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Insights into Lumbar Spine Health: MRI'S Diagnostic Efficacy IN Assessment of Lumbar Spine

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KEYWORDS

Lower back pain, lumber spine, disc bulge, Magnetic resonance imaging, spondylosis, osteoporosis.

ABSTRACT:

Introduction: Low back pain presents a significant global health concern, affecting individuals across diverse demographics and resulting in substantial disability. Managing it poses challenges for healthcare systems and economies worldwide. Accurately diagnosing both acute and chronic low back pain relies on identifying the underlying pathologies within the lumbar spine through MRI imaging.

Objectives: The objective of this study was to evaluate the effectiveness of MRI in diagnosing pathologies in patients with lumbar spine disorders.

Methods: During this study, a prospective methodology was employed to assess patients who underwent lumbar spine MRI. The collected data was organized and analysed using Microsoft Excel, categorized into distinct groups for evaluation.

Results: Gender distribution showed 205 (41%) males and 295 (59%) females, with limb numbness as the primary complaint (42%). The peak age group was 30-40 years (33%). Disc protrusion predominated (87%), mainly at L4-L5 (33%). Detailed analysis depicted the distribution of abnormalities across various lumbar spine levels, with posterior disc bulge being the most common.

Conclusions: This study utilized advanced MRI to analyse lumbar spine abnormalities, revealing insights into their prevalence and impact of demographic factors. Disc protrusion, notably at L4-L5, was common. Demographic factors like age and gender, along with associated abnormalities, highlighted the complexity of lumbar pathology, emphasizing the importance of thorough evaluation for effective management.

1. Introduction

With a lifetime frequency of 60–85%, low back pain (LBP), which is defined as pain in the lumbar spinal area with or without sciatica, is a frequent cause of disability worldwide [1]. About 95% of LBP patients are nonspecific, however they might have substantial underlying pathologies including disc herniation, spinal stenosis, infection, inflammation, tumours, or fractures as their etiology [2]. A good imaging technique for assessing spinal disorders is magnetic resonance imaging, which has been shown to have good sensitivity and specificity [3]. MRI is preferable to conventional tests like radiography and CT scans because it can clearly visualize the spinal cord, nerve roots, intervertebral disc, and spinal column ligaments. A traditional magnetic resonance imaging examination targets a specific spine area, such the cervical, thoracic, or lumbar, and is recommended based on the major symptom that the patient reported to the doctor [4]. Estimates of the 1-year

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incidence of a first-ever episode of low back pain range from 6.3% to 15.4%, while estimates of the 1-year incidence of any episode of low back pain range from 1.5% to 36%. Low back pain is a very common disease that most people will experience at some point in their lives [5]. Since postponing therapy has been linked to worse results, diagnostic confirmation is necessary whenever there is even the slightest suspicion of significant spinal illness. Even with guidelines in place, when a particular cause of low back pain is highly unlikely, a request for diagnostic confirmation is nonetheless frequently made. This is frequently done to comfort patients or out of a concern of overlooking significant pathology. MRI is one of the imaging techniques that may be used to confirm a diagnosis [6]. MRI is presently the preferred imaging modality among all existing methods. One benefit of MRI is that it doesn't use ionizing radiation and has exceptional visualization capabilities, particularly for soft tissues. As a result, it is thought to be the most effective technique for identifying disc abnormalities, spinal infections, and spinal metastases [7]. Although MRI is excellent at detecting tissue-specific disease along the spine, it is frequently unclear if these results have any practical significance. Therefore, diagnostic MRI for lower back pain is advised for specific individuals only. In cases where there are weaker risk factors (such as suspicion of cancer, spinal infection, cauda equina syndrome, or presence of severe neurological deficits), the American College of Physicians' guidelines for diagnostic imaging recommend delaying imaging until after a treatment trial [8]. Utilizing MRI presents a novel method for assessing and investigating LBP. It is a non-invasive method with no known negative consequences. It may therefore be applied in longitudinal research. Any plane may be used to create images with outstanding soft tissue contrast. The paraspinal muscles, intervertebral discs, and nerve roots are all very visible in the lumbar spine. It is easy to see the spinal canal's dimensions and form. The evaluation of intervertebral disc hydration by MRI makes it possible to identify early indications of disc deterioration. On a T2-weighted MR scan, disc degeneration causes a progressive loss of water from the nucleus pulposus, which is shown as a reduction in disc signal Protrusion of the intervertebral discs may also be delineated on MRI. [9] At least 50% of adults would have experienced an LBP episode. Some studies have demonstrated that LBP is one of the most common cause of visits to a physician. [10] Men and women are equally affected by LBP. The literature shows that 30% of adolescents worldwide experience at least one LBP episode. [11] The purpose of this study was to check the ability and the potential role of MRI in the evaluation of lumber spine pathologies in patients complaining with lower back pain numbness of limbs and PIVD we conducted a cross-sectional study that aimed to evaluate the pathologies related to lumber spine.

