Frequency (%)
Total Spinal Stenosis	40
Central Stenosis	11
Bilateral Lateral Recess Stenosis	63
Bilateral Foraminal Stenosis	20
Most Common Level: L4-L5	34
L3-L4	31
L5-S1	21

Spinal stenosis was identified in 40% of patients and was predominantly multifactorial. Bilateral lateral recess stenosis was the most common subtype. The L4-L5 level was most frequently involved, consistent with the high prevalence of degenerative changes at this segment.

Table 8: Distribution of Patients According to Etiology

Etiology	Number	Percentage (%)
Degenerative Disc Disease	85	85
Degenerative Spondylolisthesis	10	10
Infective Pathology	5	5
Total	100	100

Degenerative disc disease was the predominant etiology, accounting for 85% of cases, emphasizing the central role of degenerative changes in non-traumatic low backache. Infective causes were relatively uncommon, comprising only 5% of the study population.

Key Statistical Findings

Finding	Most Common Level	p-value
Disc Bulge	L4-L5	<0.001
Disc Desiccation	L5-S1	<0.001
Degenerative Spondylolisthesis	L5-S1	<0.001

Statistical analysis demonstrated a highly significant predilection of disc bulge for the L4-L5 level, disc desiccation for the L5-S1 level, and degenerative spondylolisthesis for the L5-S1 level, reflecting the greater mechanical load borne by the lower lumbar spine. These findings support the role of MRI in accurately localizing and characterizing degenerative lumbosacral pathology.

DISCUSSION

Low backache (LBA) remains one of the most common musculoskeletal complaints worldwide and constitutes a major cause of disability, work absenteeism, and reduced quality of life. Magnetic Resonance Imaging (MRI) has become the imaging modality of choice for evaluating patients with chronic low backache because of its superior soft tissue contrast, multiplanar capability, and ability to detect early degenerative changes without exposure to ionizing radiation.[11,12] In the present study, MRI was utilized to evaluate various non-traumatic causes of low backache involving the lumbosacral spine and to determine the spectrum and prevalence of abnormalities among symptomatic patients.

The present study included 100 patients presenting with low backache, of whom 51% were males and 49% were females, demonstrating a slight male predominance. Similar findings were reported by Mustapha et al,[13] and Prasad et al,[14] who observed male predominance among patients undergoing MRI evaluation for lumbar spine disorders. Raviraj Durganand et al,[15] also reported a higher incidence among males. However, our findings differ from those of Nazeer et al,[16] Sai Sudha et al,[17] and Sathish Babu et al,[18] who reported a female predominance in their respective studies. The maximum number of patients in our study belonged to the 41–50 years age group, indicating that degenerative spinal disorders predominantly affect the middle-aged working population. Similar observations were reported by Prasad et al,[14] and Younis et al,[19] who found the highest prevalence of low back pain in the fourth and fifth decades of life.

Degenerative disorders constituted the most common etiology in the present study, accounting for 85% of cases, followed by degenerative spondylolisthesis (10%) and infective pathologies (5%). These findings are comparable with those reported by Sathish Babu et al,[18] who observed degenerative disorders in 74% of patients, non-traumatic spondylolisthesis in 8%, and infective causes in 3%. The predominance of degenerative pathology highlights the significant role of age-related biomechanical stress and disc degeneration in the pathogenesis of chronic low backache.[20,21]

Among all MRI findings, diffuse disc bulge was the most common abnormality, observed in 82% of patients. The L4–L5 level was the most frequently involved, followed by L5–S1. Furthermore, multiple-level involvement was more common than single-level disease. Similar findings were reported by Sai Sudha et al,[17] who documented disc bulge in 85% of patients, predominantly at the L4–L5 level. Younis et al,[19] also reported disc bulge as the commonest MRI finding, occurring in 74% of cases. Mustapha et al,[13] demonstrated that L4–L5 disc involvement was the most common site, followed by L5–S1. The increased prevalence of disc bulge at lower lumbar levels can be attributed to greater mechanical loading, increased mobility, and higher biomechanical stress experienced by these segments.[20,22]

