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# A 3 Tesla Magnetic Resonance Imaging Study of Disco - Vertebral Changes and Nerve Root Compression in Degenerative Lumbar Radiculopathy

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**Abstract:** ***Lumbar radiculopathy, characterized by lower back and hip pain radiating to the lower limbs, often involves symptoms such as anaesthesia, hypoesthesia, paresthesia, motor loss, and pain, with degenerative changes and nerve root compression frequently implicated. This study aimed to evaluate the role of 3 Tesla MRI in identifying disco - vertebral changes and nerve root compression in patients with degenerative lumbar radiculopathy. Conducted among 50 patients at Narayana Medical College and Hospital, Nellore, from October 2022 to April 2024, the study found a slight male predominance, with most participants aged between 40 and 59. The L4/L5 disc level was most commonly affected, followed by L5/S1. The primary disc abnormalities observed were disc desiccation and disc bulge, with additional findings including ligamentum flavum hypertrophy, mild thecal sac indentation, and complications such as cauda equina and nerve root compression. The study highlights the effectiveness of 3 Tesla MRI in detecting these degenerative changes and neural compromises.***

**Keywords:** lumbar radiculopathy, lower back pain, degenerative changes, nerve root compression, 3 Tesla MRI

## 1. Introduction

Spinal degenerative disease encompasses an extensive array of abnormalities. Degeneration affects intervertebral discs and osseous structures, but many aspects of spine degeneration are inextricably linked due to the identification of chronic excess as the primary common pathogenic factor. Constant alterations occur in the spine throughout an individual's lifetime in response to axial load induced by physiologic processes.

Ageing is a prevalent factor frequently associated with degenerative diseases of the spine. Its prevalence rises with age, ranging from 85 to 95 percent, with the greatest concentration among adults aged 50 to 55 who have no sexual distinction.2 According to one estimation, this symptom impacts as many as 80% of the population at some point in their lives.3Real or apparent desiccation, fibrosis, narrowing of the disc space, diffuse bulging of the annulus beyond the disc space, extensive fissuring (i. e., numerous annular tears) and mucinous degeneration of the annulus, defects and sclerosis of the endplates, and osteophytes at the vertebral apophyses are all encompassed within the term degeneration.4

As a load - bearing structure, the lumbar spine of humans transfers and bears the weight of the lower extremities via the sacrum and pelvic. There exists a robust correlation between back pain and intervertebral disc degeneration.8 Individuals exhibiting symptoms may manifest back pain or radicular pain syndrome (Sciatica).9 Lumbar degenerative disease pain is primarily caused by disc herniation - induced mechanical compression of neural elements, in addition to direct biochemical and inflammatory processes. Asymptomatic patients may be afflicted with spinal stenosis and degenerative disc bulges.7, [8]Spine degenerative disease has been associated with various factors beyond age. These include genetic predisposition, a history of physical overload, trauma, and compromised nutrition.

Since its inception, MRI has been the imaging modality of choice for diagnosing degenerative lumbar spine disorders. Current MRI techniques may also be most effective in assessing the intervertebral disc, vertebrae, ligaments, spinal canal, and neural foramina. In cases of degenerative lumbar spine disease, MRI is the imaging modality of choice due to its accurate delineation and multiplanar imaging capabilities.1[3] The objective of this study design is to determine how MRI contributes to the diagnosis and evaluation of degenerative alterations in the lumbar spine.

## 2. Material and Methods

This descriptive study was undertaken among 50 patients in the department of Radiodiagnosis of Narayana Medical College and Hospital, Nellore between October 2022 to April 2024. The patients thus selected were subjected for standard lumbar spine MR imaging by using **GE with a magnetic field strength of 3 T**. The data was collected in a predesigned proforma and analysed using Statistical Package for Social Services (SPSS vs 20). Ethical clearance was obtained before the study was conducted. An informed, bilingual and written consent was obtained from all the patients before they were included in the study.

**Inclusion criteria:**

a) All patients presenting with non traumatic lower back pain, with or without radiation to lower limbs and Patients with decreased or loss of sensation or tingling sensation of lower limbs.
b) Patients referred from clinicians for degenerative lumbar spine evaluation.

**Exclusion criteria:**

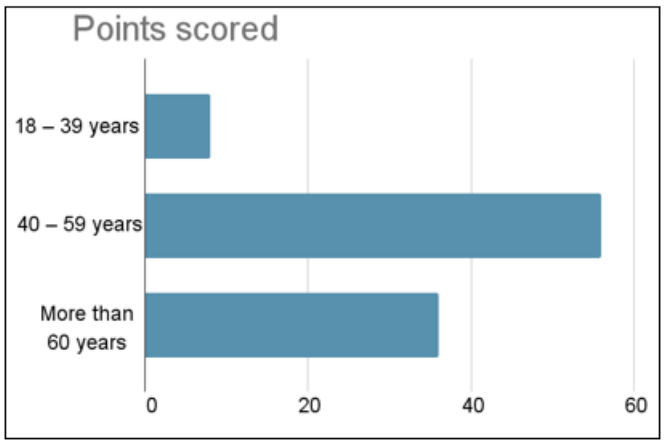
a) Patients with magnetic devices like cardiac pacemaker, defibrillator, metallic cardiac valves, aneurysmal clips, cochlear implants, annuloplasty rings or any ferromagnetic foreign body in situ.
b) History of trauma or operative intervention to lower back.
c) Low back pain due to infective or neoplastic aetiology
d) Patients with claustrophobia.
e) Patients whose age is below 18 years.

