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Original Research Article

An observational MRI study on lower back pain correlating age-associated lumbar spine changes and degenerative pathologies

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ABSTRACT

Background: One of the most prevalent medical complaints is lower back pain, which may vary in severity from moderate to severe. It might develop chronic and persist for many months or even longer, or it can be acute and only last for a few days to a few weeks. Variations in the size of the lumber spinal canal are caused by a variety of factors, including trauma or injury, obesity, arthritis, herniated or bulging discs, sciatica, and muscle or ligament tension.
Methods: A convenient sample of thirty patients, aged 20 to 70, both male and female, were included in this prospective observational study. At the time of the initial examination, a complete history of the individual was obtained, including any reports from prior MRI investigations or any other prior history relevant to the current study.
Results: The research included 30 patients, half of them were male and half of them were female. The majority of patients were between the age of 20 and 40. Degenerative alterations such as disc herniation, nerve root compression, and disc desiccation were the most common causes of lower back pain, leading to changes in spinal canal dimensions, and were shown to be most common in individuals aged 40 to 60 years.
Conclusions: This research aimed to estimate the occurrence of inter-vertebral disc problems in different age groups, analysing the relationship between degenerative changes in the lumbar spine and changes in the spinal cord due to age.

Keywords: MRI, Disc herniation, Nerve root compression

INTRODUCTION

Lower Back Pain (LBP) commonly referred as lumbar pain or lumbago, is a common medical problem involving spine and back muscles. Mainly characterized as discomfort or a sort of pain in lower spine. More specific to be between the thoracic cage and the pelvic region. LBP ranges from mild to severe including acute short term; 0-6 weeks, sub-acute 6-12 weeks and chronic long term; >12weeks based on the duration of disease. As per reports the LBP is prevalent for lifetime to be 70-85%.[1,2] Lower back pain can result from various factors/activities, including muscle strain, injury, poor posture, or underlying medical conditions, and it can significantly impact a person's daily life and mobility. Primarily acute lower back pain is the most common problem faced by the people.[3]

Acute back pain if associated with neurologic symptoms may indicate a serious underlying condition affecting the nerves in the spine. Neurologic symptoms may include: firstly, radiating pain: the pain traveling down the leg, often following a specific nerve pathway. This can be indicative of nerve compression or irritation. Secondly, numbness or tingling: sensations of numbness, tingling,

or "pins and needles" in the lower back, buttocks, or legs, which includes nerve involvement. Thirdly, muscle weakness: weakness in specific muscle groups, particularly the one's connected to affected nerves. This results in difficulty in walking or performing daily activities. Lastly, loss of reflexes: reduced or absent reflexes in the affected area may indicate nerve dysfunction.[4]

These neurologic symptoms often point's out conditions like herniated discs, spinal stenosis, or nerve compression due to injury or inflammation. When acute back pain is accompanied by neurologic symptoms, it's crucial to seek urgent medical evaluation and treatment to address the underlying cause and prevent potential complications.[5]

The most commonly used imaging modalities for diagnosing and treating the cause of lower back pain include: X-rays are often the initial imaging choice for lower back pain. They detect issues like fractures, dislocations, and degenerative changes in the spine. X-rays use ionizing radiation, so best suited for detecting structural abnormalities.[6] Computed tomography (CT) scans provide detailed cross-sectional images of the spine and are helpful in assessing bone and joint abnormalities, spinal fractures, and more complex conditions. CT scans are specifically useful when more detailed images are needed after an initial X-ray.[7] Magnetic resonance imaging (MRI is highly effective for visualizing soft tissues, such as spinal discs, nerves, muscles, and ligaments. It's particularly valuable for diagnosing conditions like herniated discs, spinal stenosis, and nerve compression. MRI does not use ionizing radiation.[8] Ultrasound, less commonly used for lower back pain, ultrasound can be useful for assessing soft tissue structures and guiding certain diagnostic and therapeutic procedures, such as injections etc.[9] Bone Scans: Bone scans can detect areas of increased bone activity, which may indicate conditions like infections, tumors, or fractures that might not be apparent on X-ray.[10] Fluoroscopy technique is often used during certain minimally invasive procedures, such as epidural steroid injections or discography, to guide the placement of needles or catheters.[11]

The selection of imaging modality depends on the known cause of lower back pain and the information needed for an accurate diagnosis. It's essential for healthcare professionals to consider factors like radiation exposure, cost, and the specific clinical situation when determining which imaging test to use.

