

EVALUATE THE FREQUENCY OF LUMBAR DISC HERNIATION THROUGH MAGNETIC RESONANCE IMAGING, A STUDY BASED ON SPECIFIC AGE GROUPS AND ANALYZE ASSOCIATED SYMPTOMS

Amna Bibi^{*1}, Musa Raza², Syeda Shajeeha Tanveer³, Komal Batool⁴,
Muhammad Danish Azeem⁵, Iqra Saeed⁶

^{*1}Lecturer Radiology RIT Zohra Institute of health Sciences Rawalpindi

²Medical Imaging Technologist. TMCH & IDC Bs RIT GCUF and Fellowship in ISO International in QMS and Internal Audit from Ripha International.

³BS RIT Center of Advance Studies in Health and Technology (CASHT)

⁴ Lecturer Radiology RIT Gilgit Baltistan institute of science and technology

⁴ Lecturer Radiology Health Services Academy Islamabad

⁶Imaging Technologist Radiology Tamar Medical and cardiac hospital Rawalpindi

^{*1}amnabibi2803@gmail.com, ²musarazamalik41@gmail.com, ³sshajeeha@gmail.com,
⁴baigarika5@gmail.com, ⁵danishazeem776@gmail.com, ⁶iqrasaeed20031@gmail.com

Corresponding Author: *

Amna Bibi

DOI: <https://doi.org/10.5281/zenodo.23615691>

Received 30 January 2026	Accepted 15 March 2026	Published 31 March 2026
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ABSTRACT

Background:

This study aims to evaluate the frequency of lumbar disc herniation in different age groups using MRI findings and to analyze the common clinical symptoms presented by affected individuals. The goal is to establish a clearer link between age-related disc pathology and patient-reported symptoms, thereby aiding in better clinical decision-making and patient education.

Introduction:

This research explores that lumbar disc herniation (LDH) is one of the most common causes of chronic low back pain (LBP) and sciatica, as well as the basis of spinal disorders. The main imaging technique and diagnostic tool for evaluating disc herniation is magnetic resonance imaging (MRI).

Materials and Methods:

Data collection for this research was conducted at Modern Diagnostic Center and Capital Development Hospital Islamabad. The collected data pertained to eligible patients, meeting predefined inclusion and exclusion criteria. The dataset comprised demographic details, medical history, and clinical information, integral for the comprehensive execution and evaluation of our society.

Results:

In our study of 105 patients, 50 were female and 55 were male. We found 86 cases of lumbar disc herniation in which 39 had disc bulge, 31 had disc protrusion, and 16 had disc extrusion. Additionally, experiencing backache, radiating leg pain and numbness as well.

Conclusion:

In conclusion, our research has identified that lumbar disc herniation primarily affects the L4–L5 and L5–S1 levels and seems to be most common in middle-aged people, with a slightly higher incidence in men. Acute low back pain, leg pain, and numbness are typical symptoms that closely match imaging results. These trends demonstrate the degenerative character of disc disease and the value of MRI in early identification and focused treatment.

Keywords:

CHAPTER 1 INTRODUCTION Background

The most common cause of sciatica and constant low back pain (LBP), the root cause of spinal conditions, as well as the primary reason behind of disability in the general population is lumbar disc herniation (LDH). LDH primarily targets middle-aged and senior citizen who perform manual labor or sit for extended period of time. But, as a result of increased employment pressure in last few years, the age at which LDH first appears is declining (1), which has a significant effect on society. A positive straight leg raising test, numbness in the dermatomes distribution, and leg pain which emits to the feet and toes, either unilaterally or bilaterally are all signs of sciatica. Sciatic pain becomes worse through standing, walking, bending, straining, and coughing (2).

Weakness, claudication, pain relief when bending forward, and sensory problems in the legs are additional signs of lumbar disc degeneration. Growing age, socioeconomic status, smoking, obesity, heavy lifting, vibration, trauma, immobilization, psychosocial factors, gender, height, genetic and hereditary factors, and occupations such as office workers, carpenters, and machine drivers are risk factors for lumbar disc degenerative disease (3).

Magnetic resonance imaging (MRI) is the primary screening tool and imaging technique used to assess disc herniation. Magnetic resonance imaging (MRI) is useful screening tool, and a precise diagnosis of lumbar disc herniation is essential for effective treatment. MRI is a harmless imaging method utilizing a strong magnetic field and electromagnetic radio waves to produce finely comprehensive images of the body. When a lumbar disc herniation occurs, MRI can help create incredibly detailed pictures of the spine and the damaged disc (4).

To identify lumbar disc herniation, health care PR actioners look for certain MRI scan such as disc protrusion, disc extrusion, and nerve root compression. Still, MRI remains the gold standard for diagnosing lumbar disc herniation, and its use has greatly improved patient outcomes(5).

Our study aims to evaluate the frequency of lumbar disc herniation in different age groups using MRI findings and to analyze the common clinical symptoms presented by affected individuals. The goal is to establish a clearer link between age-related disc pathology and patient-reported symptoms, boosting clinical decision-making in the process and patient education.

Overview of Lumbar Disc Herniation

A spinal herniated disc, which happens when the nucleus pulposus leaves the intervertebral space, causes back pain. In addition to feeling burning or tingling, pain can radiate to the lower limbs and be accompanied by muscle weakness and sensory abnormalities. The disc protects the spine from harm by acting within the vertebral bodies as a supportive layer. Sometimes a disc pressing on a nerve or spinal cord can cause discomfort.

While herniated discs can result in discomfort, there are limited effective conservative treatment choices. While refractory patients might require surgical intervention or procedures, the majority of cases resolve with conservative treatment. When a patient experiences a herniated disc, the medical professional must monitor for any significant neurological issues that require immediate referral for neurosurgical intervention (6).