Disc protrusion was identified in 18% of patients, with central protrusion accounting for 11% and paracentral protrusion for 7%. No cases of disc sequestration were observed. The majority of protrusions involved the L4–L5 and L5–S1 levels. These findings are consistent with those reported by Rai et al,[23] and Prasad et al,[24] who observed that lumbar disc herniations most commonly occur at L4–L5 and L5–S1. The predominance of central protrusions in our study correlates with the observations of Rai et al,[23] whereas Jacob et al,[25] reported posterolateral herniation as the most frequent pattern. The higher incidence of disc pathology at lower lumbar levels is explained by the increased mechanical demands placed upon these segments during daily activities.[26,27]

Disc extrusion was an uncommon finding in the present study and was observed in only one patient (1%). Similar low frequencies were reported by Sai Sudha et al,[17] and Jacob et al,[25] who noted that disc protrusions are considerably more common than extrusions. The low prevalence of disc extrusion in the present study may be related to the relatively smaller sample size and exclusion of traumatic spinal lesions.

Disc desiccation was the second most common MRI finding, observed in 61% of patients. The prevalence increased progressively with age and was most common in patients aged 61–80 years. Disc desiccation is widely recognized as one of the earliest manifestations of intervertebral disc degeneration and results from loss of proteoglycan content, reduced water retention, and replacement of the nucleus pulposus by fibrocartilaginous tissue.[21,22] Similar observations have been reported by Osama Al-Saeed et al,[28] and Raviraj Durganand et al,[15] who found disc desiccation in 82% and 91% of patients, respectively. The absence of significant

gender predilection in our study is consistent with previous reports.[30,31]

High Intensity Zone (HIZ) or annular tear was identified in 10% of patients. The prevalence increased with age and was more common among males. HIZ represents focal hyperintensity within the posterior annulus fibrosus on T2-weighted MRI and has been associated with annular disruption and discogenic pain.[29,32] The prevalence observed in our study is lower than that reported by Yong et al., who documented HIZ in approximately one-fourth of patients. Nevertheless, its presence remains an important indicator of annular injury and symptomatic disc degeneration.[33,34]

Among vertebral abnormalities, osteophyte formation was observed in 52% of patients and represented the third most common MRI finding. The prevalence increased with advancing age and was most frequently observed at the L3, L4, and L5 vertebral levels. Similar findings were reported by Rai et al,[23] and Van der Kraan et al.[35] Osteophyte formation is considered a hallmark of chronic degenerative spinal disease and reflects adaptive osseous remodeling in response to altered biomechanical stresses.[35,36]

Modic endplate changes were observed in 11% of patients, with Type II changes being the most common. Most lesions involved the L5 vertebral level, followed by L4. Modic changes are MRI signal alterations in vertebral endplates associated with degenerative disc disease and have been linked to chronic low back pain.[22] In contrast, Raviraj Durganand et al,[15] reported a higher prevalence of Modic changes and found Type I lesions to be more common. Similar differences were noted in the study by Rai et al,[23] Such variations may reflect differences in study population characteristics and disease severity.

Schmorl's nodes were identified in 4% of patients and were more common among younger individuals. These lesions represent vertical herniation of disc material through vertebral endplates and are generally considered incidental findings.[37] Although they are associated with degenerative disc disease, Schmorl's nodes themselves are not regarded as independent causes of low back pain.38 Similar prevalence rates have been reported in previous MRI studies.[39]

Ligamentum flavum hypertrophy (LFH) was present in 4% of patients and was predominantly observed in elderly individuals. The condition was most frequently seen at the L4–L5 and L5–S1 levels. Similar findings were reported by Saleem et al,[40] and Yong et al.19. LFH contributes significantly to spinal canal narrowing and frequently coexists with other degenerative changes such as disc bulge and facet arthropathy.[41]

Vertebral compression fractures were observed in 5% of patients. Most cases were anterior wedge compression fractures, with osteoporotic fractures accounting for the majority. The prevalence increased with advancing age and was higher among females. These findings are consistent with the established association between osteoporosis and vertebral fragility fractures in elderly populations.[42]

