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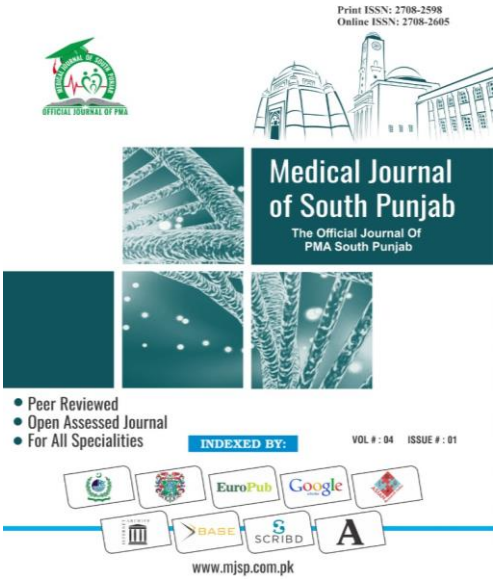

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Original Article

Prevalence and Abnormalities of Intervertebral Disc at Various Levels in Lumbosacral Spine Magnetic Resonance Imaging

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ABSTRACT

Objective: *The find out the prevalence and determine different abnormalities in the intervertebral disc at different levels in the lumbosacral spine using magnetic resonance imaging.*

Methods: *Cross-sectional study. The study was conducted in the Radiology Department of Hayatabad Medical Complex Peshawar, Pakistan for six months from January 2023 to June 2023. Patients with Intervertebral disc abnormalities were scanned using standard protocol sagittal T1WI, T2WI, T2W STIR, T2W myelo, and in axial T1WI and T2WI.*

Results: *The most frequently affected levels were L4-L5 and L5-S1, with single-site engagement being 30.0% and multi-site involvement being 69.9%. Numbness was 69.9%, Tingling 30.0%, herniated nucleus pulposus 30%, Protrusion 23.5%, Extrusion 6%, Posterolateral 2.7%, Posterocentral 26.2%, Foraminal 3.1%, Canal stenosis (mild 42.2%, moderate 63.2%, severe 5.5%, Thecal sac 36.4%, Lateral recess 55.5%, Foramen 20.1%, Multiple locations 8.3%, Diffuse disc bulge 96.4% (most common on L4-S1), Asymmetric disc bulge 2.4% and Modic changes 21.1% (grade-I 4.2%, grade-II 15.5%, grade-III 1.4%).*

Conclusion: *Middle-aged persons are at increased risk, females and older individuals showed higher Intervertebral disc abnormalities, and L4-L5 and L5-S1 are the two most afflicted regions.*

Keywords: Annular tear, Disc Bulge, High-Intensity zone, Lumbosacral spine, Modic Changes

1. INTRODUCTION

Intervertebral discs (IVDs), which connect vertebral bodies to facilitate spinal motion and act like shock absorbers, are referred to as complex fibrocartilaginous tissues. The progression of Intervertebral Disc degeneration with age is shown in over 80%, which also shows degeneration-related alterations in adults older than 50. A well-acknowledged cause of back discomfort is intervertebral disc disorder (IDD)[1]. Although it is generally accepted that intervertebral disc degeneration occurs gradually with aging and clinical signs[2]. IVD degeneration and protrusion are also linked to other serious spinal disorders like degenerative lumbosacral stenosis and cervical spondylomyelopathy[3].

Intervertebral disc disorders (IDDs) are most frequently seen in young and middle-aged populations. Lower back discomfort is a typical complaint among individuals with prolapsed lumbar intervertebral discs which is the primary contributor to worker disability and socioeconomic burden[4]. The fibrous annulus, which has outer and inner portions, the central nucleus pulposus, and the terminal plates make up the three layers that make up the intervertebral disc. A herniation is when the outer fibrous annulus of the disc completely or partially ruptures, causing the disc to bulge. The direction of the bulge can be anterior, posterolateral, or posterior[5]. The nucleus pulposus (NP), a proteoglycan-rich center region, the annulus fibrosus (AF), a fibrocartilaginous peripheral region, and the superior and inferior cartilaginous endplates (CEP) are all used interchangeably[6]. The nucleus pulposus serves as the center of IVD and is encircled by the Annulus Fibrosus. It aids in resisting compressive forces and securing the Nucleus pulposus during compression[7].