For all patients undergoing lumbar spine evaluation, sagittal and axial T2 weighted MR imaging sequences were employed. The facility's protocol consisted of fast spin - echo acquisitions for the sagittal T2 - weighted images, as well as axial T2 - weighted scans. Specific parameters included a repetition time of 3400 milliseconds, echo time of 114 milliseconds, 32 cm field of view, 4 mm contiguous section thickness with a 1 mm interslice gap.

## 3. Results

**Table 5:** Distribution of study group according to age group

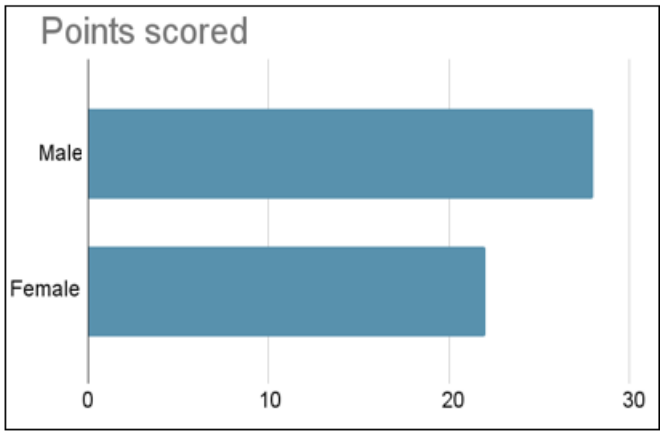
| Age group | Frequency | Percentage |
|---|---|---|
| 18 – 39 years | 4 | 8 |
| 40 – 59 years | 28 | 56 |
| More than 60 years | 18 | 36 |
| Total | 50 | 100 |




**Graph 1:** Distribution of study group according to age group

**Table 6:** Distribution of study group according to gender

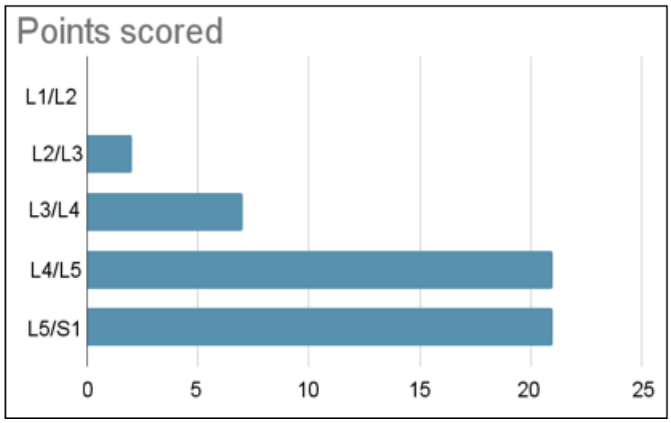
| Gender | Frequency | Percentage |
|---|---|---|
| Male | 28 | 56 |
| Female | 22 | 44 |
| Total | 50 | 100 |




**Graph 2:** Distribution of study group according to gender

**Table 7:** Distribution of study group according to spine level affected

| Spine level affected | Frequency | Percentage |
|---|---|---|
| L1/L2 | 0 | 0 |
| L2/L3 | 2 | 4 |
| L3/L4 | 7 | 14 |
| L4/L5 | 21 | 42 |
| L5/S1 | 20 | 40 |
| TOTAL | 50 | 100 |




**Graph 3:** Distribution of study group according to spine level affected

**Table 8:** Distribution of study group according to disc changes

| Disc changes | Frequency | Percent |
|---|---|---|
| Annular tear | 10 | 20 |
| Disc bulge | 17 | 34 |
| Disc desiccation | 23 | 46 |
| TOTAL | 50 | 100 |

**Graph 4:** Distribution of study group according to disc changes

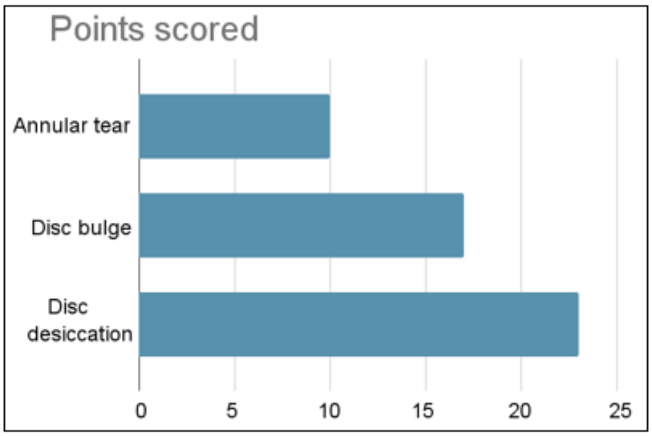
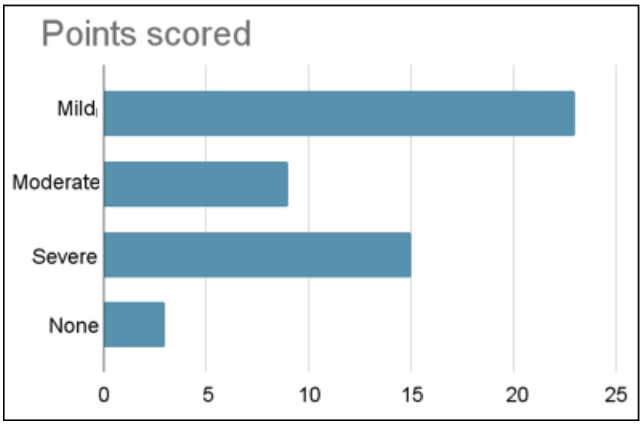