2. Objectives

The article evaluates MRI's effectiveness in detecting various lumbar spine issues. It assesses both sensitivity and specificity of MRI findings, comparing them with clinical symptoms and other diagnostic methods to gauge accuracy. The focus is on specific conditions like disc herniation, spinal stenosis, and spondylolisthesis, examining how MRI contributes to their diagnosis.

3. Methods

The study utilized a Philips healthcare fixed 3 Tesla MRI machine, specifically the Ingenui 3 CX model. This machine features various application software and has a bore design of 70 cm. It incorporates Helium saves technology to minimize boil off, with a cryogen boil off rate under regular scan conditions. The maximum field of view (FOV) is 55 cm, and the magnet weight is 3060 kg with a slew rate of 200 T/m/s and a maximum amplitude of 45 Mt/m.

4. Results

The findings were presented in numerical format, as percentages, and with measures of central tendency and dispersion including mean and standard deviation. Additionally, the Chi-square test was employed for further analysis. The primary objective of this investigation was the identification of abnormalities within the lumbar spine. Specifically, our study examined various conditions including diffuse disc bulge, disc protrusion, partial desiccation, neural foraminal stenosis, spondylosis, osteoporosis, spinal haemorrhage, osteophyte spurs, and sclerotic changes. Furthermore, we assessed gender and age distributions among the 500 patients admitted to NIMS Hospital in Jaipur, Rajasthan. This study utilized MRI Spine

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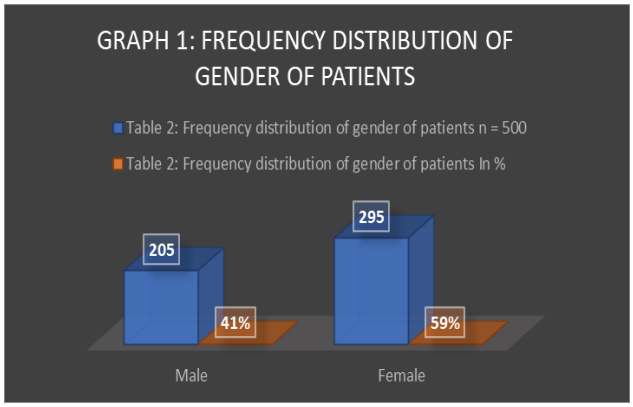
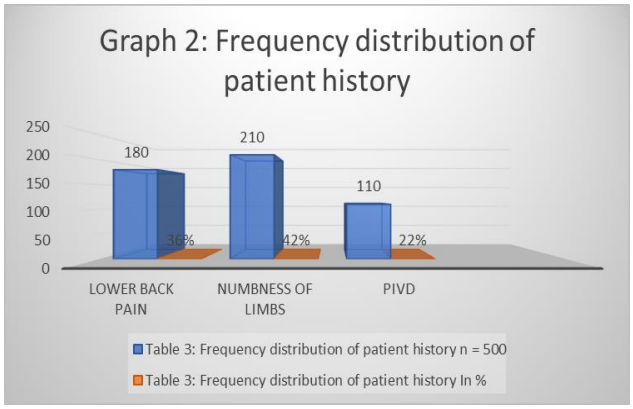
protocol Sequences conducted on a 3 Tesla MRI machine, encompassing T1-weighted, T2-weighted, fluid-sensitive, STIR (Short Tau Inversion Recovery) or fat-suppressed, gradient-echo, and T1-weighted images.

