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ORIGINAL RESEARCH

Role of MRI in degenerative spinal diseases

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ABSTRACT

Introduction: Degenerative spinal disease leads to lower back pain and primarily impacts individuals ranging from young to middle-aged. MRI is commonly used to accurately evaluate the intervertebral disc (IVD) in both normal & degenerative conditions.The aim of present study is to establish the role of MRI in degenerative spinal diseases & the severity in patient. **Material and methods:** The present prospective study was conducted at "Department of Radiodiagnosis JNUIMSRC, Jaipur" among 200 patients having complain of backpain & suspected degenerative disease of the spine for MRI. Scan was performed on all cases that had a documented history of back pain & were believed to have a degenerative condition of the spine through SIEMENS 1.5 TESLA SCANNER. All the operations were done according to protocol. **Results:** Male & female comprised of 45.5% & 54.5% of the subjects respectively. Mean age among the study subjects was 48.37±14.85 years with maximum subjects from age group of 51-60 years (28%).Most common disc level involvement was L4-L5 (31%) followed by L5-S1 (27.5%), C1-C7 (11.5%) & L3-L4 (9.5%).Disc herniation viz. protrusion & extrusion was revealed in 65% & 13.5% of the subjects. Osteophytes was present in 99% of the subjects. Bulge was reported in 89.5% of the subjects. Disc desiccation was revealed in 79.5% of the subjects. **Conclusion:** MRI is the preferred imaging technique for identifying disc pathology because it does not require radiation, has the ability to image many areas simultaneously, provides great contrast between spinal soft tissues, & accurately identifies alterations in intervertebral discs.

Keywords: Age, Degenerative, Diseases, MRI, Spine

INTRODUCTION

The primary factor contributing to spine degenerative disease is aging. Its occurrence becomes more prevalent with advancing age, ranging from 85% to 95% among individuals aged 50 to 55 years, without any distinction based on gender[1,2]. Hult's research suggests that as many as 80% of the population experience symptoms of this condition at some point in their lives[3]. Symptoms may manifest as either back pain or radicular pain syndrome in affected individuals[4]. Degenerative disease of the lumbar spine can be symptomatic or asymptomatic in individuals, although it is more frequently asymptomatic[5-8].

Degenerative disc disease leading to lower back pain primarily impacts individuals ranging from young to middle-aged, with its highest occurrence typically around the age of 40. While radiological findings show an increase in the prevalence of lumbar disc degeneration with age, it's important to note that not all degenerated discs result in pain. Moreover, the condition of low back pain caused by degenerative disc disease tends to affect men more than women[9].

Typically, the first imaging technique used to study Degenerative Disc Disease (DDD) involves regular standing X-rays taken from front to back & from side to side. Typical symptoms encompass a decrease in the height of the disc, the creation of osteophytes, the hypertrophy of the facet, & alterations in the alignment of segments. MRI is commonly used to accurately evaluate the intervertebral disc (IVD) in both normal & degenerative conditions. Magnetic resonance imaging (MRI) employs proton density, water content, & biochemical composition as indicators to represent the hydration status & morphological attributes of the disc. MRI, apart from its radiation-free nature, provides exceptional tissue contrast & facilitates the comprehensive assessment of spinal tissues through multiplanar & multiparametric examination. Hence, MRI has emerged as the prevailing imaging technique for identifying IVD disorders. Nevertheless, existing techniques predominantly evaluate DDD by focusing on superficial morphological alterations, frequently employing inconsistent & subjective grading systems that fail to sufficiently account for the intricate pathophysiological mechanisms at play[10,11].

In the last ten years, researchers have utilized advanced magnetic resonance imaging (MRI)

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methods to investigate different parameters, including relaxation times, MT, &ADCin order to examine the biochemical makeup of the intervertebral disc (IVD) at various stages of degenerative disc disease (DDD)[12].

Although magnetic resonance imaging (MRI) scans have become the most sensitive diagnostic technique for detecting aberrant structures, the management of degenerative disc disease continues to provide significant challenges in terms of expense, effort, & complexity[13]. This study examines a range of symptoms linked to the illness, encompassing anomalies in stability & alignment, degeneration or herniation of intervertebral discs, spinal stenosis, & facet disease. The focus is on establishing a connection between technical progress, areas need additional investigation, & the significance of meticulous clinical assessment in effectively diagnosing & managing the condition.