**Table 9:** Distribution of study group according to thecal sac indentation:

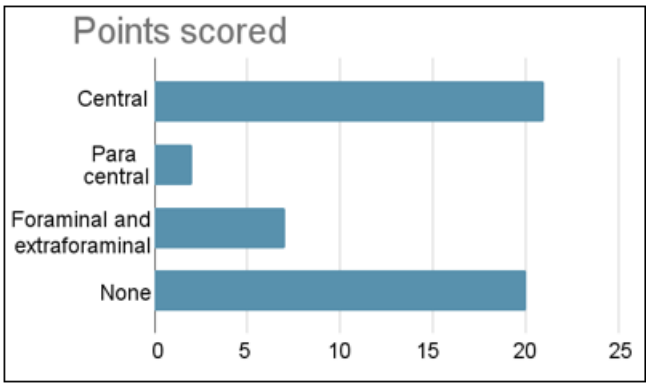
| Thecal sac indentation | Frequency | Percent |
|---|---|---|
| Mild | 23 | 46 |
| Moderate | 9 | 18 |
| Severe | 15 | 30 |
| None | 3 | 6 |
| Total | 50 | 100 |




**Graph 5:** Distribution of study group according to thecal sac indentation

**Table 10:** Distribution of study group according to location of disc herniation

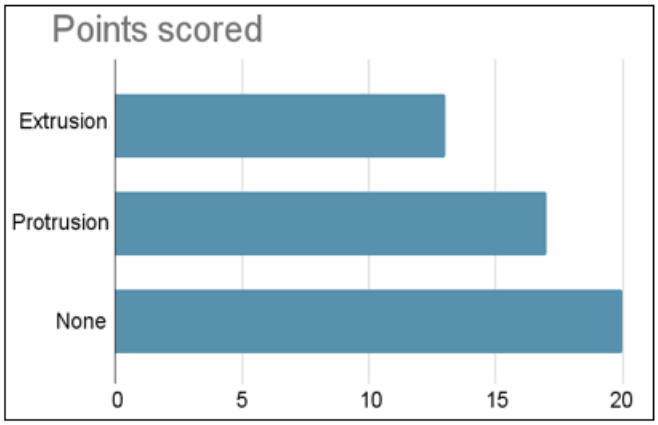
| Location of disc herniation | Frequency | Percent |
|---|---|---|
| Central | 21 | 42 |
| Para central | 2 | 4 |
| Foraminal and extraforaminal | 7 | 14 |
| None | 20 | 40 |
| Total | 50 | 100 |




**Graph 6:** Distribution of study group according to location of disc herniation

**Table 11:** Distribution of study group according to type of disc herniation

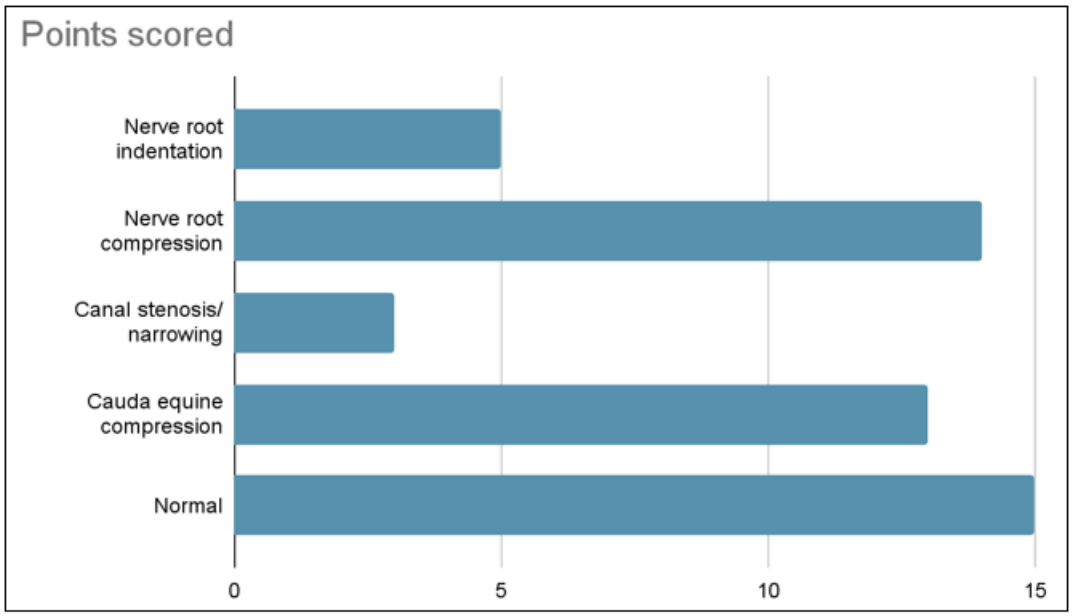
| Type of disc herniation | Frequency | Percent |
|---|---|---|
| Extrusion | 13 | 26 |
| Protrusion | 17 | 34 |
| None | 20 | 40 |
| Total | 50 | 100 |