According to research by Takatala et al sportsmen frequently experience disc degeneration, disc bulging, radial rips, spondylosis, and abnormalities of the sacroiliac joint. Women were more likely to have high-intensity zone lesions than males were to have disc herniations; disc extrusion was less common in both genders. High-intensity zone lesions are typically identified at L4-L5, and degenerative disc abnormalities

are frequently found at the L5-S1 level[8]. A study in Nigeria has 99% changes on their MRI. Desiccation, disc height loss, and disc herniation are the most frequent MRI abnormalities, occurring in roughly 59% of patients. In addition, 56.25% of patients with MRIs showed disc herniations. Majority of patients showed multilevel abnormalities, primarily at L4/L5 and L5/S1. Affectation at the L5/S1 level is also common[9]. The prevalence in Chinese population indicated that LDD was 40% more common in those under 30 years and increased to nearly 90% between the ages of 50 and 55. Additionally, most frequent MRI characteristics seen in the symptomatic young Arabs were a diminished disc signal followed by disc bulging. In contrast to previous investigations, disc degenerative alterations (dehydration, bulging, and protrusion) were the most prevalent findings, accounting for around (60%) of all findings and predominately affecting the middle-aged population[10]. As compare to older people, IDD can happen to younger people and at a single intervertebral level while disc aging is most commonly present in old age people at all IVD levels[11].

A non-invasive imaging technique called magnetic resonance imaging (MRI) produces images in axial, sagittal, and coronal planes without using ionizing radiation. For the investigation and evaluation of disc degeneration (DD) and intervertebral disc (IVD) pathologies, magnetic resonance imaging (MRI) is the gold standard modality[9]. Besides this, Abnormal MRI findings include annular tears, a high-intensity zone (HIZ), lower disc height, reduced signal intensity, changes in the disc's shape, and endplate alterations are also easily detectable through MRI[12]. The study aims to find out the prevalence and determines different abnormalities in the intervertebral disc at different levels in the lumbosacral spine using magnetic resonance imaging.

2. METHODOLOGY

This cross-sectional study with convenient sampling Technique was conducted in the Department of Radiology at the Hayatabad Medical Complex (HMC), a tertiary care hospital in Peshawar, Pakistan, from January

2023 to June 2023. The study was approved by the Institutional Research and Ethical Review Board (IREB) under the approval no.1443. Sample size was calculated on Open-Epi calculator taking IVD cumulative frequency of 17.8% from research with confidence level 99% and margin of error 1%. Total sample size was 389 patients of either gender between the ages of 20 and 60 who were referred to the Radiology department for a lumbosacral spine MRI and diagnosed with IVD abnormality and who gave consent to participate in the study were included.

Patients without informed consent and those with history of trauma were excluded. Written consent forms were obtained and participants were enlisted at the MRI room reception desk. The degree of physical activity, clinical information, and biodata were recorded. Following 1.5T MRI, the lumbosacral spine was scanned using standard protocol sagittal T1WI, T2WI, T2W STIR, T2W myelo and in axial T1WI and T2WI. At the workstations, the MRI pictures were evaluated. The senior investigator created the appropriate radiological reports under the guidance of two consultant radiologists with extensive training in neuroradiology imaging.

Any arguments were resolved through discussion. After MRI scan, if any abnormality found we gather all the information from the patient about the IVD abnormality, pain, symptoms, and severity. The patient was given all the necessary questions, and their responses were recorded on the questionnaire. Every image had its own set of data, which was frequently verified for consistency, accuracy, and completeness. Any flaws were immediately fixed.

Only complete responses for each participant were sorted, coded, and analyzed using the SPSS version 26. Mean with standard deviation was calculated for quantitative variables. Frequency and percentages were calculated for categorical variables. Significant was defined as a chi-square test with p-value of <0.05. All results were presented in the form of tables and graphs.