Magnetic resonance imaging MRI is commonly used to evaluate back pain for several key reasons: soft tissue visualization: MRI excels to study soft tissues in the body, making it easy for assessing the structures in and around the spine. This includes spinal discs, nerves, muscles, ligaments, and blood vessels. Many causes of back pain, such as herniated discs, spinal stenosis, and nerve compression, involve soft tissue abnormalities that can be detected and evaluated with MRI.[12] Multi-planar imaging provides images in multiple planes sagittal, axial, and coronal, allowing healthcare personal to examine the spine from various angles. This type of comprehensive view helps to identify the exact location and extent of abnormalities and aiding in accurate diagnosis.[13] Non-Invasiveness: MRI is a technique that does not use ionizing radiation, unlike X-rays or CT scans. This makes it safer for repeated use and minimizes radiation exposure concerns.[14] High resolution: modern MRI machines offer's high-resolution images, enabling healthcare providers to detect even small abnormalities and do precise diagnoses.[15] Distinguishing between tissues: MRI can distinguish between different types of soft tissues based on their water content and molecular composition. This helps identifying conditions like inflammation, tumors, or infections, which may contribute to back pain.[16] Functional Information: Functional MRI and other specialized MRI techniques provide information about blood flow and neural activity in the spine and surrounding areas. This can be valuable for diagnosing certain conditions like vascular issues or spinal cord disorders.[17] Safety and versatility: MRI is a safe and versatile imaging method suitable for a wide range of patients, including one's with allergies to contrast agents used in other imaging techniques.[18]

Due to its ability to show detailed, non-invasive, multi-dimensional images of the spine and its surrounding structures, MRI is often the imaging modality of choice when evaluating the cause of back pain, especially when soft tissue abnormalities are suspected. It allows healthcare providers to make accurate diagnoses and develop proper treatment plans for patients with back pain.[19,20]

METHODS

This present study utilized prospective observational data from a multi-specialty hospital in the department of radiology during a time period of six months between October 2020 to March 2021. This study has been approved from the department of RIT SGT university Gurugram. The study included convenient sample of 30 patients referred to the radiology department for lumbosacral spine MRI, both male and female aged between 20 to 70 years with complaint of non- traumatic lower back pain were included. Patients with recent surgical history, ferromagnetic implants, uncooperative cases, congenital spinal dysraphism were excluded from the study.

Radiological examination and clinical evaluation

The current study involves all the referred patients for lumber spine MRI examinations on 1.5T MRI scanner (Philips multiva). Lumbar spine of all the patients (L1-L2 to L5-S1) were examined to evaluate degenerative diseases of spine by using T2W axial, sagittal images (TR/TE-2700/85, matrix size-180*211, slice thickness – 4

mm, NEX-1) in order to access and diagnose degenerative diseases of the spine such as disc herniation, compression, fractures, central canal stenosis, infection, ankylosing spondylitis, metastases etc. the medial sagittal plane was used to measure anterior posterior AP diameter of the spinal canal at the disc level from the discs posterior boundary to the bony spinal canals posterior boundary end. The left and right lateral canals cross sectional regions, the dural sacs transverse diameter and its AP diameter have been measured. The radiologist assisted all the images at an electronic PACS work station.

Statical analysis

In this study, used excel and SPSS version 21.0 for data analysis

RESULTS

In this prospective observational study total 30 patients were included, out of which 15 were male and 15 were female, the patients were divided into different age groups 20-40, 40-60 and above 60 years of age. The average age of patient were 40.1 years the spinal canal AP diameter was measured from L1 to S1 level in all the 30 patients from the posterior margin of disc to the posterior end of bony spinal canal in mid-sagittal plane. The average spinal canal diameter ranges from 9.35mm to 10.46mm. The average diameter of spinal canal after measuring in AP diameter were different at various levels. The average diameter of spinal canal was highest at L1-L2 level (10.46 mm) and lowest at L4-L5 level (8.36 mm). The average canal diameter at various levels from L1 to S1 are shown below in graph and Table 1.