**Graph 7:** Distribution of study group according to type of disc herniation

**Table 12:** Distribution of study group according to neural compromise

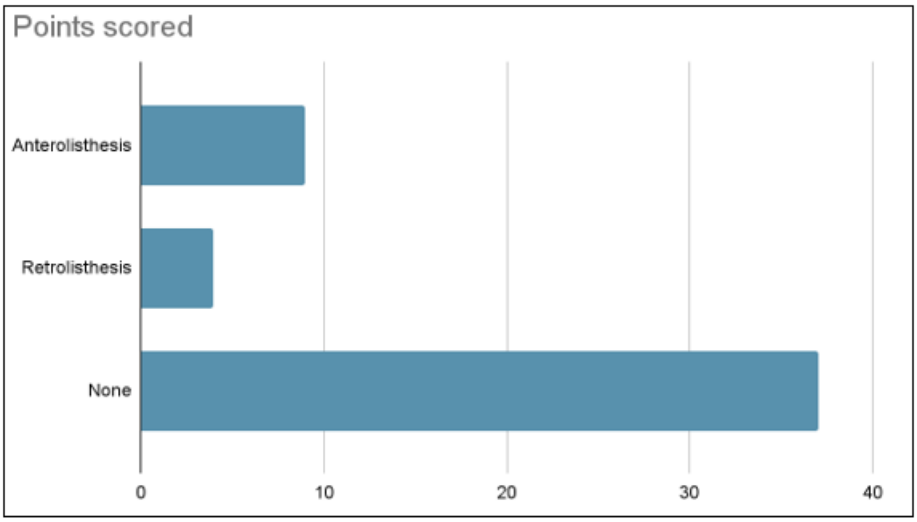
| Neural compromise | Frequency | Percent |
|---|---|---|
| Nerve root indentation | 5 | 10 |
| Nerve root compression | 14 | 28 |
| Canal stenosis/ narrowing | 3 | 6 |
| Cauda equina compression | 13 | 26 |
| Normal | 15 | 30 |
| Total | 50 | 100 |




**Graph 8:** Distribution of study group according to neural compromise

**Table 13:** Distribution of study group according to vertebral changes

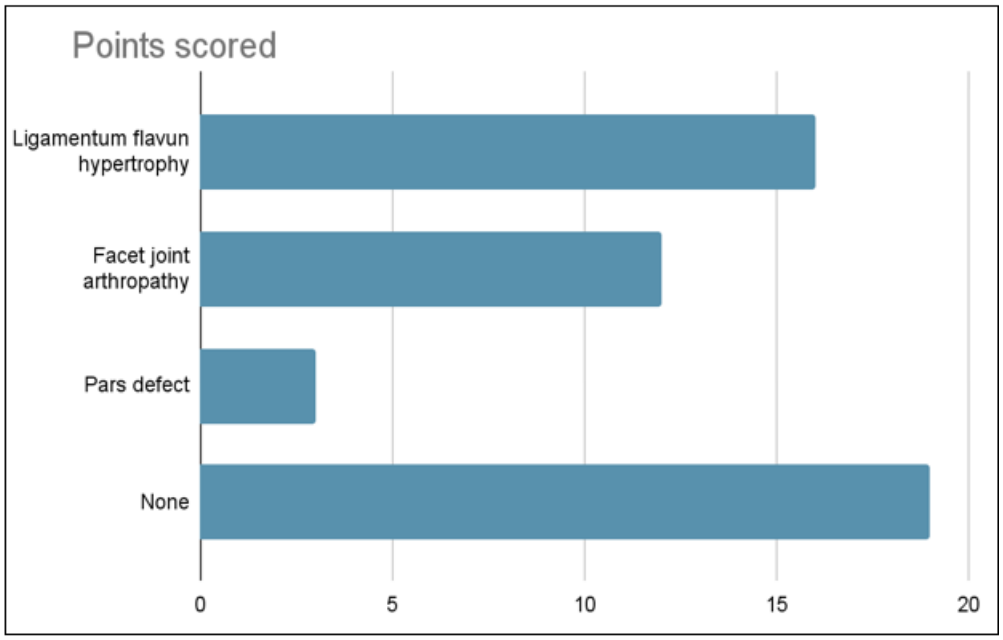
| Vertebral changes | Frequency | Percent |
|---|---|---|
| Anterolisthesis | 9 | 18 |
| Retrolisthesis | 4 | 8 |
| None | 37 | 74 |
| Total | 50 | 100 |