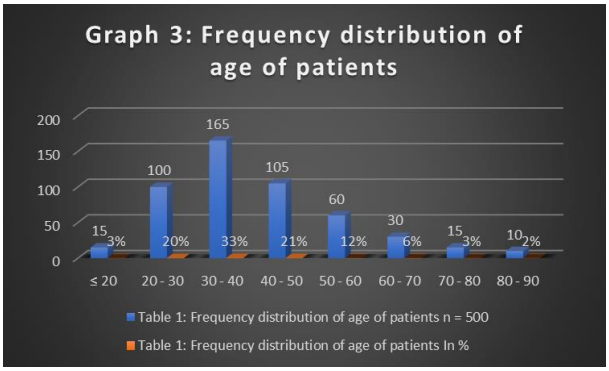
In Graph 1 The gender distribution among the 500 patients is illustrated, with 205 (41%) being male and 295 (59%) female. Females outnumbered males in this study.



In Graph 2 the breakdown of complaints or medical histories is as follows: 180 (36%) report lower back pain, 210 (42%) experience limb numbness, and 110 (22%) present with PIVD symptoms. The most common complaint among the patients is limb numbness.



In Graph 3 the age distribution is categorized as follows: 15 patients (3%) are aged 10-20 years, 100 patients (20%) are aged 20-30 years, 165 patients (33%) are aged 30-40 years, 105 patients (21%) are aged 40-50 years, 60 patients (12%) are aged 50-60 years, 30 patients (6%) are aged 60-70 years, 15 patients (3%) are aged 70-80 years, and 10 patients (2%) are aged 80-90 years. The highest number of patients fall within the age range of 30-40 years, comprising165 individuals (33%).



In Graph 4 Among 500 patients, 435 (87%) show disc protrusion, 175 (35%) present partial desiccation, 80 (16%) have neural foramina issues, 5 (1%) display signs of spondylosis, 60 (12%) have osteoporosis, 10 (2%) depict spinal haemorrhage, 145 (29%) demonstrate osteophyte spurs, and 13 (3%) showcase sclerotic changes. Notably, disc protrusion is the most prevalent condition, observed in the majority of cases (87%).

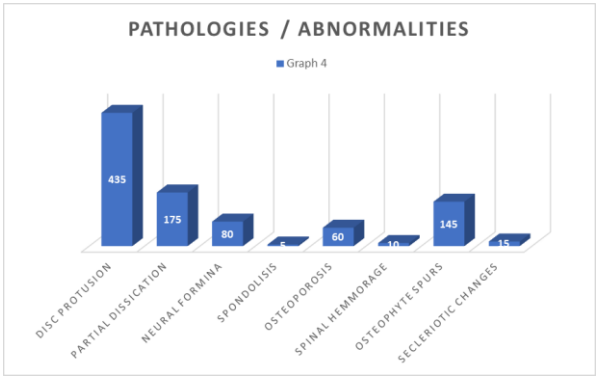


Table 1 This chart illustrates the distribution of diffuse disc bulges across different levels of the lumbar spine region among 500 patients. Ten patients (2%) exhibit diffuse disc bulge at the L1-L2 level. Another ten patients (2%) demonstrate diffuse disc bulge at both the L1-L2 and L3-L4 levels. Similarly, ten patients (2%) present diffuse disc bulge at both the L1-L2 and L2-L3 levels. Additionally, one patient (1%) displays diffuse disc bulge at the L1-L5 level, while five patients (1%) show it at the L2-L3 level. Another five patients (1%) exhibit diffuse disc bulge at both the L2-L3 and L3-L4 levels. Notably, a significant proportion of patients (20%) display diffuse disc bulge at the L3-L4 level, with 15 patients (3%) showing it at both the L3-L4 and L4-L5 levels. Moreover, the highest incidence of diffuse disc bulge is observed at the L4-L5 level, with 140 patients

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(28%) exhibiting it there. Additionally, 115 patients (23%) have diffuse disc bulge at both the L4-L5 and L5-S1 levels. A subset of patients (13%) does not presents any abnormalities. It is notable that the majority of patients with diffuse disc bulge are observed at the L4-L5 level.