When the nucleus pulposus protrudes through the annulus fibrosus, a tough collagenous ring encircling the nucleus pulposus, it leads to disc herniation. With aging, a degenerative process deteriorates the nucleus pulposus, which is the primary cause for increasing symptoms.

Congenital abnormalities, connective tissue disorders, and injuries can all result in disc herniation. Due to biomechanical forces, it is more common in the lumbar and cervical regions, while being less prevalent in the thoracic area (7). Localized inflammation and mechanical pressure from the protruding nucleus pulposus cause herniated discs. The nerve root becomes compressed in posterior lateral herniations due to the annulus fibrosus being thinner and offering reduced structural support. Large midline disc herniations can lead to clinical myelopathy and spinal cord compression. The localized back pain arises from the chemical irritation caused by inflammation and the pressure from the disc on the longitudinal ligament. Adults with a 2:1 ratio of males to females aged between 3 to 5 years are susceptible to herniated discs (8).

Disc herniation may lead to discomfort, tingling sensations, loss of sensation, reduced feeling, weakness, and lack of stability. Herniated discs in the lower back can lead to deficits which is limited to a particular myotome in terms of motor ability and sensation. A neurological examination can help identify the extent of compression and assess sensory loss, weakness, pain sites, and reflex loss linked to different levels (9).

Non-surgical treatments, including non-steroidal anti-inflammatory drugs (NSAIDs) and physical therapy, are the primary approach for managing acute cervical and lumbar radiculopathies resulting from a herniated disc. These are effective for managing debilitating pain, but those who are neurologically compromised or who fail to respond to conservative treatment need immediate surgical evaluation. Limited evidence exists to back the use of oral corticosteroids or muscle relaxants like cyclobenzaprine; rather, opioid analgesics are advised for intense pain that remains unresolved with nonprescription pain medications. Second-line therapies for patients with symptoms lasting four to six weeks who do not improve with conservative treatment involve transaminar epidural injections and selective nerve root blocks (10).

The final choice for addressing herniated discs is surgery, encompassing discectomies, laminectomies, artificial disc replacements,

anterior cervical decompression and fusion, along with additional lumbar spine interventions. The advantages are small and typically diminish with time. Total discectomy and fusion are alternatives. Surgical procedures usually provide temporary advantages. Herniated discs are associated with a number of conditions, including synovial cyst, osteophytes, neurinoma, diabetic amyotrophy, metastasis, hematoma, epidural abscess, mechanical back pain, degenerative spinal stenosis, and discal cyst. Epidural steroid injections or radiofrequency ablation techniques may be employed to treat exacerbating myelopathic symptoms (11).

The World Health Organization (WHO) reports that sciatica and low back pain are the primary symptoms of LDH, which is highly prevalent and causes disability in both developed and developing nations. Approximately 85% of LDH patients have sciatica, and approximately two thirds of adults have low back pain (12). The average prevalence and incidence of LDH worldwide are 14% to 20% and 2% to 4%, respectively. It primarily affects adults between the ages of 30 and 50 and occurs at L4~5 and L5~S1, with a higher frequency of males than females (13).

Definition of Lumbar Disc Herniation

A clear definition of lumbar disc herniation must be established before discussing the epidemiology and pathophysiology of a herniated lumbar disc. While disc bulge, disc protrusion, and disc herniation are commonly used interchangeably in literature, the joint task forces of the American Society of Spine Physicians, of Spine Radiology, and the American Society of Neuroradiology assert that these conditions are distinct; they characterize a disc herniation as “localized or focal displacement of disc material beyond the confines of the intervertebral disc space.” This distinction is crucial because it makes it clear that a disc bulge, or diffuse annular expansion that extends outside the disc space, is a form of disc degeneration rather than a disc herniation. A true herniated disc affects less than 25% of the intervertebral disc and is a localized condition. There are three types of herniated discs: sequestrations, extrusions, and

protrusions (Fig. 1). Protrusions are broad-based herniations in which the diameter of the herniation at the base is greater than the diameter of the herniation inside the canal. Sequestrations

are herniations in which there is no continuity between the herniation and the surrounding intervertebral disc, whereas extrusions have a slim base and a large herniation inside the canal.

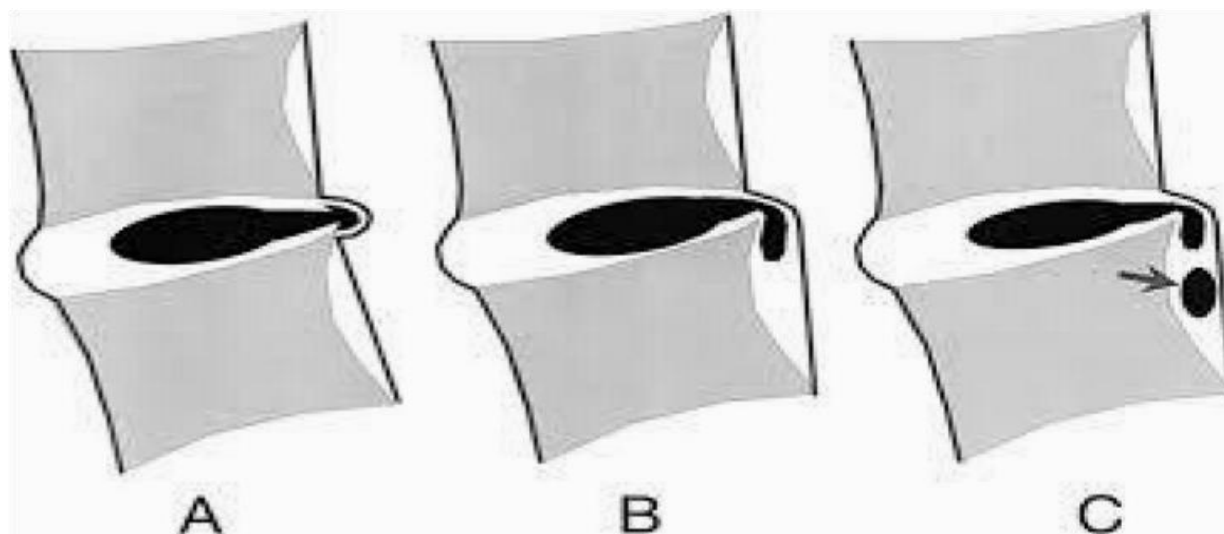


Figure 1: Schematic picture representing a protrusion (A), an extrusion (B), and a sequestration (C)(14)