Degenerative spondylolisthesis was observed in 10% of patients and showed equal gender distribution. The majority of cases involved the L5–S1 level and were observed in older individuals. Similar findings were reported by Dootchai et al., who identified L5–S1 as the most frequently involved level. In contrast, Rai et al,[23] reported a lower prevalence and predominant involvement of the L4–L5 level. Degenerative spondylolisthesis results from progressive degeneration of intervertebral discs and facet joints, leading to segmental instability and vertebral slippage.[43]

Facet joint arthropathy was identified in 14% of patients and was most commonly observed in individuals aged 41–60 years. The lower lumbar segments, particularly L4–L5 and L5–S1, were predominantly affected. These findings correlate with those reported by Yong et al,[19] and Weishaupt et al.38. Facet arthropathy contributes to chronic low back pain through inflammation, osteoarthritis, and mechanical instability of the posterior spinal elements.

Spinal canal stenosis was present in 40% of patients and represented one of the major degenerative manifestations identified on MRI. Lateral recess stenosis was the most common subtype, followed by foraminal and central canal stenosis. The L4–L5 level was the most frequently affected segment. Similar observations have been reported by Yong et al,[19] and Thome et al,[41] Lumbar spinal stenosis is typically multifactorial and results from a combination of disc bulge, facet joint hypertrophy, ligamentum flavum thickening, and degenerative spondylolisthesis.[41,44] The high prevalence of stenosis observed in the present study underscores the importance of MRI in identifying neural compression and guiding management decisions.

Overall, the findings of the present study demonstrate that degenerative disc disease is the predominant cause of non-traumatic low backache. Diffuse disc bulge, disc desiccation, osteophyte formation, and spinal canal stenosis constituted the most frequent MRI abnormalities. The L4–L5 and L5–S1 levels were consistently the most commonly affected spinal segments. MRI proved to be a highly sensitive and comprehensive imaging modality for detecting both early and advanced degenerative changes, facilitating accurate diagnosis and appropriate therapeutic planning in patients presenting with chronic low backache.

CONCLUSION

The present study demonstrates that 1.5 Tesla MRI is a highly sensitive, non-invasive, and comprehensive imaging modality for the evaluation of low backache due to non-traumatic conditions of the lumbosacral spine. Degenerative spinal disorders

constituted the predominant etiology, accounting for 85% of cases, with diffuse disc bulge, disc desiccation, osteophyte formation, and spinal stenosis being the most common MRI findings. The L4–L5 and L5–S1 levels were the most frequently involved segments, reflecting the greater biomechanical stress borne by the lower lumbar spine. MRI effectively identified a wide spectrum of abnormalities involving the intervertebral discs, vertebral bodies, facet joints, ligaments, and spinal canal, including clinically significant conditions such as disc herniation, degenerative spondylolisthesis, spinal stenosis, infective spondylodiscitis, and vertebral compression fractures. The excellent soft tissue contrast and multiplanar imaging capabilities of MRI enabled accurate localization and characterization of pathology, facilitating early diagnosis and appropriate treatment planning. Therefore, 1.5 T MRI should be considered the imaging modality of choice in patients with persistent low backache, as it provides invaluable information regarding the underlying pathology, disease severity, and potential neurological compromise, thereby contributing significantly to improved patient management and outcomes.