Table 1: Showing the diverse disc bulge in comparison with their symptoms

Type (diffuse disc buldge)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L2	0	10	0	10	**2%**
L1-L2, L3-L4	10	0	0	10	**2%**
L1-L2, L2-L3	4	6	0	10	**2%**
L1-L5	2	8	0	10	**2%**
L2-L3	1	2	2	5	**1%**
L2-L3, L3-L4	1	2	2	5	**1%**
L2-L3, L4-L5	3	2	0	5	**1%**
L3-L4	31	24	45	100	**20%**
L3-L4, L4-L5	4	0	11	15	**3%**
L4-L5	34	71	35	140	**28%**
L4-L5, L5-S1	0	10	0	10	**2%**
L5-S1	43	27	45	115	**23%**
None	13	17	35	65	**13%**
Total	**146**	**179**	**175**	**500**	**100%**

Table 2 This data depicts the distribution of disc protrusion across various levels of the lumbar spine region among 500 patients. The findings reveal that 165 patients (33%) exhibit disc protrusion at the L4-L5 level, while 170 patients (34%) show it at the L5-S1 level. Additionally, 45 patients (9%) display disc protrusion at both the L4-L5 and L5-S1 levels. Furthermore, five patients exhibit disc protrusion at the L1-L2 level, while another one patient presents it at different levels, including L2-L3 and L5-S1. Similarly, five patients have disc protrusion at the levels of L1-L2 and L3-L4, while 20 patients show it at the L3-L4 level. Another 20 patients display disc protrusion at various levels, including L3-L4 and L4-L5. Additionally, 45 patients exhibit disc protrusion at different levels of L4-L5 and L5-S1. A total of 65 patients do not exhibits any abnormalities. Notably, the majority of disc protrusion cases are observed at the L5-S1 level, with 170 patients affected.

Table 2: Distribution of disc protrusion at different level

Type (Disc Protrusion)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L2	0	5	0	**5**	**1%**
L2-L3, L5-S1	0	5	0	**5**	**1%**
L1-L2, L3-L4	5	0	0	**5**	**1%**
L3-L4	3	7	10	**20**	**4%**
L3-L4, L4-L5	4	4	12	**20**	**4%**
L4-L5	50	52	63	**165**	**33%**
L4-L5, L5-S1	10	20	15	**45**	**9%**
L5-S1	53	57	60	**170**	**34%**
None	15	15	35	**65**	**13%**
Total	**140**	**165**	**195**	**500**	**100%**

Table 3 The data illustrates the prevalence of partial desiccation at various levels of the lumbar spine among 500 patients. Specifically, 105 patients (21%) exhibit partial desiccation at the L1-L5 level, while 35 patients (7%) show it at the L4-L5 level. Additionally, 15 patients (3%) demonstrate partial desiccation at the L5-S1 level. Overall, the majority of patients with partial desiccation are observed at the L1-L5 level.

Table 3: Distribution of partial desiccation at different level

Type (Partial desiccation)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L5	25	35	45	**105**	**21%**
L2-L3, L4-L5	0	5	0	**5**	**1%**
L3-L4, L4-L5	0	0	5	**5**	**1%**
L4-L5	10	10	15	**35**	**7%**
L4-S1	5	0	0	**5**	**1%**
L4-L5, L5-S1	0	3	2	**5**	**1%**
L5-S1	3	7	5	**15**	**3%**
None	95	105	125	**325**	**65%**
Total	**138**	**165**	**197**	**500**	**100.00%**

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Table 4 The data depicts the distribution of neural foramina stenosis across various levels of the lumbar spine among 500 patients. Specifically, 30 patients (6%) exhibit neural foramina stenosis at the L5-S1 level, while 15 patients (3%) show it at the levels of L4 and L5. Additionally, 5 patients (1%) demonstrate neural foramina stenosis at the L1-L2 level. The majority of patients with neural foramina stenosis are observed at the L5-S1 level.