3. RESULTS

This study comprised 389 patients where most afflicted disc levels were L4-L5 and L5-S1 and 272 (70.0%) had multi-site disc involvement while 117 (30.0%) had single-site disc involvement. 178 (45.8%) patients were male and 211 (54.2%) were female. Participants ranged in age from 20 to 60 years, with a mean and standard deviation of 41.59 ± 12.42. They were split into four groups: 20-29, 30-39, 40-49, and 50-60. The age groups that were most frequently impacted by intervertebral disc abnormalities were 50 to 60, followed by 30 to 39 and 40 to 49. Ages 20 to 29 were least impacted. The severity of pain in patients was highest in mild 191 (49.1%), followed by moderate 161 (41.4%), and severe 37 (9.5%), Radiated (sciatica) site of pain was more prevalent with 267 (68.6%) than localized 122 (31.4%). the gradual onset of pain 218 (56.0) is greater than the sudden onset of pain 171 (44.0%).

Numbness was the most frequent associated symptom followed by tingling. The occupation with the biggest percentage of affected workers was Housewife, with 161 (41.4%), followed by other occupation 78 (20.1%), Business 74 (19.0%), Labor 45 (11.6%), Teacher 17 (4.4%), and Student 14 (3.6%). There were 195 overweight patients (50.1%), 117 healthy
weight patients (30.1%), 75 obese patients (19.3%), and 2 underweight patients (0.5%).

Only the non-parametric Chi-square test was performed on the data because the Test of Normality indicates that the data is abnormal. After all, it is <0.05. Age and BMI are cross-tested in which 58 (14.9%) of the 389 respondents have an overweight condition, with the majority of them falling between the ages of 30-39 and 50-60. The chi-square non-parametric test is used in the study since the data are nominal and not normally distributed. The Chi-Square analysis findings indicate that Ho is accepted because there isn't a discernible relationship between age and BMI, with the sig value being 0.190 > 0.05. (Table. I).

Herniated Nucleus pulposus was one of several MRI abnormalities at various Intervertebral disc (IVD) levels, in which free fragment was only present on L4-L5 while protrusion and extrusion are

Table-I: Bivariate analysis of socio-demographic factors (age) on BMI

Variable	BMI					Sig.
	Under Weight Range	Healthy Weight Range	Overweight Range	Obese Range	TOTAL	
	Frequency %	Frequency %	Frequency %	Frequency %	Frequency %	
20-29 years	1 (0.3%)	16 (4.1%)	43 (11.1%)	14 3.6%)	**74 (19.0%)**	**0.190**
30-39 years	0 (0%)	26 (6.7%)	58 (14.9%)	16 (%4.1)	**100 (25.7%)**	
40-49 years	0 (0%)	34 (%8.7)	36 (9.3%)	16 (4.1%)	**86 (22.1%)**	
50-60 years	1 (0.3%)	41 (10.5%)	58 (14.9%)	29 (%7.5)	**129 (33.2%)**	
Total	**2 (0.5%)**	**117 (30.1%)**	**195 (%50.1)**	**75 (19.3)**	**389 (100%)**	

BMI: Body Mass Index, F: Frequency, %: Percentage, Sig: Significant

Table-II: Distribution of MRI abnormalities at various Intervertebral disc levels

MRI Abnormalities	Intervertebral Disc Levels				
	L1-L2	L2-L3	L3-L4	L4-L5	L5-S1
HNP	n (%)	n (%)	n (%)	n (%)	n (%)
Protrusion	4 (1.0%)	5 (1.2%)	8 (2.0%)	34 (8.8%)	41 (10.5%)
Extrusion	0 (0%)	1 (0.2%)	3 (1.0%)	8 (2.0%)	11 (2.8%)
Free Fragment	0 (0%)	0 (0%)	0 (0%)	2 (0.5%)	0 (0%)
Location of HNP					
Posterolateral	0 (0%)	0 (0%)	2 (0.5%)	6 (1.5%)	3 (0.7%)
Posterocentral	6 (1.5%)	7 (1.7%)	9 (2.3%)	35 (8.9%)	46 (11.8%)
Foraminal	1 (0.2%)	1 (0.2%)	0 (0%)	3 (0.7%)	7 (2.0)