Table 1: The average spinal canal ap diameter at each level from L1 to S1.

Variables L	Mean ± SD	Min	Max
Age	40.1 ± 11.04(years)	24	68
L1-L2	10.46 ± 1.91(mm)	6.27	13.6
L2-L3	10.13 ± 2.27(mm)	3.33	13.6
L3-L4	9.31 ± 1.86(mm)	4.83	11.9
L4-L5	8.36 ± 2.66(mm)	3.53	13.2
L5-S1	9.35 ± 2.33(mm)	1	13.6

An analysis of degenerative diseases in different age groups

The thirty students were divided into three age groups: those under forty, those between forty and sixty, and those over sixty as shown in pie chart. The degenerative changes in spinal canal were different in various age groups. Degenerative changes such as Disc Herniation, Nerve root compression and Disc desiccation was found highest in age group 20-40 years and Facet hypertrophy, Ligamentum flavum hypertrophy, altered signal spinal cord, cord compression was found highest in age group 40-60. However, the 60-age group showed the least amount of all the degenerative alterations. Age groups 20 to 40 have the target Dural sac diameters in the spinal canal, while age groups above 60 years (avg.17.3mm) and the Transverse diameter of spinal canal was same in age groups 20-40 and 40-60 (avg. 12.46mm) and lowest in age group above 60 years (avg.11.03). Table 2 and Figure 2 present the prevalence of disease among challenging age groups.

Table 2: Distribution of degenerative diseases in various age groups.

Age group	Disc herniation	Facet hypertrophy	Ligamentum Flavum hypertrophy	Altered Signal spinal cord	Nerve root compression	Cord compression	Dural sac diameter	Transverse diameter	Disc dessication
20-40	7	1	1	0	11	4	17.48	12.46	14
40-60	6	4	4	2	10	5	17.47	12.46	9
Above 60	1	3	3	0	3	2	17.3	11.03	3

Table 3: Canal diameter distribution across age groups.

Age group	L1-L2 (mm)	L2-L3 (mm)	L3-L4 (mm)	L4-L5 (mm)	L5-S1 (mm)
20-40	10.72	10.4	9.6	9.26	9.61
40-60	10.45	10.52	9.33	7.25	9.24
Above 60	8.82	7.25	7.45	6.27	8.07

To compare spinal canal diameter in various age groups

The thirty patients in this prospective observational study were divided into three age groups: those under 40, those between 40 and 60 and those over 60 in which the average age of patient is 40.1 yrs. The AP diameter of spinal canal dimension varies in different age group. The spinal canal diameter was highest in age group 20-40 at

L1-L2 level (avg. 10.72mm) and lowest at above 60 years of age at L4-L5 level (avg.6.27mm). The average canal diameter at different age groups are shown below in tabular data 3 Figure 3.

Age and spinal canal diameter co relation at different level of the spine

A total thirty patients were divided into three age groups for this prospective observational study: (20 to 40, 40 to 60 and over 60). As shown in table 4 correlation of spinal canal diameter with age at various levels of the spine was done. The spinal canal diameter changes at L1-L2, L2-L3 level but most of the changes seen in the spinal levels L4 to L5 and L5 to S1. Spinal stenosis may result from a change in the diameter of the spine that cause it to become narrower and cord compression. In the below table the correlation 1 in age group indicates that there is a positive correlation of age with changes in spinal diameter. The correlation between age with spinal canal diameter at various level of the spine is significant with P value in tabular data that is less than or equal to 0.05.

Table 4: Age and spinal canal diameter correlation at different level of the spine.