MATERIALS & METHODS

The present prospective study was conducted at "Department of Radiodiagnosis JNUIMSRC, Jaipur" among patients having complain of backpain & suspected degenerative disease of the spine for MRI. The Ethics Committee of Jaipur National University Institute for National Sciences & Research Centre granted approval for the prospective study, & the experimental methods were conducted in adherence to the approved standards. Prior to the commencement of the study, all subjects provided informed consent.

Sample size- Patients diagnosed with spinal degenerative illness were identified using MRI & then enrolled in the study. The primary function of imaging is to furnish precise morphological data & exert an impact on the process of therapeutic decision-making. Final sample size came out to be of 200 patients on the basis of convenience sampling and eligibility criteria as follows-

Inclusion criteria

a. Patient presenting with back pain.
b. Patients with suspected degenerative disease of the spine.
c. Patients presenting with spinal deficit.

Exclusion criteria

a. Patients refusing to undergo the research.
b. Patients with history of surgical intervention, acute trauma,tumours,infection & tumour like conditions.
c. Patients with pacemakers & metallic implants (allowed only on doctors advice)"

Methodology: An MRI scan was performed on all cases that had a documented history of back pain & were believed to have a degenerative condition of the spine. Patients underwent magnetic resonance imaging (MRI) scans as recommended by the physician, contingent upon the availability of an appointment.

Equipment: SIEMENS 1.5 TESLA SCANNER

Protocol

i) Images with T1 weighting in both the axial & sagittal planes.
ii) The pictures were T2-weighted & captured in both the axial coronal & sagittal planes.
iii) The utilization of STIR pictures as necessary.

MR Imaging Protocol

a. The magnetic resonance imaging (MRI) examination was conducted on a 1.5T whole-body full digital MR scanner manufactured by Siemens. During the scan, the participants were in a supine position. The study was conducted utilizing a 1.5 Tesla 8-channel superconducting magnet, specifically the MAGNETOM SEMPRA SEIMENS.
b. Standard sequences for MRI applications that are applicable.
c. "Standard magnetic resonance imaging (MRI) sequences commonly employed in spine imaging encompass T1-weighted, T2-weighted, & STIR-weighted sequences, as well as T2* gradient-echo sequences & 3D imaging approaches. The musculoskeletal MRI employs pulse sequences.

- T1-weighted image -
- T2-weighted image-
- Fluid-sensitive sequence, such as STIR or fat suppressed T2"

Interpretation of the data: Study evaluated:

a. "Vertebral changes: present/absent
b. Type of presentation
c. Disc changes: present/absent
d. Vertebral changes: present/absent, Type of presentation
e. Disc changes: present/absent, Type of presentation
f. Thecal sac: present/absent, Type of presentation
g. Spinal cord: present/absent, Type of presentation
h. Posterior elements: present/absent, Type of presentation
i. Paravertebral: present/absent, Type of presentation"

Data was gathered & subsequently analyzed using statistical methods.

Statistical analysis-The acquired data was organized& presented in an Excel spreadsheet, with the assistance of a statistician. Statistical analysis was conducted using the means & standard deviations of the measurements per group, employing SPSS 22.00 for windows (SPSS Inc., Chicago, USA). The disparity between the two groups was assessed using a chi-square test, with a significance level of $p < 0.05$.