Prevalence of Lumbar Disc Herniations

Numerous potential risk factors have been identified through extensive research on the spread of lumbar disc herniations. The mean age of people with disc herniation was 41 years old, and the situation was slightly more common in men than in women (57% versus 43%, respectively), according to a study conducted by Cummins et al. with patients who were enrolled in the intervertebral disc portion of the Spine Patient Outcomes Research Trial (SPORT) (15). Because of the increased axial load on the lumbar spine, a high body mass index (BMI) is thought to be a risk factor for lumbar disc herniation. In a Finnish study, Bostman discovered that although obesity was only 16% of the general Finnish population at the time, 27% of patients having surgery for lumbar disc herniation were obese. According to a recent metaanalysis, people who are overweight (BMI: 25–30) or obese (BMI > 30) are statistically significantly more likely to be diagnosed with lumbar radiculopathy than people whose BMI is less than 25.12 (16).

Moreover, after a microdiscectomy, obesity is associated with a higher risk of recurrent disc herniations. According to Meredith et al., people

who are obese (BMI >30) are 30 times more likely to need repeat surgery and have a 12-fold higher chance of recurrent herniation than people who are not obese. Sakellaridis analyzed a series of 102 patients needing surgical treatment for lumbar disc herniation against 98 patients having elective surgery for different reasons and discovered a statistically significant rise in diabetes prevalence among those having lumbar microdiscectomy (32% compared to 19%, $p = 0.001$) (17).

Furthermore, according to Mobbs et al.14, patients with diabetes required repeat surgery seven times more frequently than patients without the disease. Longo et al.15 discovered in a case-control study that people with lumbar disc herniation had higher plasma levels of total cholesterol and triglycerides. Lastly, smoking was identified as independent contributing factors for lumbar disc herniations in a recent meta-analysis of 49 studies. The manner in which lumbar disc herniations are more common due to these comorbidities (18).

Anatomy of Lumbar Spine

The lower end of the spinal column between the first sacral vertebra (S1) and the last thoracic

vertebra (T12) is known as the lumbar spine. Five robust and movable vertebrae (L1-L5) that permit the dispersion of axial forces protect the spinal cord in this area. At the level of the L1 and L2 vertebrae, the spinal cord ends in the conus medullaris after passing through the middle of the vertebral column. The bundle of spinal nerve roots known as the cauda equina, or horse's tail in Latin, starts at the end of the spinal cord and descends through the rest of the canal. Bone, cartilage, ligaments, nerves, and muscle make up the lumbar spine (19).

Lumbar Vertebra

There are various parts that make up each lumbar vertebra. These consist of the dorsal structures known as the posterior elements and the vertebral body. Two pedicles that connect to the laminae are located directly dorsal to the vertebral body. The pedicles transfer forces from the posterior elements to the vertebral body and resist motion. The spinous process extends posteriorly from where the two laminae meet. Two transverse processes and four articular processes are located at the intersection of the pedicles and laminae. The transverse processes extend laterally, serving as attachment points for ligaments and musculature. The superior and inferior articular processes create the zygapophyseal joints (the facet joints). This joint occurs between the superior articular process of a vertebra and the inferior articular process of the vertebra immediately cephalad. These joints lie in the sagittal plane and participate in flexion and extension of the lumbar spine. The pars interarticularis is the location of the lamina between the superior and inferior articular processes and is prone to the development of stress fractures (spondylolysis) in the growing spine (20).

Physiology

The lumbar spine serves three primary purposes. First, the upper body is supported by the lumbar spine. Because they are larger than other parts of the vertebral column, the lumbar vertebrae (L1-L5) can absorb axial forces from the head, neck, and trunk. The spinal cord and spinal nerves are shielded by the canal formed by the lumbar

vertebrae. Information can flow from the central nervous system to the lower extremities and vice versa thanks to this configuration. Numerous truncal motions, such as flexion, extension, rotation, and side bending, are made possible by the lumbar spine. The lumbar lordosis, or concave curvature of the lumbar spine, is visible from a lateral view (21).

Blood Supply

Three major longitudinal arteries provide a rich blood supply to the spinal cord. The anterior two-thirds of the cord are supplied by a single anterior spinal artery. The posterior third of the cord is supplied by two posterior spinal arteries on the dorsal side. The vertebral column receives collateral blood supply from a number of anterior and posterior radicular arteries. The ventral and dorsal nerve roots receive blood flow from these radicular arteries. The largest radiculomedullary artery, the artery of Adamkiewicz, supplies blood to the lumbar spinal cord. branching from a posterior intercostal or radicular artery, the artery's origin varies from T8 to L2. Usually located to the left of the spinal cord, it climbs the spinal canal, forms a hairpin loop, and then joins the anterior spinal artery. Specific to the lumbar spine, four pairs of lumbar arteries originate from the abdominal aorta. These paired arteries travel posteriorly along the vertebral bodies to supply each vertebra. These arteries also supply blood to the adjacent musculature, such as the transversus abdominis and internal oblique (22).

Intervertebral Disc

Anatomy: The Normal Disc

The vertebral bodies are connected by intervertebral discs situated between them (Figure 2). These discs constitute approximately one-third of the spinal column's height and serve as its primary joints. Because they continuously transfer loads from muscle contraction and body weight through the spinal column, their primary function is mechanical. They provide flexibility by allowing torsion, flexion, and lateral bending. In the lumbar region, the intervertebral discs measure approximately 4 cm in diameter (anterior-posterior plane) and are 7 to 10 mm thick (23).