**Graph 9:** Distribution of study group according to vertebral changes

**Table 14:** Distribution of study group according to posterior element changes

| Posterior element changes | Frequency | Percent |
|---|---|---|
| Ligamentum flavum hypertrophy | 16 | 32 |
| Facet joint arthropathy | 12 | 24 |
| Pars defect | 3 | 6 |
| None | 19 | 38 |
| Total | 50 | 100 |




**Graph 10:** Distribution of study group according to posterior element changes and ligamentum flavum hypertrophyhy

## 4. Discussion & Conclusion

Spinal degenerative disease encompasses a broad range of abnormalities. Spinal degeneration is marked by the damage of bony structures and intervertebral discs. This degeneration is closely associated with chronic overload, which is the main underlying cause. Ageing is a prevalent risk factor for degenerative spinal diseases.

Lumbar degenerative disease can manifest with symptoms or remain without symptoms. The disc undergoes degeneration, resulting in the manifestation of back pain. Typically, symptomatic individuals experience back pain or a radicular pain syndrome known as Sciatica. High - resolution magnetic resonance imaging has become a crucial method for evaluating the intervertebral disc (IVD). The intervertebral disc exhibits disc space narrowing, a decrease in T2 weighted signal intensity, the presence of fissures fluid, vacuum changes, and calcifications. At Magnetic Resonance Imaging (MRI), these changes are observed as a reduction in the space between the discs, a decrease in the signal intensity of the intervertebral disc on T2 - weighted images, the presence of fissures, fluid, vacuum changes, and calcification within the intervertebral disc, changes in the signal of the ligaments and bone marrow, the formation of bony outgrowths, disc herniation, misalignment, and narrowing of the spinal canal. This study assesses the role of MRI in diagnosing degenerative changes in the lumbar spine.

This descriptive study was undertaken among 50 patients in the department of Radiology of Narayana Medical College and Hospital, Nellore between October 2022 to April 2024. The patients thus selected were subjected for standard lumbar spine MR imaging by using GE with a magnetic field strength of 3 T. The primary goal of this study was to study the imaging characteristics of Disco - vertebral changes and neural compromise in patients with degenerative lumbar radiculopathy on a 3 tesla MRI. This study revealed that there was slight male predilection and that the majority of the participants were between the ages of 40 and 59. L4/S1 vertebral level was frequently affected. The two main disc changes were disc bulge and disc desiccation. The other findings included ligamentum flavum hypertrophy and mild thecal sac indentation. The majority of the patients had cauda equina and nerve root compression.

## 5. Summary

- Degenerative disease of the spine includes a wide spectrum of degenerative abnormalities.
- This study evaluates the contribution of MRI and diagnosis of degenerative changes of lumbar spine.
- This descriptive study was undertaken among 50 patients in the department of Radiology of Narayana Medical College and Hospital, Nellore between October 2022 to April 2024.
- **Age group** - Majority of the study subjects belonged to the 40 – 59 years age group followed by 18 – 39 years.
- **Sex** - The male: female ratio in this study was 1.27: 1.
- **Spine level affected** - L4/L5 disc was affected most in this study followed by L5/S1.
- **Disc changes** - The disc bulge was found in 34% of the cases, disc desiccation was found in 46% of the cases, and annular tear was found in 20% of the cases.
- **Thecal sac** - Mild indentation was found in 46% of the cases, moderate indentation was found in 18% of the cases, severe indentation was found in 30% of the cases.
- **Location of disc herniation** - The central herniation was found in 42% of the cases, paracentral herniation was found in 4% of the cases, foraminal and extraforaminal herniation was found in 14% of the cases and no herniation was found in 40% of the cases.
- **Type of disc herniation** - The disc protrusion was found in 34% of the cases and extrusion was found in 26% of the cases.
- **Neural compromise** - Nerve root compression was found in 28% of the cases in this study, in 10% of the cases nerve root indentation was seen, in 6% of cases spinal canal narrowing was seen, in 26% of cases cauda equina compression was present and 30% of the cases had Nil

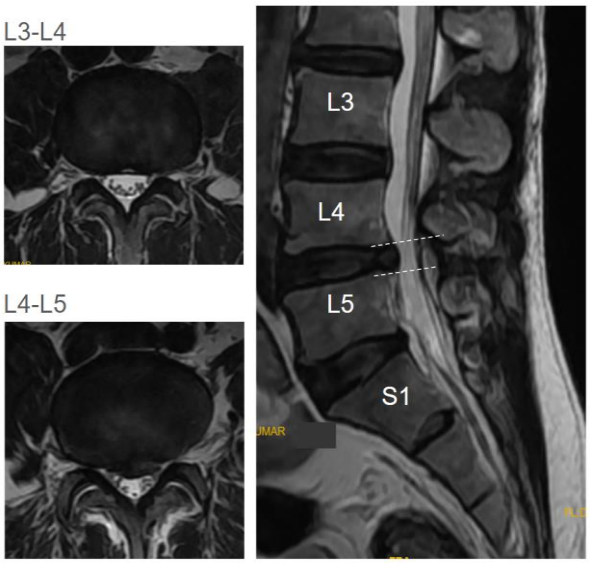
complications.