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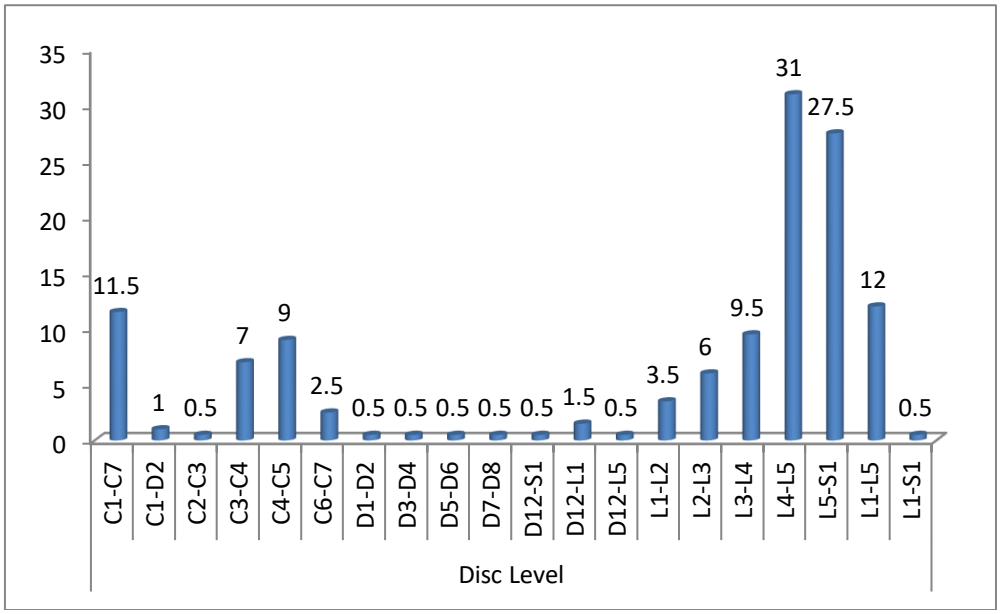
RESULTS

Table 1: Age and Gender distribution among the study subjects

Variable		N	%
Gender	Male	91	45.5
	Female	109	54.5
Age	16-30	26	13
	31-40	44	22
	41-50	34	17
	51-60	56	28
	>60	40	20

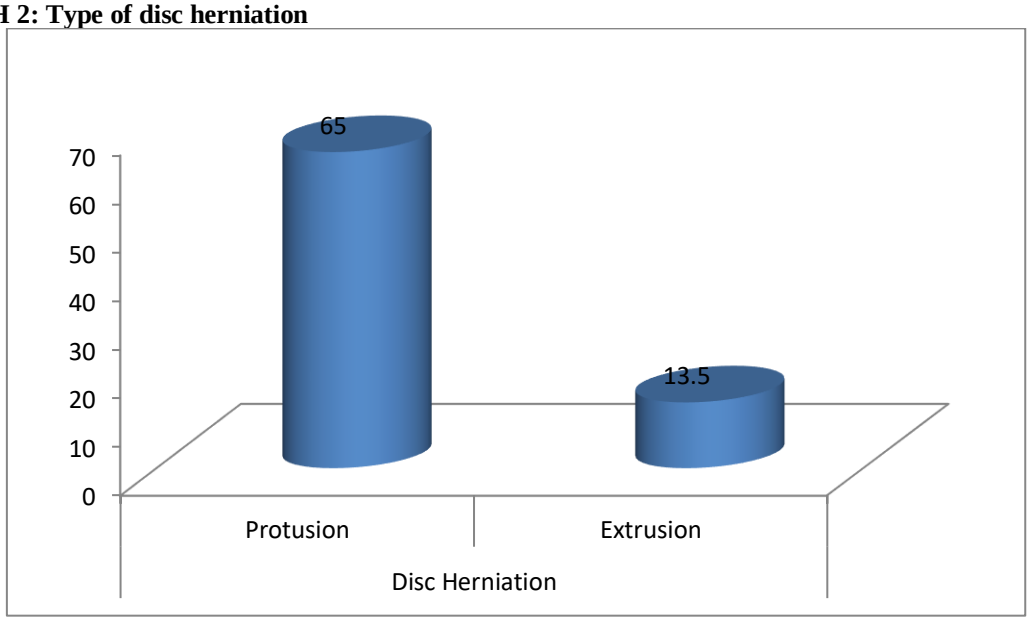
Male & female comprised of 45.5% & 54.5% of the subjects respectively. Hence there was slight female dominancy.Mean age among the study subjects was 48.37±14.85 years with maximum subjects from age group of 51-60 years (28%) followed by 31-40 years (22%) &>60 years (20%) as shown in table 1

GRAPH 1: Disc level involvement



Graph 1 shows the disc level involvement among the study subjects. Most common disc level involvement was L4-L5 (31%) followed by L5-S1 (27.5%), C1-C7 (11.5%) & L3-L4 (9.5%). C1-D2, D1-D2, D3-D4, D5-D6, D7-D8, D12-S1, D12-L5 & L1-S1 disc level involvement was reported in 1 subject each.