Table 4: Distribution of neural foramina at different level

Type (Neural Foramina)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L2	3	2	0	5	1%
L1-L5	4	0	1	5	1%
L1-S1	0	0	5	5	1%
L2-L3	5	0	0	5	1%
L3-L4	2	0	3	5	1%
L4-L5	2	8	5	15	3%
L4-L5, L5-S1	5	0	0	5	1%
L4-S1	0	0	5	5	1%
L5-S1	5	5	20	30	6%
None	80	120	220	420	84%
Total	106	135	259	500	100%

Table 5 The data illustrates the distribution of spondylosis across various levels of the lumbar spine among 500 patients. Specifically, 15 patients (3%) exhibit spondylosis at the L5-S1 level.

Table 5: Distribution of spondylosis at different level

Type (Spondylosis)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L5-S1	10	0	5	15	3%
None	285	100	100	485	97%
Total	295	100	105	500	100.00%

Table 6 The data depicts the distribution of osteoporosis across various levels of the lumbar spine among 500 patients. Specifically, 25 patients (5%) exhibit osteoporosis at the L1-L5 level.

Table 6: Distribution of osteoporosis at different level

Type (Osteoporosis)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L4	10	0	0	10	2%
L1-L5	10	0	15	25	5%
L1-S1	0	5	0	10	1%
L3-L4	0	0	5	10	1%
L3-L5	5	0	0	10	1%
L5	5	0	0	10	1%
L5-S1	5	0	0	10	1%
None	200	100	140	440	88%
Total	235	105	160	500	100%

Table 7 The data illustrates the distribution of spinal haemorrhage across different levels of the lumbar spine among 500 patients. Specifically, 5 patients (1%) exhibit spinal haemorrhage at the L1 level, while another 5 patients (1%) show it at the L4 level.

Table 7: Distribution of spinal haemorrhage at different level

Type (Spinal Haemorrhage)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1	0	3	2	5	1%
L4	0	5	0	5	1%
None	200	200	90	490	98%
Total	200	208	92	500	100%

Table 8 The data illustrates the distribution of osteophyte spurs across various levels of the lumbar spine among 500 patients. Specifically, 90 patients (18%) exhibit osteophyte spurs at the L1-L5 level, while 25 patients (5%) show them at the L1-S1 level.

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Table 8: Distribution of osteophyte spurs at different level

Type (Osteophyte Spurs)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L5	15	15	60	**90**	**18%**
L1-S1	10	15	0	**25**	**5%**
L2-L3, L3-L4	0	0	5	**5**	**1%**
L2-L4	5	0	0	**5**	**1%**
L3-L4	0	0	5	**5**	**1%**
L4-L5	5	0	0	**5**	**1%**
L4-L5, L5-S1	0	5	0	**5**	**1%**
L5	3	0	2	**5**	**1%**
L5-S1	0	5	0	**5**	**1%**
None	100	100	150	**350**	**70%**
Total	**138**	**140**	**222**	**500**	**100%**

Table 9 The data illustrates the distribution of sclerotic changes across various levels of the lumbar spine among 500 patients. Specifically, 5 patients (1%) exhibit sclerotic changes at the L4-L5 level, another 5 patients (1%) show them at the L1-L5 level, 5 patients (1%) present sclerotic changes at the L5 level, and 5 patients (1%) demonstrate them at the L5-S1 level.

Table 9: Distribution of sclerotic change at different level

Type (Sclerotic Change)	Lower back pain	Numbness of limbs	PIVD	Total	
				n = 500	In %
L1-L5	0	5	0	**5**	**1%**
L4-L5	5	0	0	**5**	**1%**
L5	0	0	5	**5**	**1%**
L5-S1	0	5	0	**5**	**1%**
None	100	100	280	**480**	**96%**
Total	**105**	**110**	**285**	**500**	**100%**

Table 10 The data illustrates the distribution of diffuse disc bulge across various segments. Among the 500 patients, central disc bulge is observed in 165 (33%) patients, posterior disc bulge in 300 (60%) patients, and anterior disc bulge in 35 (7%) patients. Posterior disc bulge appears to be the most prevalent.