- **Vertebral changes -** The vertebral changes were not seen in 74% of the cases. Anterolisthesis was found in 18% of the cases, Retrolisthesis was found in 8% of the cases.
- **Posterior element changes -** The ligamentum flavum hypertrophy was found in 32% of the cases, facet joint arthropathy was found in 24% of the cases and pars interarticularis defect in 6% of the cases.38% of cases had no obvious changes in posterior elements.

## 6. Illustrative Cases:

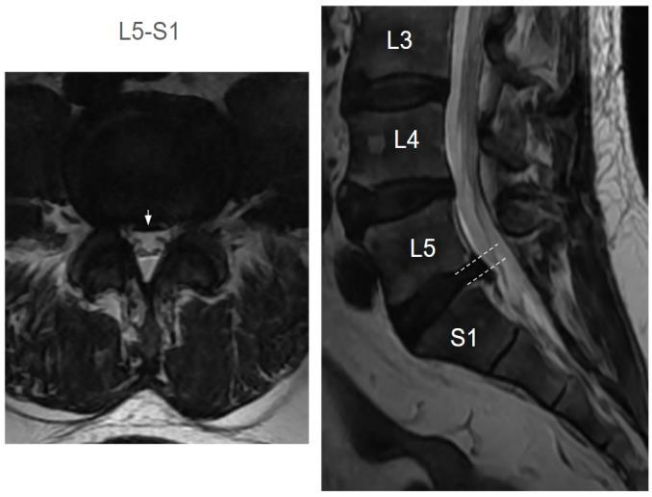
**Case 1: Demonstrating Protrusion**

- Age: 49, M
- Clinical history: Low back ache, radiating to right lower limb with tingling sensation of right foot.
- FINDINGS: Central disc protrusion at L4 - L5 level with compression of left neural exiting nerve root.



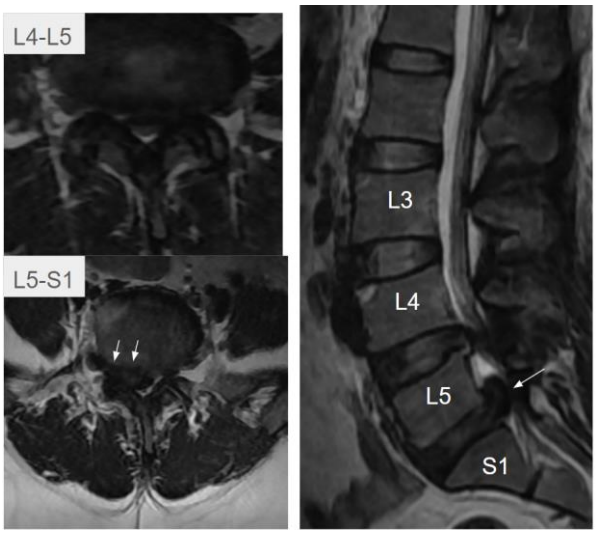

**Case 2:** Demonstrating Extrusion (Central type)

- Age: 54, M
- Clinical history: Back ache radiating to the left lower limb.
- FINDINGS: Central disc extrusion and ligamentum flavum hypertrophy at L4 - L5 level causing bilateral lateral recess narrowing.



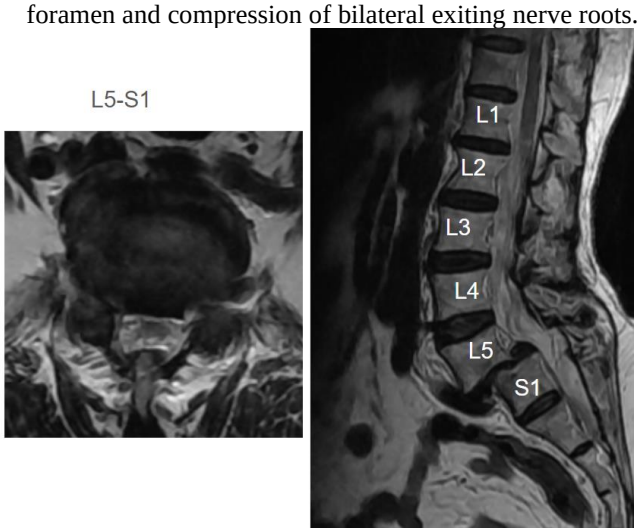

**Case 3:** Demonstrating Extrusion (Paracentral and foraminal types)

- Age: 53, F
- Clinical history: Severe low back ache.
- FINDINGS: L5 - S1: Right paracentral and foraminal disc extrusion compounded with ligamentum flavum hypertrophy causing severe thecal sac indentation, right L5 exiting nerve root and cauda equina compression.