GRAPH 2: Type of disc herniation



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Disc herniation viz. protrusion& extrusion was revealed in 65% & 13.5% of the subjects respectively. Hence protrusion was found more commonly as compared to extrusion as shown in graph 2.

Table 2: Type of disc herniation w.r.t. disc level

Disc Level	Protrusion	Extrusion	Total
C1-C7	9	2	11
C3-C4	8	1	9
C4-C5	7	2	9
C6-C7	1	1	2
L1-L2	2	1	3
L2-L3	5	2	7
L3-L4	8	4	12
L4-L5	46	7	53
L5-S1	33	5	38
L1-L5	11	2	13
Total	130	27	157

The most common location w.r.t. protrusion & extrusion was L4/L5 & L5/S1 as shown in table 2.

Table 3: Description of various MRI findings in patients

Variable		N=200	%
Osteophytes	Present	198	99
	Absent	2	1
Bulge	Present	179	89.5
	Absent	21	10.5
Disc desiccation	Present	159	79.5
	Absent	41	20.5
Thecal Sac compression	Present	152	76
	Absent	48	24
Lateral recess narrowing	Present	123	61.5
	Absent	77	38.5
Traversing nerve root compression	Present	121	60.5
	Absent	79	39.5
Annular tear	Present	90	45
	Absent	110	55
Schmorl'snode	Present	47	23.5
	Absent	153	76.5
Modic changes	Present	42	21
	Absent	158	79
Neural foramina narrowing	Present	40	20
	Absent	160	80
Ligamentum Flavum Hypertrophy	Present	36	18
	Absent	164	82
Facetal arthropathy	Present	21	10.5
	Absent	179	89.5
Listhesis	Present	7	3.5
	Absent	193	96.5

Osteophytes was present in 99% of the subjects. Bulge was reported in 89.5% of the subjects. Disc desiccation was revealed in 79.5% of the subjects. Thecal sac compression was present in 76% of the subjects.Lateral recess narrowing was shown in 61.5% of the subjects.Traversing nerve roots compression was found in 60.5% of the subjects.Annular tear was reported among 45% of the subjects. Schmorl's node was revealed among 23.5% of the subjects. Modic Changes was present in 21% of the subjects .Neural foramina narrowing was found in 20% of the subjects.Ligamentum flavum hypertrophy was found in 18% of the subjects. Facetal arthropathy was revealed in 10.5% of the subjects.Listhesis was present in 3.5% of the subjects as shown in table 3.

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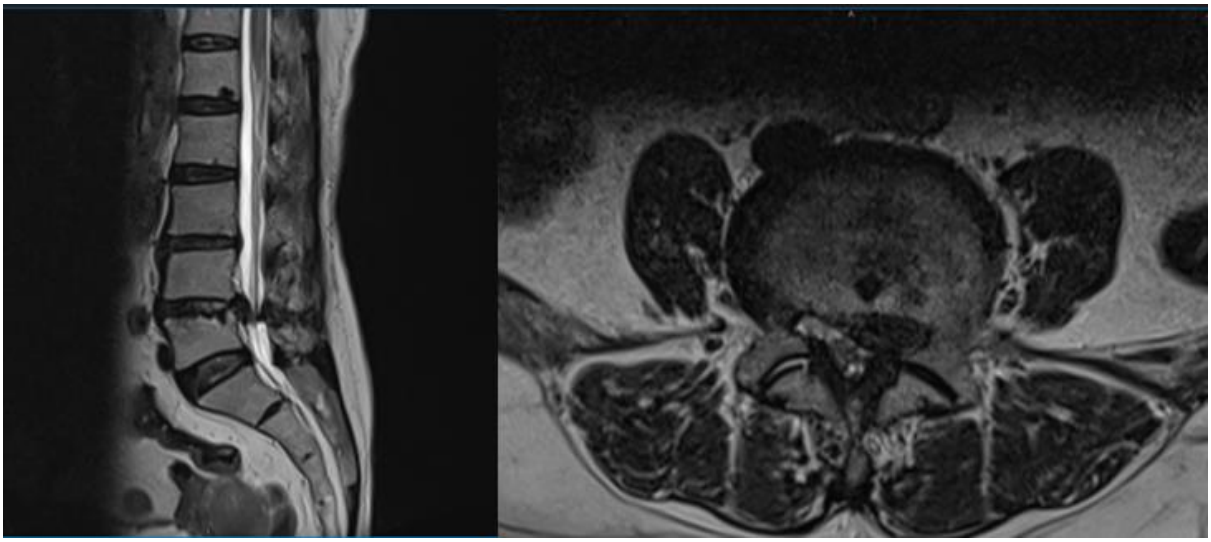