Extra-Foraminal	0 (0%)	1 (0.2%)	0 (0%)	3 (0.7%)	0 (0%)
Canal Stenosis					
Mild	3 (0.7%)	10 (2.5%)	25 (6.4%)	48 (12.3%)	79 (20.3%)
Moderate	1 (0.2%)	7 (2.0%)	31 (7.9%)	109 (28.0%)	98 (25.1%)
Severe	0 (0%)	1 (0.2%)	1 (0.2%)	9 (2.3%)	11 (2.8%)
Nerve Root Compression					
Thecal Sac	6 (1.5%)	5 (1.2%)	19 (4.8%)	47 (12.0%)	66 (16.9%)
Lateral Recess	1 (0.2%)	5 (1.2%)	32 (8.2%)	95 (24.4%)	84 (21.5%)
Foramen	1 (0.2%)	4 (1.0%)	9 (2.3%)	32 (8.2%)	33 (8.4%)
Multiple Location	0 (0%)	2 (0.5%)	2 (0.5%)	12 (3.0%)	17 (4.3%)
Disc Bulge					
Asymmetric	2 (0.5%)	0 (0%)	1 (0.2%)	3 (0.7%)	4 (1.0%)
Diffuse	8 (2.0%)	9 (2.3%)	44 (11.3%)	147 (37.7%)	168 (43.1%)
Modic Changes					
Grade-I	1 (0.2%)	0 (0%)	1 (0.2%)	4 (1.0%)	11 (2.8%)
Grade-II	0 (0%)	1 (0.2%)	2 (0.5%)	20 (5.1%)	38 (9.7%)
Grade-III	0 (0%)	0 (0%)	1 (0.2%)	4 (1.0%)	1 (0.2%)
Hypertrophy Of Ligaments	1 (0.2%)	1 (0.2%)	9 (2.3%)	38 (9.7%)	30 (7.7%)
Hypertrophy Of Facet Joints	1 (0.2%)	3 (0.7%)	8 (2.0%)	40 (10.2%)	35 (8.9%)
High-Intensity Zone	0 (0%)	3 (0.7%)	20 (5.1%)	55 (14.1%)	37 (9.5%)
Annular Tear	0 (0%)	3 (0.7%)	20 (5.1%)	50 (12.8%)	32 (8.2%)

HNP: Herniated Nucleus Pulposus, n: Frequency, %: Percentage

higher at L5-S1. The overall location of HNP was highest in the posterocentral followed by foraminal, posterolateral (higher at L5-S1), and extra-foraminal. The percentage of Moderate canal stenosis was higher than mild and severe. In nerve root compression, Lateral Recess most frequently occurs at L4-L5 while Thecal Sac, Foramen, and Multiple Location were occurring at L5-S1. Diffuse disc bulge most prevalent at L5-S1. Modic alterations were most frequently at L5-S1. The percentage of ligamentum flavum hypertrophy, facet joint hypertrophy, High-Intensity Zone, and annular tear was highest at L4-L5 level. (Table. II).

Figure-I: T2 Weighted Sagittal and Axial Images at L4-L5 level of a 60Y male showing dehydrated diffuse disc bulge with central disc protrusion causing bilateral exit canal severe stenosis with nerve root compression and a high-intensity zone is seen in the disc posteriorly suggestive of annulus fibrosus tear**.**

Figure-II: T2 Weighted Sagittal and Axial Images at L5-S1 level of a 20Y female patient showing dehydrated diffuse disc bulge causing relative spinal canal stenosis and bilateral exit canals narrowing with nerve root impingement. Facet joint and ligamentum flavum hypertrophy are noted.

4. DISCUSSION

This study focuses abnormalities of IVD such as HNP, location of HNP, canal stenosis, nerve root compression, disc bulging, ligament and facet joint hypertrophy, HIZ, Annular tear, and Modic alterations. According to this study, there were 30.0% single-site impacted patients and 69.9% multiple-site affected. Similar study done in 2012 by Osama Al-Saeed et al. showed that 39% of patients had single-site abnormalities and 61% of patients had multi-site abnormalities[13] but this differed from another study by Nitin Joseph et al. published, 61.5% of patients had participation at a single site, while 34.7% had engagement at several sites[14]. The most impacted intervertebral disc levels were L4-L5 and L5-S1 which was also shown in a study by Singh et al. in (2021) that L4-L5 and L5-S1 have more tendency to be affected[15]. In this study, patients in the 50–60 age range had the highest rate of IVD abnormality, followed by 30-39 and 40–49 age groups, while 20–29 age range had the lowest rate. According to a study conducted by Nitin Joseph et al. revealed that most commonly 46-55 year age group patients had IVD problems[14].