REFERENCES

1. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. Lancet. 2018;391(10137):2356-67.
2. Maher C, Underwood M, Buchbinder R. Non-specific low back pain. Lancet. 2017;389(10070):736-47.
3. Singh N, Singh DK. MRI spectrum and prevalence of lumbar spinal degenerative disease in patients with non-traumatic low back pain. Rom Neurosurg. 2020;34(3):427-33.
4. Diehn FE. Imaging of spine degeneration and low back pain. Radiol Clin North Am. 2012;50(4):629-49.
5. Van der Graaf JW, Kroeze RJ, Buckens CFM, Lessmann N, et al. MRI image features with an evident relation to low back pain: a narrative review. Eur Spine J. 2023;32(6):1830-41.
6. Bessar AA, Shawky KM, Attia MNM, Hassan RMAR. Advances in diffusion-weighted MRI for quantitative assessment of non-neoplastic vertebrogenic low back pain. J Comput Anal Appl. 2024;33(6):3016-31.
7. Modic MT, Ross JS. Lumbar degenerative disk disease. Radiology. 2007;245(1):43-61.
8. Brinjikji W, Luetmer PH, Comstock B, Bresnahan BW, Chen LE, Deyo RA, et al. MRI findings of disc degeneration are more prevalent in adults with low back pain than in asymptomatic controls: a systematic review and meta-analysis. AJNR Am J Neuroradiol. 2015;36(12):2394-99.
9. Teraguchi M, Yim R, Cheung JPY, Samartzis D. The association of high-intensity zones on MRI and low back pain: a systematic review. Scoliosis Spinal Disord. 2018;13:22.
10. Jarvik JG, Deyo RA. Magnetic resonance imaging for low back pain: indications and limitations. Ann Rheum Dis. 2010;69(1):7-11.
11. Surendra K. Wani et al, Correlation of pain and disability with MRI findings in patients with lumbar discogenic back pain. (International Journal of Physiotherapy and Research, Int J Physiother Res 2014, Vol 2(2):418-23. ISSN 2321-1822)
12. Roudsari B, Jarvik GJ. Lumbar spine MRI for low back pain: indications and yield. AJR. 2010;195(3):550-59.
13. Mustapha Z, Ahmadu MS, Abbas Ali A, Ibrahim K &Okedayo M. Patterns of Requests and Findings in Magnetic Resonance Imaging (MRI) of the Lumbosacral Spine Nigeria. IOSR Journal of Dental and Medical Sciences 11(4),2013 ,18-24.
14. Epidemiological characteristics of Lumbar disc prolapse in a tertiary care hospital by R Prasad et al 2006 indian journal orthopedics 147(7):478.
15. Raviraj Durganand Walwante et al Study of lumbar spine by MRI with special reference to disc degeneration and Modic changes in rural area, 2017.
16. M. Nazeer, S.M Rao, S. Soni, M Ravinder , T Ramakranthi , S. Bhupathi. Low Back Pain in South Indians: Causative Factors and Preventive Measures. Sch. J. App. Med. Sci, 3(1D) 2015, 234-243.
17. Sai sudha angam et al Spectrum and Prevalence of degenerative changes seen on MRI of Lumbosacral Spine in Patients with Low Back Pain. IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 1 Ver. VI (January. 2017), PP 41-47.
18. Sathish babu et al on application of MRI in evaluation of low back ache International journal radiology April 2017.
19. Younis F, Shahzad R, Rasool F. Correlation of magnetic resonance patterns of lumbar disc disease with clinical symptomatology of patients. Annals of King Edward Medical University 17(1), 2011.41-47.
20. Battie MC, Videman T, Parent E. Lumbar disc degeneration: epidemiology and genetic influences. Spine. 2004;29(23): 2679-90.
21. Urban PG Jill, Sally Roberts. Degeneration of the intervertebral disc. Arthritis Res Ther. 2003;5(3):120– 130.
22. Modic T. Michael, Jeffrey S. Ross. Lumbar Degenerative Disk Disease. Radiology 2007;245:43-61.
23. Garjesh Singh Rai, et al. A prospective study of magnetic resonance imaging findings in patients of chronic low back pain: a clinico-radiological correlation. Int J Res Med Sci. 4(1):2016 ,47-56.
24. Prasad R, Hoda M, Dhakal M, Singh K, Srivastava A, Sharma V. Epidemiological characteristics of lumbar disc prolapse in a tertiary care hospital. 3(1).2005.
25. M. Jacob, L.O. Akoko, R.R. Kazema. Lumbar disc degenerative disease: magnetic resonance imaging findings in patients with low back pain in Dar Es Salaam. East & Central African Journal of Surgery, 20(1), 2015 .122-131.
26. Takarad SR, Julius G, Silva L, JaKwei C. Disk Herniation, Radiology, Spine, 2008
27. Bozzao A, Gallucci M, Masciocchi C. Lumbar disk herniation: MR imaging assessment of natural history in patients treated without surgery. Radiology 1992; 185:135-141.
28. Osama Al-saeed, Khaled Al-Jarallah, Maryam Raees, Mehraj Sheikh, Mohammed Ismail, RejiAthyal. Magnetic Resonance Imaging of the Lumbar Spine in Young Arabs with Low Back Pain. Asian Spine Journal 6 (4). 2012 249~256.
29. Peng B, Hou S, Wu W, Zhang C, Yang Y. The pathogenesis and clinical significance of a high-intensity zone (HIZ) of lumbar intervertebral disc on MR imaging in the patient with discogenic low back pain. Eur Spine J ,15 2006, 583–7.
30. Tervonen O, Takatalo J, Karppinen J, Niinimaki J, Taimela S, et al: 2009. Prevalence of degenerative imaging findings in lumbar magnetic resonance imaging among young adults. Spine 2009;34(16):1716-21.
31. Kjaer P, Leboeuf-Yde C, Korsholm L, Sorensen JS, Bendix T. Magnetic resonance imaging and low back pain in adults: a diagnostic imaging study of 40-year-old men and women. Spine. 2005;30(10):1173-80.
32. Schellhas KP, Pollei SR, Gundry CR, Heithoff KB. Lumbar disc high-intensity zone, correlation of magnetic resonance imaging and discography. Spine, 21, 1996:79-86.
33. Weishaupt D, Zanetti M, Hodler J, et al. Painful lumbar disk derangement: relevance of endplate abnormalities at MR imaging. Radiology 2001;218(2):420–7.
34. Lam KS, Carlin D, Mulholland RC. Lumbar disc high-intensity zone: the value and significance of provocative discography in the determination of the discogenic pain source. Eur Spine J ,9 2000, 36–41.