Figure 1: At L4-5, diffuse circumferential bulging with left paracentral and left intraforaminal extrusion and cranial migration of disc

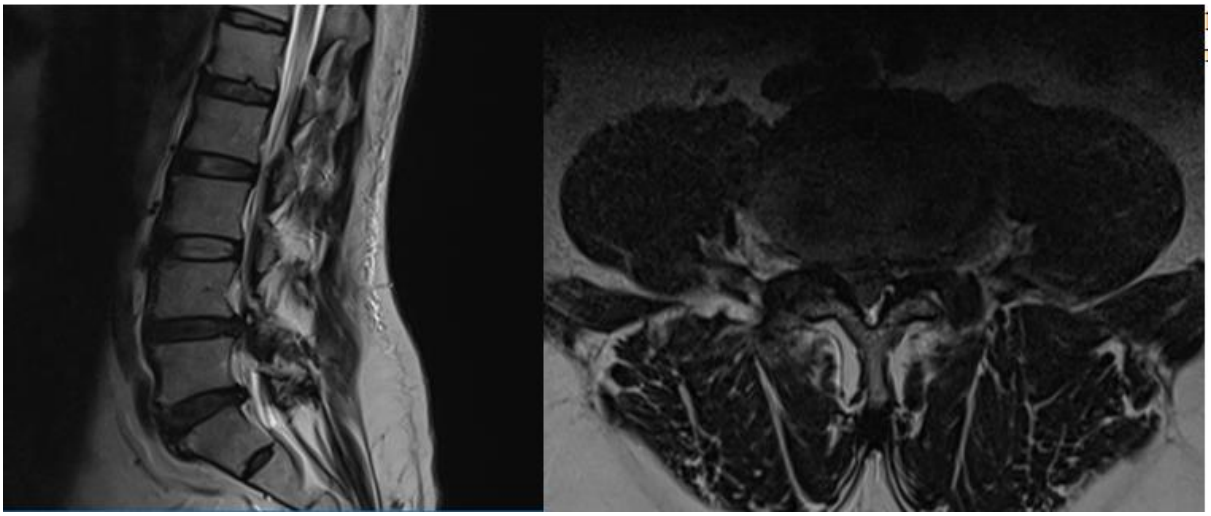

Figure 2: At L4-5, diffuse circumferential bulging with posterocentral protrusion of disc and bilateral lateral recess stenosis with facetal joint arthropathy and ligamentum flavum hypertrophy causes severe compression over thecal sac

DISCUSSION

Delayed spinal cord illness encompasses a broad range of degenerative disorders. Degenerative disc disease can cause low back pain (LBP) in individuals ranging from young to middle-aged. Degenerative disorders are characterized by the reduced integrity of an intervertebral disc & its associated spine structure. The utilization of magnetic resonance imaging (MRI) enables a comprehensive assessment of both static & dynamic elements associated with degenerative spinal illness, hence facilitating the diagnosis of many facets of spine degeneration[14]. The objective of this study was to examine the role of magnetic resonance imaging (MRI) in degenerative spinal disorders & its impact on patient severity.

The present prospective study was conducted among 200 OPD & IPD patients back pain & suspected degenerative disease of the spine for MRI coming to Jaipur National University Institute of National Sciences & Research Centre.