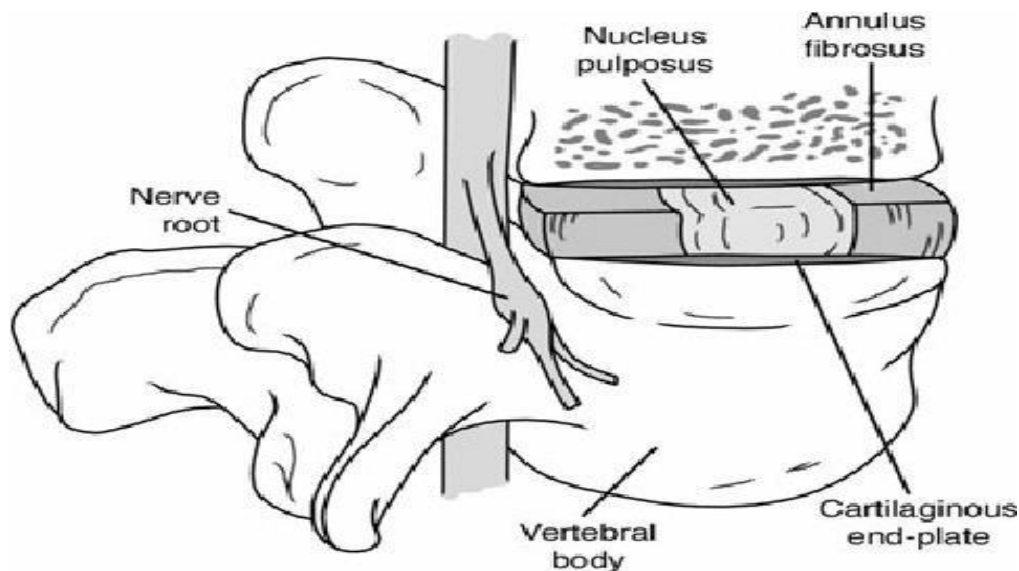


Figure 2: A line illustration depicting a spinal segment consisting of two vertebral bodies with a normal intervertebral disc between them (24)

The intervertebral discs are intricate structures made up of a more gelatinous core called the nucleus pulposus, this is surrounded by a thick outer ring of fibrous cartilage known as the annulus fibrosus. The nucleus pulposus is enclosed superiorly and inferiorly by cartilage endplates (25).

Structure of the Nucleus Pulposus

Collagen fibers, which are randomly arranged, and elastin fibers, which can occasionally reach a length of 150 mm, are found in the central nucleus pulposus. These fibers are embedded in a highly hydrated gel rich in aggrecan. Chondrocyte-like cells, occasionally residing within capsules in the matrix, are sparsely distributed at a density of approximately 5,000 cells per mm³. Surrounding the nucleus pulposus is the annulus fibrosus, with a clearly defined boundary between these two regions in young individuals (26).

Structure of the Annulus

This structure consists of 15–25 concentric rings, or lamellae, with collagen fibers aligned parallel within each ring. In adjacent lamellae, the fibers are oriented at approximately 60° angles to the vertical axis, alternating directions between left

and right. Between the lamellae are elastin fibers, which may aid in the disc's ability to reorganize after bending, regardless of flexion or extension movements, elastin fibers radiate outward from each lamella to the next, they might also hold the lamellae together (25).

The annulus's cells, especially those in the outer part, they are often thin, elongated, and run parallel to the collagen fibers. The cells may adopt a more oval shape within the inner annulus. Disc cells can exhibit multiple long thin cytoplasmic projections, up to 30 mm long, in both the annulus and nucleus.

Articular cartilage cells do not exhibit these characteristics. Although their exact role in the disc is unknown, it has been hypothesized that they could serve as sensors and messengers due to mechanical stress within the tissue (27).

The Structure of the Endplate

The cartilage endplate, which is thin horizontal layer of hyaline cartilage that is typically less than 1 mm thick, is the third morphologically distinct region. This connects the vertebral body and disc. It contains collagen fibers that extend into the disc and run horizontally and parallel to the vertebral bodies (25).

Nerve Supply of the Disc

In a healthy adult intervertebral disc, blood vessels are scarce or absent, although some nerves—primarily located in the outer lamellae—are present, including endings in proprioceptors (28). Similar to other hyaline cartilages, the cartilaginous endplate is generally completely avascular and aneural in healthy adults. The spinal artery branches into vessels supplying the longitudinal ligaments adjacent to the disc and the cartilage endplates in individuals younger than 12 months (29).

It has been shown that the disc contains nerves, which frequently accompany these vessels but can also exist on their own as branches of the sin vertebral nerve or because of the ventral rami or gray rami communicants. The meningeal branch of the spinal nerve, called as the recurrent sinovertebral nerve, originates near the disc space. This nerve exits from the dorsal root ganglion and enters the foramen, when it splits into a lesser descending branch and a major ascending branch. Studies on animals have demonstrated that additional afferent contributions to the sinovertebral nerve originate from several superior and inferior dorsal root ganglia through the rami communicantes. Furthermore, branches originating in the dorsal root ganglion also provide afferent innervation to the anterior longitudinal ligament. Nociceptive fibers from the ascending branch of the sinovertebral nerve provide abundant innervation to the posterior longitudinal ligament (PLL). The surrounding outer layers of the annulus fibrosis are also innervated by these nerves. Schwann cells, also known as glial support cells, coexist with some disc nerves (30).

Pathophysiology of Lumbar Disc Herniations

As people get older, the intervertebral disc goes through a normal process of degeneration that can make the discs more likely to be damaged. These changes happen in the first few years of life. By the time the child is three, there are a lot fewer capillaries going from the endplate to the AF. The cells in the NP have changed shape and density, and small gaps have formed in the AF. Many studies have tried to describe each stage of the

intervertebral disc's degeneration as people get older. However, the changes to the AF may be especially important in the formation of intervertebral disc herniations (31).