Correlations							
		Age	**L1-L2**	**L2-L3**	**L3-L4**	**L4-L5**	**L5-S1**
Age	Pearson Correlation-value	1	-0.158	-0.28	-0.246	-.362*	-0.1
	P value		0.405	0.134	0.19	0.049	0.6
L1-L2	Pearson Correlation-value	-0.158	1	.856**	.704**	0.277	0.284
	P value	0.405		0.001	0.001	0.138	0.128
L2-L3	Pearson Correlation-value	-0.28	.856**	1	.863**	.496**	.422*
	P value	0.134	0.001		0.001	0.005	0.02
L3-L4	Pearson Correlation-value	-0.246	.704**	.863**	1	.703**	.637**
	P value	0.19	0.001	0.001		0.001	0.001
L4-L5	Pearson Correlation-value	-.362*	0.277	.496**	.703**	1	.654**
	P value	0.049	0.138	0.005	0.001		0.001
L5-S1	Pearson Correlation-value	-0.1	0.284	.422*	.637**	.654**	1
	P value	0.6	0.128	0.02	0.001	0.001	

*At the 0.05 level of significance, co relation is significant. **At the 0.01 level of significance, co relation is significant.

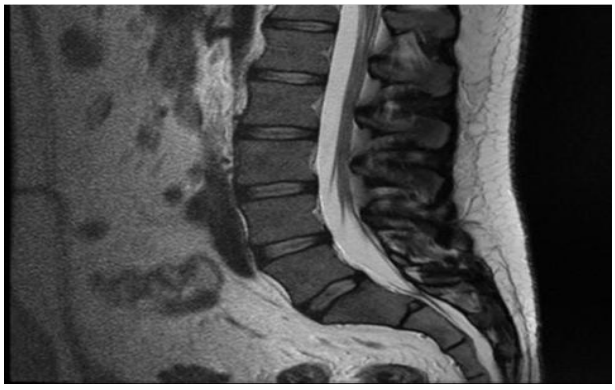

Figure 1: Comparison of cord compression and spinal canal stenosis in various age group.

Figure 2: Sagittal view shows normal lumbar spine without cord compression and disc herniation.

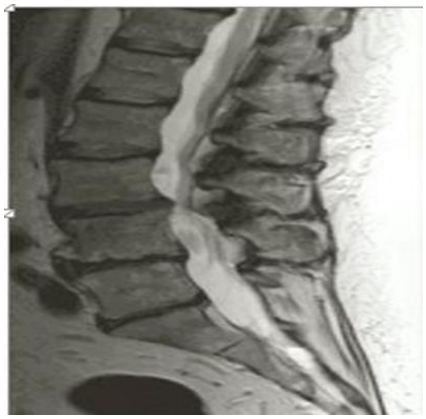

Figure 3: Sagittal view shows disc herniation at level of spinal cord L4 to L5 and L5 to S1.

The relationship between spinal canal stenosis and cord compressions at various age groups.

The spinal canal AP diameter was measured from L1 to S1 level in all the 30 patients from the posterior margin of disc to the posterior end of bony spinal canal in mid-sagittal plane. The spinal canal diameter was different in various groups of ages are 20 to 40, 40 to 60 and more than 60 age group. The spinal canal dimension becomes narrower mostly at L4 to L5 of the spine, the and spinal stenosis develops as a result of the canal narrowing. A disorder called spinal stenosis causes the spinal canal to narrow and compress the spinal cord. As shown in the picture 4 spinal canal dimension become narrower at L4-L5 level of the spine in the age group above 60 years (average 6.27 mm). Up to 95% of the people have degenerative changes in their spine by the age 50 and adults over 60 are most likely to develop spinal stenosis.