Male & female comprised of 45.5% & 54.5% of the subjects respectively. Hence there was slight female dominancy in the present study. Kuswaha et al[14] in their study too revealed similar gender distribution. The study conducted by Pokhraj Suthar et al found that out of the total number of patients, 60 patients (55.04%) were male & 49 patients (44.95%) were female[15].

The average age of the study participants was 48.37±14.85 years. The largest proportion of participants was within the age range of 51-60 years (28%), followed by 31-40 years (22%), & those above 60 years (20%). According to a study conducted by Jain et al[16], a higher prevalence of disc disease was observed among individuals aged 40-60 years who experienced low back pain. The older age group, on the other hand, had widespread alterations in the

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lower lumbar spine, characterized by an increasing pattern of involvement in the higher lumbar disc. The findings align with those of the current investigation. Kuswaha et al[14] reported an age range spanning from 18 to 80 years, with a mean age of 50 ± 12.5 years. This age range aligns with the findings of the current study.

The study conducted by Pokhraj Suthar et al[15] found that the most prevalent cause of disc degeneration occurred throughout the 4th & 5th decades of life.

The study conducted by Ken Hsu et al. examined the occurrence & causes of high lumbar disc degeneration using MRI. The researchers found that isolated disc pathology was more prevalent among individuals aged 24 to 48 years, with a mean age of 40.7 years. Furthermore, this condition was found to be associated with pre-existing or coexisting abnormalities that increased the susceptibility of the disc to further mechanical stress. Degeneration can be conceptualized as the expedited progression of the typical maturation process that occurs with advancing age. Degeneration of the intervertebral disc initiates as early as 20 years of age & can be detected at an early stage with MRI. Sether& colleagues (year) provided a description of age-related alterations in the MR signal intensity of the disc. The prevalence, pattern, & timing of early degenerative changes in the lumbar spine were investigated by Minna O Erkintalo et al using MRI. The study's findings indicated that degenerative changes occurred swiftly following the teenage growth spurt, & were more prevalent among symptomatic adolescents at an earlier age[17,18].

The study found that the most prevalent interference at the L4-L5 level was 31%, followed by L5-S1 at 27.5%, C1-C7 at 11.5%, & L3-L4 at 9.5%. One subject each reported participation at the C1-D2, D1-D2, D3-D4, D5-D6, D7-D8, D12-S1, D12-L5, & L1-S1 levels of the disc.

The most prevalent degenerative alterations in the spine occur at the L4-5 & L5-S1 levels, perhaps as a result of heightened mechanical stress at the lumbosacral curvature.

In a study conducted by West et al[19], it was observed that the most commonly deteriorated discs were located at L4-5 (31.2%) & L5-S1 (30.6%97). In a study conducted by Li-Peng Yu et al, it was observed that Modic alterations in the vertebral marrow were more commonly observed at L4-5 & L5-S1. This finding aligns with previous reports from other researchers [20]. In their investigation, Ong et al [21] reported comparable levels of engagement at the Disc level.

The occurrence of L4 – L5 disc involvement was observed in a total of 93 cases, accounting for 38.59% of the observed cases. A reduction in the height of the discs was observed throughout 31 levels, with the L5-S1 level exhibiting the highest decrease in disc height, accounting for 32.26% of the total decline, as reported by Pokhraj Suthar et al in their study[15]. The study conducted by Birney et al. demonstrated the utility of MRI in the identification of DDD. The researchers noted a higher prevalence of L4-L5 degeneration in comparison to other levels[22]. The investigation conducted by Kiran L yielded similar findings.

In the present investigation, it was shown that 21% of the individuals exhibited modic changes. The percentage observed in this study is comparable to the 23% reported by Kuisma et al., while it is lower than the prevalence rates of 43% reported by Jensen et al & 28% reported by Kuswaha et al[14]. This study revealed a steady increase in Modic alterations as the spine level decreased, with the most prevalent locations being L4/L5 & L5/S1. The aforementioned observation aligns with prior research conducted by Kuisma et al &Toyoneet al. Modic alterations are linked to lower back pain (LBP), although they can also occur in persons who do not have LBP[14].