The quantity and extent of annular clefts increase with patient age, as do fibroblast-like cell clustering and apoptosis. The evident distinction between AF and NP gradually disappears beginning in adolescence. Importantly, disc herniations may be avoided by maintaining the integrity of the AF's outer layer, which remains unaffected until advanced age. Histological analysis of operative specimens has demonstrated that a pure herniation of the nucleus pulposus (NP) is uncommon, despite the common perception that a herniated disc represents extrusion of the NP through the annulus fibrosus (AF). Approximately 20% of all herniations involve a portion of the cartilaginous endplate, and in two-thirds of cases, the herniated material includes part of the annulus fibrosus (32).

Most often, lumbar disc herniations commonly occur in the posterolateral region, impacting the traversing nerve root. The nerve root may become irritated chemically or mechanically, causing discomfort. In addition, the herniation initiates a significant inflammatory cascade crucial for disc resorption; however, this response can also lead to chemical irritation of the nerve root, causing radicular symptoms. Additionally, mechanical compression may deform and stretch the nerve while compromising its microcirculation, resulting in ischemia and further radicular symptoms (33).

Key inflammatory mediators and molecules involved include Tumor Necrosis Factor-alpha (TNF- α), Interleukin-1 (IL-1), Fibroblast Growth Factor (FGF), Intracellular Adhesion Molecule-1 (ICAM-1), Lymphocyte Function-Associated Antigen (LFA), MidKine (MK), Monocyte Chemotactic Proteins 3 and 4 (MCP-3, MCP-4), RANTES, and interferon gamma-Induced Protein 10 (IP-10) have all been found to be elevated following a lumbar disc herniation. Only a small number of cytokines have been thoroughly studied in relation to radicular symptoms and intervertebral disc resorption. Human lumbar disc herniation surgical specimens have higher levels of FGF, a cytokine

that strongly draws macrophages to the site of injury. Furthermore, the amount of FGF is considerably higher in larger herniations, like extrusions and sequestrations, than in smaller protrusions. It has been demonstrated that an increase in FGF concentration in a rabbit model is advantageous since, it causes disc resorption to increase. MK has also been demonstrated to enhance herniated disc resorption in a similar model, and it is also elevated in herniated disc tissue (34).

The inflammatory cascade contributes to the clinical features of a herniated disc, but it is also advantageous because it causes the herniated discs to resorb. Up to 80% of surgically removed disc herniations contain nerve tissue, despite the fact that intact intervertebral discs have little innervation. Furthermore, lumbar disc herniations have a much higher concentration of TNF alpha (TNF- α) and it has been repeatedly demonstrated to cause radiculitis, even in the presence of intact intervertebral discs (35).

Igarashi et al. showed in a rat study that when TNF alpha is applied exogenously to nerve roots of the lumbar spine, the rats exhibit modifications in behavior resembling a lumbar herniated disc. In addition, microscopic alterations in the nerve root, including endoneurial space edema, myelin alterations, and ultimately Wallerian degeneration of parts of the nerve, were noted. Likewise, Genevay et al. reported that patients with herniated lumbar discs and radiculopathy exhibited elevated levels of TNF-alpha in their epidural fat compared to those undergoing lumbar spine surgery without radicular symptoms (36).

Etiologic Factors Related to Lumbar IVD Degeneration

In the past, it was previously believed that the primary risk factors for the development of lumbar degenerative Disc Disease (DD) were environmental variables, including smoking, occupations involving heavy manual labor, and vibration exposure (37).

Recent research by Batie and Videman, along with other investigators 6,105 has provided compelling evidence that while environmental factors contribute to the incidence and

progression of degenerative Disc Disease (DD), genetic factors are the strongest predictors. These genetic influences affect the size and shape of spinal structures as well as the composition and degradation of Intervertebral Disc (IVD) components. In a large cohort of identical twins, Videman and Batie compared lumbar MRI findings with lifestyle variables and reported a heritability estimate of 74% (38).

It's interesting to note that people who had a family history of herniated lumbar discs were 4-5 times more likely to have been identified with the condition prior to the age of 21(39). The fact that DD is most common in people who also have osteoarthritis in their hands and feet supports the idea that genetics plays a big role in the cause of DD.

Another possible explanation is that cells are programmed to behave in strange ways, like apoptosis (programmed cell death). For instance, recent research has demonstrated that these specific cellular abnormalities are present not only in degenerative intervertebral discs (IVDs) but also in discs associated with scoliosis and spondylolisthesis. Furthermore, smoking and a history of heavy physical loading have not been identified as significant contributing factors to degenerative disc disease (DD). In fact, competitive weight lifters have less degeneration than expected when there is no trauma (40).

Age-Related Degenerative Changes in the IVD

It is widely acknowledged that DD is caused by a variety of aging-related events, but that the decline in the IVD's nutritional capacity is a major contributing factor(41).

Several interconnected mechanisms work together to achieve this. Tissue fluid exchange between the intervertebral disc (IVD) and the vertebral body vasculature is reduced due to decreased endplate permeability and impaired metabolic transport, both of which are associated with a diminished concentration of proteoglycan molecules within the IVD matrix (42).

The nucleus shrinks and decompresses as a result of this gradual loss of hydration, though it frequently keeps its hydrostatic characteristics. More crosslinks are produced between these collagen fibrils as a result of the denser, in the

nucleus type I collagen takes the place of the comparatively thin type II collagen. This makes the disc's fibrous environment denser, which is believed to further prevent tissue-fluid exchange(43).

Increased cross-linking forms a barrier that diminishes the rate of collagen and proteoglycan turnover and repair, changing IVD homeostasis and causing the retention of damaged macromolecules. However, the proteoglycans that are still present in the disc may still be able to function (44).