DISCUSSION

In this study, the correlation between the age, lumber spinal canal dimensions and existence of degenerative changes in patient with LBP was observed across different age groups. The results highlight on age related changes in lumber spinal canal dimensions; the AP diameter was measured from L1-S1 9.35mm to 10.46mm) and the average diameter of spinal canal was highest at L1 to L2 10.46 mm whereas lowest at L4 to L5 8.36 level. Additionally degenerative changes in patients of age group (20-40years) were higher occurrence of disk herniation, disk dissection and nerve root compression moreover the patient in the age group of 40-60 years displayed conditions like Facet Hypertrophy, Ligamentum Flavum Hypertrophy, altered signal spinal cord. In addition to this, patient above 60 years exhibited a lower occurrence of above degenerative changes. The spinal canal diameter varied with age, the most significant changes observed at L4-L5 and L5-S1 level. The correlation indicates that there is a positive correlation of age with changes in spinal diameter. The narrowing of the spinal canal, was observed particularly in older patients at the level of L4-L5 as the diameter of the spine changes and become narrower this can lead the cause of spinal stenosis and cord compression. Understanding the structural changes in lumber spine is vital for early detection, particularly in patients who were more probably susceptible to degenerative diseases.

Shrinuvasan et al conducted a study on assessment of low back pain at a rural hospital in Southern India utilizing a low field open MRI scanner. The 235 patients in the research revealed that disc herniation, vertebral collapse, infections, and neoplasms were the most frequent causes of back pain. A number of pathological abnormalities associated with low back pain, such as disc degeneration, disc herniation, lumbar canal stenosis, spondylosis, spondylolisthesis, and infective spondylodiscitis, have been reported to be detectable by MRI. This is a thorough investigation on the use of MRI to determine the origins of low back pain. It focuses about the fact that MRI is helpful in identifying a variety of disorders, including disc degeneration, spinal injuries, infections, neoplastic illnesses, and other unspecified reasons. The study reveals substantial fresh data about the incidence of low back pain in the Indian population as well as the diagnostic utility of MRI for a variety of low back pain-related disorders. The results of this study may have a big impact on how low back pain is diagnosed and treated, especially in rural healthcare facilities where access to modern imaging methods may be scarce 1.

According to the study conducted by Ogbole GI et al the most common reason for an MRI was low back discomfort, and the most common result was a degenerative condition of the spine. Author also addresses how MRI affects patient care in Nigeria, stressing the importance of MRI as a diagnostic tool while recognizing its challenges to access that result from high prices and a shortage of MRI facilities. The study points out the potential advantages of increasing access to revolutionary MRI technology in resource-constrained contexts and provides insight into the clinical value of MRI in Nigeria, specifically in detecting diseases linked to low back pain.[21]

The study conducted by Savage RA et al provides valuable findings, how well magnetic resonance imaging (MRI) can be used to diagnose low back pain (LBP) and looked at how different occupational groups' MRI appearances varied from one another. 149 working males from five different professions who had lumbar spine MRIs were included in the research. The results indicated that MRI appearances varied with age, with disc degeneration appearing more frequently in older people. But there was no apparent relationship between LBP and the MRI's appearance. The most common abnormality, more common in older patients, was disc degeneration; over half of the subjects had normal lumbar spines. Furthermore, no statistically significant variation in the frequency of disc degeneration was seen amongst the various occupational categories in the research. It was also noticed that elderly people had higher rates of disc

protrusion and nerve root compression. According to the research, working conditions may have an impact on the likelihood of getting low back pain (LBP), and lumbar spine MRI appearances might not always line up with LBP. The study also found that MRI is not an excellent pre-employment screening method for determining who is at risk of LBP.[22]

Limitation

A limited or non-representative sample (e.g., by age, gender, occupation, lifestyle) can affect the generalizability of the results. Without follow-up, the study can't assess the progression of degenerative changes over time. Pain perception is subjective and may not accurately reflect the degree of pathology visible on MRI. Factors like physical activity, body mass index (BMI), occupational stress, or comorbidities may influence both pain and degenerative changes but may not be fully controlled in the study.

CONCLUSION

There is lack of awareness and inadequate knowledge The presence of degenerative diseases and age-related changes in the lumbar spine are significantly correlated, according to an observational MRI study on lower back pain. The results show that as people age, structural changes such disc degeneration, disc bulging, facet joint arthropathy, and spinal canal stenosis become more prevalent and are frequently linked to symptoms of persistent lower back pain. People over 40 were more likely to have these degenerative alterations, highlighting age as a significant risk factor.

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