Disc herniation viz. protrusion& extrusion was revealed in 65% & 13.5% of the subjects respectively. Hence protrusion was found more commonly as compared to extrusion. Osteophytes was present in 99% of the subjects. Bulge was reported in 89.5% of the subjects. Disc desiccation was revealed in 79.5% of the subjects. Thecal sac compression was present in 76% of the subjects. Lateral recess narrowing was shown in 61.5% of the subjects. Traversing nerve roots compression was found in 60.5% of the subjects. Annular tear was reported among 45% of the subjects. Schmorl's node was revealed among 23.5% of the subjects. Neural foramina narrowing was found in 20% of the subjects. Ligamentum flavum hypertrophy was found in 18% of the subjects. Facetalarthropathy was revealed in 10.5% of the subjects. Listhesis was present in 3.5% of the subjects. The most common location for the entire above mentioned disc contour abnormalities was L4/L5 & L5/S1. Due of the substantial mechanical stress experienced by LS, it is a frequently impacted region that undergoes degenerative alterations. This observation within the study group may be partially attributed to this phenomenon. The average age of this study group is greater than 48 years, which could be an alternative reason. Degenerative alterations are frequently observed in adults over the age of 40, & their prevalence gradually rises to over 90% by the ages of 50-55.

The lumbar degenerative findings were found in 94% of the patients, with disc degeneration (indicating reduced signal intensity) being the most common finding in 83% of cases. This was followed by nerve root compression in 77% of cases, disc herniation in 63% of cases, disc bulge in 39% of cases, & central canal stenosis in 30% of cases. The study conducted by Kuswaha et al[14] found that the least frequent observation was Modic alterations, which were observed in 47 individuals (28%). Protrusion accounted for almost 98% of all herniated discs. Just three (2%) of the discs were extrusions. The majority of the degenerative observations were observed at the

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lower lumbar levels, specifically the L4/L5 & L5/S1 regions, accounting for 42% & 28% of cases, respectively. The occurrence rates of disc degeneration, Modic changes, disc bulge, disc herniation, central canal stenosis, & nerve root compression at L4/L5 were 109 (66%), 22 (13%), 38 (23%), 78 (47%), 41 (25%), & 107 (65%), respectively. Similarly, at L1/L2, the corresponding rates were 24 (14%), 3 (2%), 1 (1), 3 (2%), 1 (1%), & 5 (3%). The findings align with those of the current investigation. Pokhraj Suthar et al[15]observed that at the L4-L5 disc level, there was a high incidence of annular disc rupture, disc herniation, disc extrusion, narrowing of the spinal canal, narrowing of the lateral recess, compression of the neural foramen, thickening of the ligamentum flavum, &facetal arthropathy. This is in accordance with the current investigation.

The existence of degenerative change does not necessarily imply the presence of symptoms, & there is a significant incidence observed in persons who do not exhibit any symptoms. The clinical manifestation of pain in degenerative diseases is multifaceted & seems to arise from a combination of mechanical deformation & the presence of inflammatory mediators. The primary function of imaging is to furnish precise morphological data & exert an impact on the process of therapeutic decision-making.

CONCLUSION

Lumbar disc degenerative disease is the most common condition that results in low back pain that neurosurgeons & radiologists frequently encounter. MRI is the preferred method for assessment of disc degeneration & its sequelae due to its multiplanar capability. In conclusion, we evaluated the common variables associated with intervertebral disc degeneration such as thecal indentation, disc protrusion, annular tears, disc extrusion, spinal canal narrowing, posterior osteophytes, lateral recess narrowing, facetal joint arthropathy, ligamentum flavum hypertrophy, compression of neural foramina& as well as the combined effects of these changes on the spinal canal such as lumbar canal stenosis which were more commonly found at L4-L5 & L5–S1 levels in lumbar disc degeneration. Multidisc involvement followed by contiguous double levels & presence of Modic changes at prolapsed levels were the unique findings in the current study.MRI is the preferred imaging technique for identifying disc pathology because it does not require radiation, has the ability to image many areas simultaneously, provides great contrast between spinal soft tissues, & accurately identifies alterations in intervertebral discs.

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