It is crucial to stress that these changes, which are mostly harmless and happen with age, don't cause a big drop in disc height. The "dark disc" is a common T2-weighted MRI finding. It is marked by a decrease in signal intensity from the nuclear region and the formation of nuclear clefts. It's important to remember that the changes that happen to the structure of the IVD as people get older are resemble to those that happen to articular cartilage and don't always cause pain (45).

Risk Factors

The majority of people with LDH are mid-life adult and senior citizen who pass considerable time in sitting or doing manual labor. But, the age of initial LDH has decreased due to increased job pressure in recent years, which has a significant impact on society (1).

Risk factors for lumbar disc degenerative disease include advancing age, low socioeconomic status, smoking, obesity, repetitive heavy lifting, exposure to vibration, prior trauma, prolonged immobilization, psychosocial stressors, sex, stature, genetic predisposition, and certain occupations such as machine operators, carpenters, and office workers. It has been determined that smoking, diabetes, and hyperlipidemia are additional medical comorbidities that may be contributing factors for lumbar disc herniations (3).

Clinical features

The key clinical features of LDH include Weakness involving the myotomal distribution of one or more lumbosacral nerve roots, along with sensory disturbances and radicular pain. Focal

paresis, reduced trunk flexion, and increased leg pain during coughing, sneezing, and straining are also suggestive (46).

Patients typically experience more pain because sitting is known to increase disc pressure by about 40%. The dermatome is affected by the kind and extent of herniation. While far lateral herniations affect the exiting nerve root, paracentral herniations affect the transversing nerve root. For example, at the L4-L5 level, a paracentral herniation cause L5 radiculopathy, whereas a far-lateral herniation at the same level would produce L4 radiculopathy. Pain that improves with sitting is more characteristic of Lumbar Spinal Stenosis (LSS), as forward flexion increases intradiscal pressure by 100-400% and is likely to exacerbate pain in cases of isolated LDH (47).

According to recent research by Rainville et al., who correlated the symptoms of LDH with Lumbar spinal stenosis, patients with LSS are more likely to present with a higher incidence of medical comorbidities, lower disability and leg pain scores, abnormal Achilles tendon reflexes, and pain predominantly localized to the posterior aspect of the knee (48).

Imaging Modalities

Magnetic Resonance Imaging

The most accurate approach for imaging to confirm possible LDH is magnetic resonance imaging (MRI), which demonstrates inter-observer agreement and 97% diagnostic accuracy (49). MRI findings of a higher appearance on T2-weighted signal from the rear. A disc herniation is strongly suggested by 10% of the disc diameter (50).

This procedure is not recommended for all LDH patients, though in view of the considerable resource consumption required for this testing process.

Neurologic motor impairments and CES are conditions under which MRI may be considered in early (less than 6 weeks). Diffusion tensor imaging (DTI) is one MRI technique which is capable of identifying microstructural alterations in the nerve roots of patients with LDH. Wu et al. investigated these alterations and compared them to the duration of sciatica symptoms and

Oswestry Disability Index (ODI) disability scores (51).

Two microstructural metrics— specifically, decreased fractional anisotropy, which indicates reduced water movement within the tissue and elevated apparent diffusion coefficient, which indicates Reduced microstructural integrity of the nerve root was associated with both the Oswestry Disability Index (ODI) score and the duration of symptoms. This implies that DTI could help us better grasp the changes in nerve roots caused by compression in LDH and to differentiate between individuals who need surgical and nonsurgical management approach (52).

Computed Tomography

Although computed tomography (CT) was once believed on clinical grounds less effective than magnetic resonance imaging (MRI) in detecting LDH, developments such as multidetector CT (MDCT) have improved CT's diagnostic benchmark to almost match that of MRI. For confirming suspected LDH, the NASS Evidence-Based Guideline Development Committee suggests CT myelography as a good substitute for MRI (53). CT myelography is preferred over MRI for a number of reasons, such as situations in which MRI is impractical or unavailable (such as cardiac pacemakers or auditory prosthesis) or in which patients would experience extreme discomfort (such as fear of enclosed spaces or unmanageable lower back pain). Nevertheless, due to the procedure invasive characteristics, a CT myelogram needs the assistance of a professional radiologist and is associated with potential risks such as post-dural puncture headache (most frequent), exposure to ionizing radiation, meningitis(52).

Radiographs

A plain radiograph is the primary imaging modality used to alleviate the pain in lower back. Radiographs should only be taken 6–12 weeks later for the treating primary care physician if there is no neurologic compromise. Because radiographs only give a stationary understanding of the spine, technologists recommend obtaining flexion and extension sequences in extension to anteroposterior (AP) and lateral images to

determine the function of instability in the patient's sign. In this modality, findings indicative of LDH include compensative scoliosis, a small intervertebral distance, and the existence of traction osteophytes (52).

LITERATURE REVIEW

Takatalo et al. (2011) assessed lumbar disc degeneration in 18–25-year-olds using a retrospective MRI-based analysis and found that early indications of disc degeneration and herniation were already present in over 40% of asymptomatic people. This research casts doubt on the conventional wisdom that LDH mostly affects middle-aged people and highlights the need for younger groups to adopt preventative measures (52).

A study by Zhong et al. (2021) examines MRI data from more than 1000 individuals to determine on age-related patterns of LDH. According to their research, LDH prevalence increased steadily from the second decade of life, peaked in the fifth decade, and then started to diminish declined as people age. The decline in older patients may be attributed to decreased disc hydration and reduced flexibility, limiting disc extrusion potential (54).

A study by Brinjikji et al. (2015), disc herniations are more common in symptomatic patients, they are also occur in a significant proportion of asymptomatic individuals. According to their meta-analysis, disc degeneration was seen on MRI in about 30% of people in their 30s and up to 84% of people in their 80s, highlighting the need for clinical correlation to prevent over diagnosis and needless intervention(55).