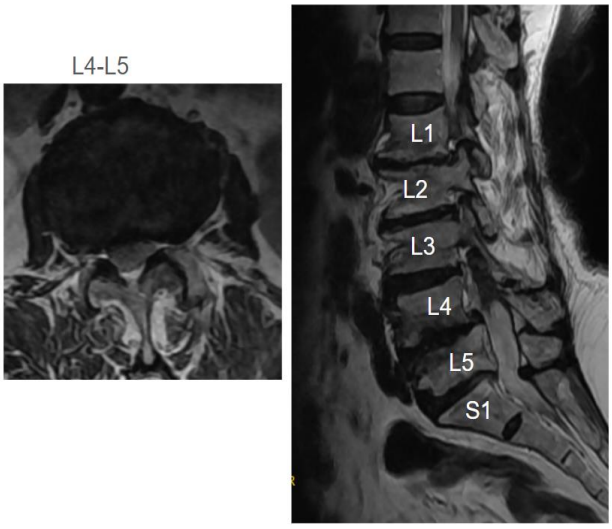

**Case 4:** Demonstrating Anterolisthesis

- Age: 74, F
- Clinical history: Severe low back ache, especially while trying to stand from sitting position and radiating to bilateral lower limbs along with tingling sensation.
- FINDINGS: Grade 2 anterolisthesis of L5 over S1 with pseudo disc bulge causing narrowing of bilateral neural foramen and compression of bilateral exiting nerve roots.

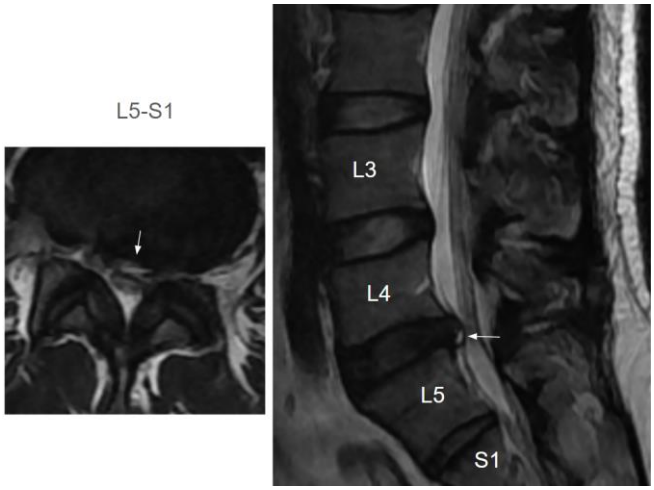



**Case 5:** Demonstrating Retrolisthesis

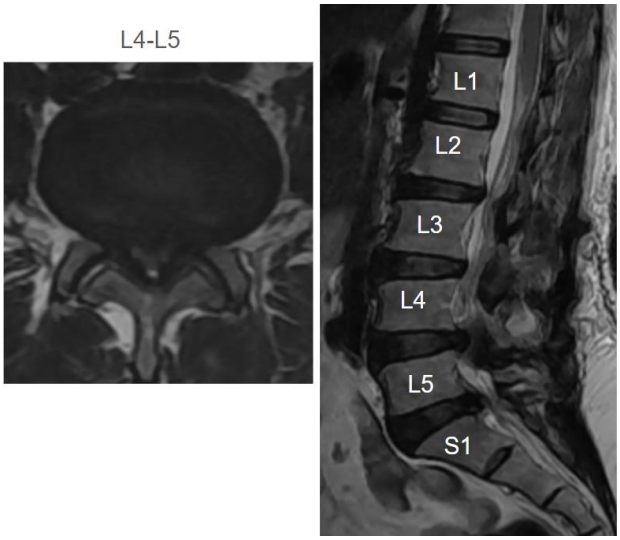
- Age: 80, F
- Clinical history: Severe low back ache, unable to stand up from sitting position. Radiating pain to the left lower limb.
- FINDINGS: Grade 1 retrolisthesis of L5 over S1.



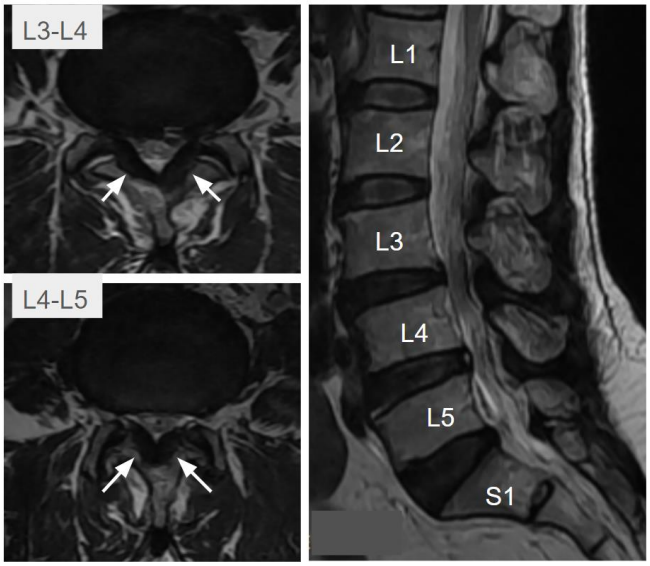

**Case 6**: Demonstrating Posterior annular tear
- Age: 53, F
- Clinical history: Mild low back ache.
- FINDINGS: L5 - S1: Disc desiccation with Posterior annular tear.