Additionally, the current study demonstrates that there were 54.2% female patients more than male patients 45.6% which was also shown by Lukecha et al. (2022) affected females was greater 52.9% than male 47.1%[8]. According to this study, housewives made up 41.4% of the patients with IVD abnormalities, while other occupations made up 20.1%, business was 19%, labor was 11.6%, teachers made up 4.4%, and students made up 3.6%. This finding demonstrates how severe job loads, especially those that are constant and influence,

most housewives as well as people in other professions like labor, business, teaching, and students (mostly due to false postures during study and sleeping). Another study conducted by Lukecha et al reports that students had IVD abnormalities at the lumbosacral spine at a rate of 15.3% and in professional (officially employed) occupations at a rate of 52.2%[8].

The most prevalent BMI group for patients was overweight, followed by healthy weight, obese and underweight. This is because the majority of people do not exercise to prevent obesity and maintain healthy weight. In the current study, patients reported experiencing 37 (9.5%) severe pain, 191 (49.1%) moderate pain, and 161 (41.4%) mild pain. This differed only slightly from a study by Elmelegy et al in which 42% of participants reported mild, 37% moderate, and 21% severe levels of pain[16]. Localized sites of pain were 31.4%, while radiated sites (sciatica) had the 68.6% which is similar to a study by Elmelegy et al, sciatica accounts for 70% of radiated pain and 30% of localized pain[16]. Another study by Lukecha et al reveals that 61.8% of the pain was radiating (sciatica) and 38.2 % was localized[16]. Gradual onset of pain was increased with almost 56.0% and sudden 44.0% identical to that done by Lukecha et al. (2022), who noted that 55.4% were gradual and 44.6% were sudden[8]. Mostly associated symptoms were numbness 69.9% and tingling 30.1% which was slightly different from a study by Elmelegy et al. in (2018) where 45% of patients reported feeling numb, while 30% reported tingling[16].

In our study, protrusion was 23.5%, extrusion was 6%, posterolateral was 2.7%, Posterocentral 26.2%, foraminal 3.1%, and extra-foraminal 0.7%. which is little different from a study by Elmelegy et al which report that 27% of cases were protrusion and 3.7% were extrusion[16] while Sathish Babu S et al report that protrusion was 29.7%, extrusion was 9.1%, posterolateral was 60.5%, Posterocentral was 23.7%, and foraminal was 15.6%[17]. In terms of canal stenosis, mild 42.2%, moderate 63.2%, and severe 5.5% which contrasts with research by Yousof M et al, where spinal stenosis was over 30.9%[18]. The

thecal sac's nerve root compression was 36.4%, lateral recess 55.5%, foramina 20.1%, and it was 8.3% in several locations whilst Yousof M et al. show that the nerve compression occurs in 47.8%[18]. The majority of patients' disc bulges were diffuse (96.4%) frequently occurred at L5-S1; asymmetric disc bulges were far less common (2.4%). Other researchers Yousof M et al had 81.30%[18], Kanaan et al had 78.5%[10], Elmelegy et al had 68%[16] and E. C. Iyidobi et al. (2018) had 63.3%[9]. Overall Modic alterations in the current study were 21.1% while according to Kanaan et al, Modic changes were 24.1%[10]. Ligament flavum hypertrophy was 20.1%, facet joints hypertrophy 22%, High-Intensity zone 29.4% and annular tear 26.8% are frequently seen on L4-L5. According to a study by Kanaan et al, facet joint hypertrophy was 50%, and ligament flavum hypertrophy was 27.6%[10]. Mark Hancock et al revealed that the High-Intensity Zone (HIZ) was 22% in patients[19] while Wang et al has 23.5%[20].

5. CONCLUSION

This study demonstrates the intervertebral disc abnormalities (IVD) at different levels of the lumbar spine MRI. Males were less impacted than females, and older patients tended to have more IVD abnormalities although middle-aged people were still more susceptible. The most often afflicted sites are L4-L5 and L5-S1, as well as multi-site disorders. Study Limitations: For patients whose investigations required contrast or who had scans with contrast, hence no data were collected from these patients. All of the patients received no follow-up care.

Conflict of Interest and Ethical issues: No conflicts of interest are disclosed by the authors and the study was approved by the Institutional Research and Ethical Review Board (IREB) of Hayatabad Medical Complex (HMC) Peshawar, Pakistan under the approval no.1443.

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