A study by Park et al. in 2018 examined the relationship between lumbar disc herniation, age group, and symptom presentation in over 700 patients. They found that younger patients (<40 years) commonly presented with acute symptoms such as radiculopathy, while older patients (>60 years) often reported chronic back pain, neurogenic claudication, and concurrent spinal stenosis. This study supported the hypothesis that age influences both anatomical and symptomatic presentation of LDH (56).

A study of Teraguchi et al. (2014) on a Japanese population revealed a strong association between

BMI, physical workload, and disc herniation on MRI. The study concluded that both environmental and genetic factors play key roles in the development of disc pathology and that MRI findings must be contextualized within age-related changes and patient history (57).

A study by Francesco Capra et al. in Italy in 2011, According to their results, the straight leg raise (SLR) test demonstrates limited effectiveness in diagnosing lumbar herniated discs at the L4/5 and L5/S1 levels compared to magnetic resonance imaging (MRI). Within our group of patients, the SLR test's capacity to differentiate between impacted and unaffected discs decreases with advancing patient age. Consequently, the test result might be less conclusive when dealing with older patients (58).

A study by Zhiwei Chen et al. in 2024, the high prevalence of LDH in Gansu states varied considerably by nationality, gender, and latitude, suggesting possible demographic and lifestyle influences in Gansu. LDH is one of the common causes of chronic LBP, a chronic pain condition that significantly reduces patients' quality of life and has a long recovery period and limited curative effect. Patients with lumbar spine disorders face significant stress and financial strain, as their medical costs rank fifth among all hospitalized diseases, and the costs of absenteeism and disability resulting from these conditions are higher than those of other illnesses. Large-scale epidemiologic studies on the prevalence of LDH in Gansu are lacking because of the region's distinct geographic features and dietary practices, as well as the fact that the prevalence of LDH and its contributing factors differ among various ethnic groups and geographical areas. In Gansu, the prevalence of LDH was 22.77% (59).

A study by Ranjan Kumar et al. in 2021 in Patna, India, revealed a notable incidence of nerve root compression in both males and females. Disc herniation was frequently observed in individuals aged 19-21, while nerve root compression became more common in those aged 22-24. These findings also highlighted a nerve root compression tended to affect the L2/3, L3/4, L4/5 and L5/S1 segments to greater extent (60).

In 2007, Lal Rehman et al. carried out an analytical study in the Neurosurgery department

of the Pakistan Institute of Medical Sciences (PIMS), Islamabad, between May 1, 2002, and March 1, 2003. Fifty patients with prolapsed intervertebral discs were chosen for this study. MRI results were correlated with the clinical degree of disc herniation. Eighteen patients (36%) had bilateral sciatica, while 29 patients (58%) had right sciatica. Forty-seven (94%) of the patients had positive results from the straight leg raising test. Two (4%) patients had L3-4 disc herniation, and 48 (96%) cases had prolapsed intervertebral discs (PIVD) at the L4-L5 and L5-S1 levels on MRI. Twelve patients experienced central disc herniation, and thirty-eight patients experienced posterolateral disc herniation. At L4-L5 level, the sensitivity, specificity, positive predictive value and negative predictive value of all clinical features was 92%, 96%, 95.8% and 88.46% respectively (5).

A study by Mok F.P et al. in 2016, Chinese study found that modic changes were relatively common in the lumbar spine among southern Chinese individuals, affecting about 5.8% of the population studied. These changes were predominantly observed in the lower lumbar levels. However, when comparing the occurrence of modic changes between the upper and lower lumbar regions, significant differences were noted in the factors that influence their presence and their clinical applications (61).

In 2023, an Indian study by Hussain M. et al. examined the use of convolution neural networks (CNNs) and deep learning (DL) in MRI-based disc disorder diagnosis. DL provides doctors with highly accurate and reasonably priced diagnostic assistance. For better decision-making, the study underlined the necessity of improving CNN's generalizability, data standardization, and clinical application. The study assessed performance metrics and projected future developments in this area, emphasizing its importance for researchers studying MRI, radiology, and image processing.(62).

A study by Jun Zhang et al. in 2022 from China states that there is a limited understanding of the risk factors for lumbar disc herniation (LDH) in younger people, even though the evidence suggests that LDH is more prevalent in this population. This study aimed to comprehensively

analyze the risk factors for LDH in adolescents and young adults. BMI of more than 30, genetic history, sitting posture, daily sitting time of more than 6 h, and a history of low back trauma are the high-risk factors for adolescents and young adults with LDH. Therefore, providing them with the proper guidance and education, particularly about the protection of the lower back and the reduction of spinal load, could play a key role in preventing and reducing LDH(63).

A study by Ghulam Mustafa Waedak et al. in 2018, rationale of the study was to learn more about the underlying causes of lumbar disc herniation in young adults because doing so would enable the clinician to obtain pertinent medical history, conduct a directed physical examination, and order the right imaging tests. This will help achieve a positive result and start early intervention, whether it be conservative or operative. Their research revealed that the primary underlying cause of lumbar disc herniation in young adults was mechanical load, which includes trauma, RTA, long-distance driving, and weightlifting. (4).

Awadalla et al. (2023) address the assessment and treatment of lumbar disc herniation and the function of the medical team in assessing and enhancing patient care. Conservative treatment is the first line of treatment, and pain is often managed with anti-inflammatory drugs and paracetamol. In some circumstances, the use of opioid analgesics requires chemist supervision. Even though surgery is occasionally the last resort, patients usually experience lasting pain and neurological damage. When physical therapy isn't working, MRI interpretation is required. Since back pain is often associated with mental health problems, it should be treated by primary care physicians or mental health specialists. Maintaining a healthy body weight and engaging in regular exercise can improve results (64).

MATERIAL AND METHODOLOGY

Study Design

Data is collected through retrospective study.

Sample Size

The sample of 105 patients was calculated by using a software 'Raosoft Statiistical Software.

Study Setting

Patients were enrolled from Modern Diagnostic Center.