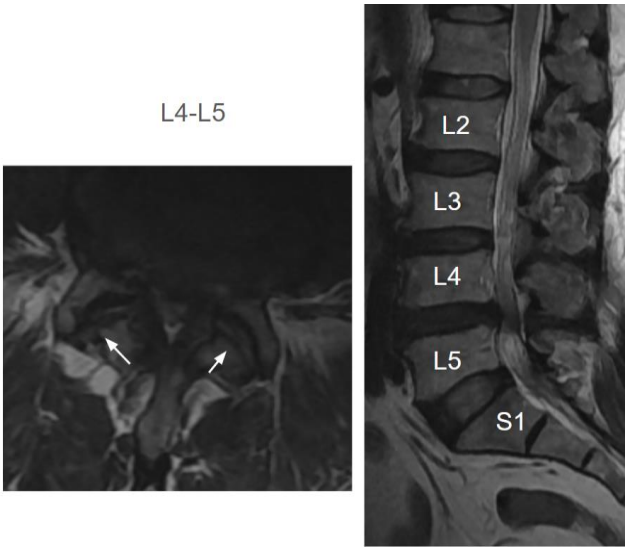

**Case 7:** Demonstrating Severe spinal canal narrowing
- Age: 54, F
- Clinical history: Severe low back ache radiating to bilateral lower limbs upto toes.
- FINDINGS: Central posterior disc protrusion compounded by ligamentum flavum hypertrophy at L4 - L5 level causing severe spinal canal narrowing.




**Case 8:** Demonstrating Ligamentum Flavum Hypertrophy
- Age: 54, F
- Clinical history: Low back ache, radiating to both the thighs and feet along with tingling sensation of feet.
- FINDINGS: Ligamentum flavum hypertrophy causing moderate thecal sac indentation at L3 - L4 and L4 - L5.

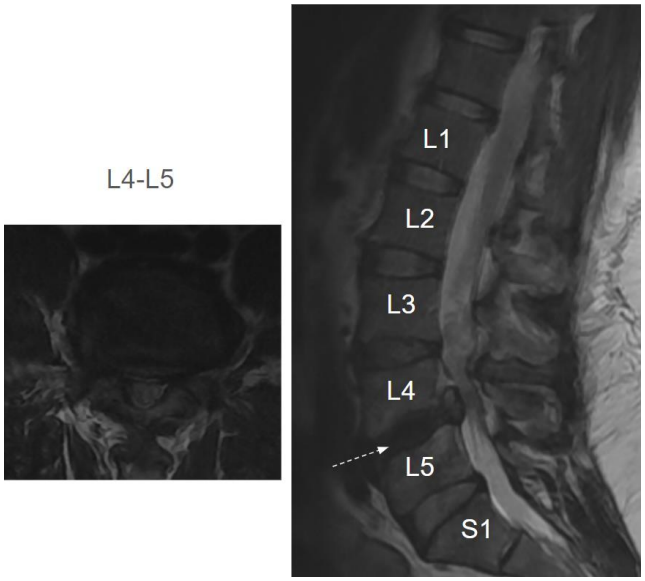



**Case 9:** Demonstrating Facet Joint Arthropathy
- Age: 64, M
- Clinical history: Low back ache and generalised body aches.
- FINDINGS: L4 - L5: Central disc protrusion compounded with ligamentum flavum hypertrophy and facet joint arthropathy causing severe thecal sac indentation, cauda equina and bilateral L5 traversing nerve root compression.



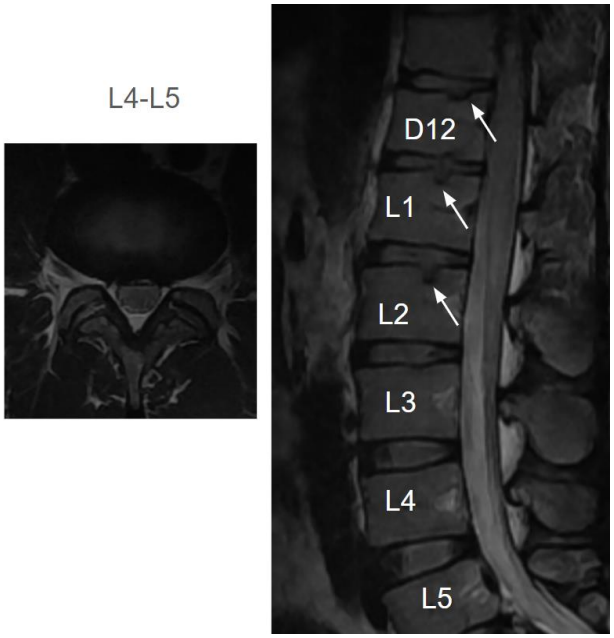

**Case 10:** Demonstrating Disc desiccation changes

- Age: 53, F
- Clinical history: Severe low back ache, unable to stand up from sitting position.
- FINDINGS: L4 - L5: Disc desiccation changes with central disc extrusion




**Case 11:** Demonstrating Schmorl's nodes

- Age: 44, M
- Findings: Schmorl's nodes at superior margins of D12, L1 and L2 vertebral bodies.

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