Table 10: Distribution of pattern based on disc bulge

Disc bulge	n = 500	In %
C	165	33%
PC	300	60%
E	35	7%

5. Discussion

Magnetic Resonance Imaging has revolutionized the diagnosis and evaluation of lumbar pathologies, providing detailed anatomical insights without radiation exposure. The utilization of the MRI Lumbar Spine Protocol is paramount in diagnosing a spectrum of conditions affecting the lumbar region. This protocol offers comprehensive visualization, facilitating the identification of various issues such as disc herniation, degenerative disc disease, and spinal stenosis. Despite its efficacy, limitations such as cost, contraindications, image artifacts, and limited availability restrict its accessibility to a subset of patients. Nonetheless, MRI remains a potent tool for assessing lumbar pathologies, and ongoing advancements hold promise for improving diagnostic accuracy and clinical outcomes. A study done by Mogahed M. Zidane et al. observed that out of 50 patients who underwent lumbar spine MRI, including 22 males and females. The majority of participants were aged over 60 (30.0%), while the youngest age group, 25-35 years old, comprised 10.0% of the total patients. Incidental findings were common in MRI scans of individuals with discopathy, with haemangioma being the most frequently reported (36.0%). However, no significant associations were found between gender and incidental findings or between age and diagnosis type. These incidental findings are prevalent in clinical practice, and providing information about them aids in their management, ultimately impacting patient health [12]. Suwaidi MA et al. conducted a review of 261 patients, comprising 187 males and 74 females, with ages ranging from 2 to 95 years and a mean age of 46.43 ± 15.7 years. The most frequently performed MRI procedure was lumbo-sacral imaging (46.4%), followed by cervical (44.1%), thoraco-lumbar spine (4.2%), thoracic spine (3.8%), and combined cervical and lumbar scans (1.5%). The primary indication for MRI was low back pain, observed in 211 (80.8%) patients, with trauma accounting for 36 (17.8%) patients. Approximately

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19.6% of MRI scans revealed normal results, while spondylosis and moderate disc prolapse were identified in 31.5% of cases, and compressive fractures were present in 7.3% of cases [13]. This study utilized a 3 Tesla MRI scanner along with discrete sequences to assess various lumbar spine abnormalities. The outcome variables under evaluation included diffuse disc bulge, disc protrusion, partial desiccation, neural foramina stenosis, spondylosis, osteoporosis, spinal haemorrhage, osteophyte spurs, and sclerotic changes. Furthermore, the study investigated the influence of independent variables such as age, gender, and medical history. A dataset comprising 500 patients was analysed to derive the study outcomes. Further examination of the patient population revealed significant insights into the distribution and characteristics of lumbar spine abnormalities. Among patients with disc protrusion, the majority showed involvement at a single level (67%), while a smaller subset exhibited multi-level protrusions (23%). Notably, the most frequently affected lumbar levels were L4-L5 (33%), followed by L5-S1 (28%) and L3-L4 (21%), indicating a preference for lower lumbar segments. Analysis of disc protrusion morphology revealed diverse types, including central (42%), paracentral (31%), foraminal (18%), and extruded (9%) protrusions, emphasizing the need for detailed characterization in clinical assessment and management. The other abnormalities, spondylolisthesis was detected in 12% of patients, with a notable prevalence at the L5-S1 level (45%). Additionally, spinal stenosis was observed in 18% of cases, predominantly affecting the central canal (63%) and neural foramina (37%). The presence of associated findings such as facet joint arthropathy (15%) and ligamentum flavum hypertrophy (9%) added to the complexity of lumbar pathology observed in the study cohort. These findings underscore the varied nature of lumbar spine abnormalities and highlight the importance of comprehensive evaluation in clinical practice.

Conclusion: This research used advanced MRI technology to evaluate various lumbar spine abnormalities, providing insights into their prevalence, morphology, and distribution. The analysis included disc bulge, protrusion, desiccation, neural foramina stenosis, spondylosis, osteoporosis, spinal haemorrhage, osteophyte spurs, and sclerotic changes. Disc protrusion was notably common, especially at the L4-L5 level. The study highlighted the impact of demographic and clinical factors like age, gender, and medical history on lumbar spine pathology. Associated abnormalities such as spondylolisthesis and spinal stenosis emphasized the complexity of lumbar pathology. These findings emphasize the need for thorough evaluation in clinical practice to manage lumbar spine disorders effectively.

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