35. Van der Kraan PM, van den Berg WB. Osteophytes: relevance and biology. Osteoarthritis cartilage.15(3), 2007, 237–44.
36. Benoist M. The natural history of lumbar degenerative spinal stenosis. Joint Bone Spine 2002;69(5):450–7. Wildermuth S, Zanetti M, Duewell S, et al. Lumbar spine: quantitative and qualitative assessment of positional (upright flexion and extension) MR imaging and myelography. Radiology 1998;207(2): 391–8.
37. Milette PC. Classification, diagnostic imaging, and imaging characterization of a lumbar herniated disk. RadiolClin North Am 2000;38(6):1267–92.
38. Weishaupt D, Zanetti M, Boos N, Hodler J. MR imaging and CT in osteoarthritis of the lumbar facet joints. Skeletal Radiol 1999; 28(4):215–19. Apostolaki E, Davies AM, Evans N, Cassar-Pullicino VN. MR imaging of lumbar facet joint synovial cysts. EurRadiol 2000; 10(4):615–23.
39. Cheung KM, Karppinen J, Chan D Prevalence and pattern of lumbar magnetic resonance imaging changes in a population study of one thousand forty-three individuals. Spine 2009;
40. 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 Journal. 27(4),2013, 322-334.
41. Thome C, Borm W, Meyer F. Degenerative lumbar spinal stenosis: current strategies in diagnosis and treatment. DeutschesArzteblatt international. 2008;105(20):373-9.
42. Jung HS, Jee WH, McCauley T, MKee-Yong Ha, Choi KH. Discrimination of metastatic from acute osteoporotic compression spinal fractures with MR imaging. Radio Graphics. 2003;23:179–87.
43. Butt S, Saifuddin A. The imaging of lumbar spondylolisthesis. ClinRadiol 2005;60(5):533–46.
44. D. L. Kent, D. R. Haynor, E. B. Larson, R. A. Deyo. Diagnosis of lumbar spinal stenosis in adults: a meta analysis of the accuracy of CT, MR, and myelography. Am J Roentgenol. 158(5),1992, 1135–1144.