Study Duration

Study duration was three months (April 2025 – June 2025).

Sampling Technique

Non-probable purposive.

Modality Magnetic Resonance Imaging

0.3 Tesla Hitachi MRI scanner.

Patient Preparation

Before the examination, ask the patient to remove all metal object including keys, coins, wallet, any cards with magnetic strips, jewelry, hearing aid and hairpins. Moreover, they asked the patient to off their dress and put on a hospital gown. Contrast injection risk and benefits must be informed to the patient before the scan. The patient should only get gadolinium if their GFR is greater than 30.If at all possible, assign a chaperone for claustrophobic patients (e.g. relative or staff). Explain the procedure to the patient. Also advice the patient to remain motionless. Note the weight of the patient.

Scan Protocol

The lumbar spine MRI scan usually consists of several sequences: sagittal T1-weighted images are used to assess the anatomical structure and bone marrow, while sagittal T2-weighted images highlight disc pathology and spinal canal issues; other sagittal STIR or fat-suppressed T2 sequences are useful for detecting inflammation or edema; axial T2-weighted images are acquired at each disc level to assess the nerve roots, intervertebral discs, and neural foramina; in certain cases, axial T1-weighted images may be added, particularly when contrast is used.

Procedure

After being brought to the MRI room, the patient is placed on the MRI table supine, or on their back. To increase comfort and lessen the tension on the lumbar spine, a cushion or pad is positioned beneath the knees. Usually at the L3

vertebral level, the technologist positions the patient's lumbar spine in the middle of the scanner. To improve image quality, a body coil or spine coil is positioned around the lumbar area. Because of the MRI machine's tremendous noise, the patient is advised to stay still during the scan and may be provided with ear protection. Sometimes there is a phone button to connect with the technologist. The scan then begins, capturing a series of image sequences in sagittal and axial planes, including T1, T2, and STIR (if needed).

Inclusion criteria

- Include individual aged 20-60 years.
- Both genders.
- Patients with symptoms such as back pain, leg pain and numbness.
- Patients with no other serious systemic diseases like stroke, serious infection, or psychosis. Patients referred for MRI due to suspected lumbar disc herniation (LDH).

Exclusion criteria

- Patients with a history of lumbar surgery or trauma.
- Patients with incomplete investigation data.
- Patients with congenital spine disorders and tumors.
- Patients with lumbar spinal stenosis or lumbar spondylolisthesis caused by factors such as hypertrophy of ligamentum flavum.

Ethical approval

This research was conducted after the approval of Hospital Internal Review Board (IRB).

Data analysis

Data was analyzed through SPSS (Statistical Package for Social Sciences) Version 26.0.1.0.

RESULTS

- Age
- Gender
- Symptoms
- MRI finding

Demographic details

Pie graph showing frequency of gender

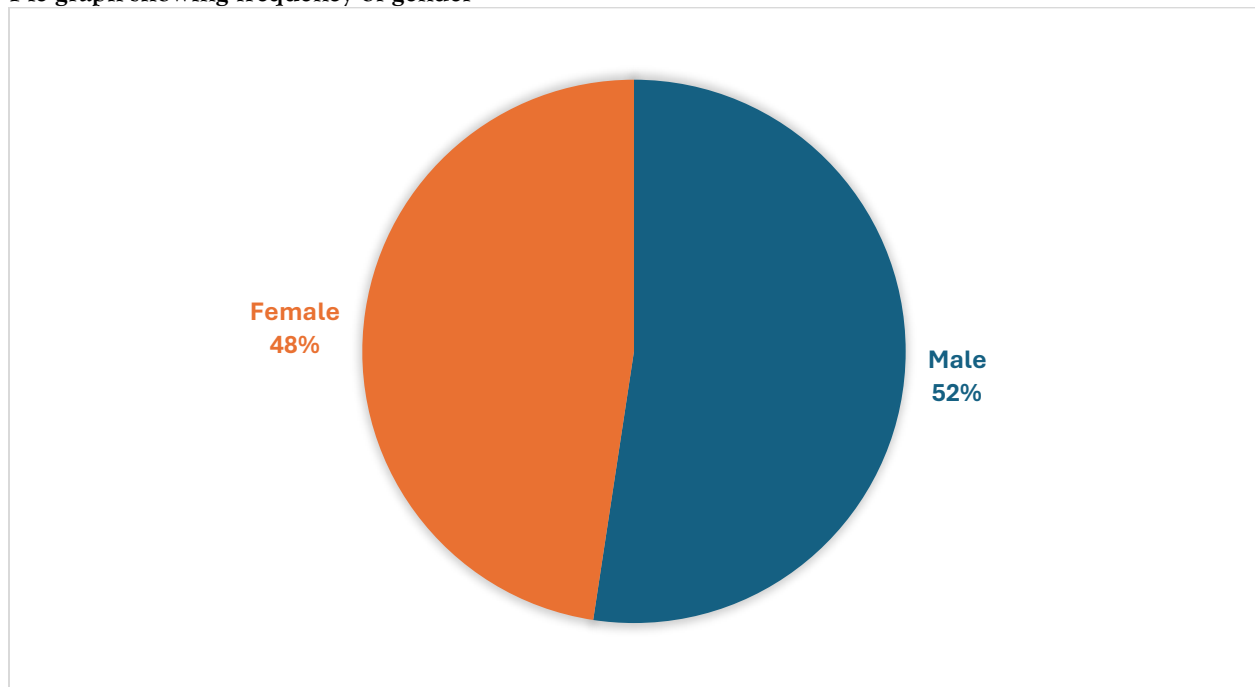


Figure 3: Shows the frequency of male and female patients in population

Figure 3 display the gender distribution within a sample of 105 individuals. Among the total, males constitute the larger segment accounting

for 52% of the group, while females make up the remaining 48%.

Bar graph showing incidence of lumbar disc herniation among age groups

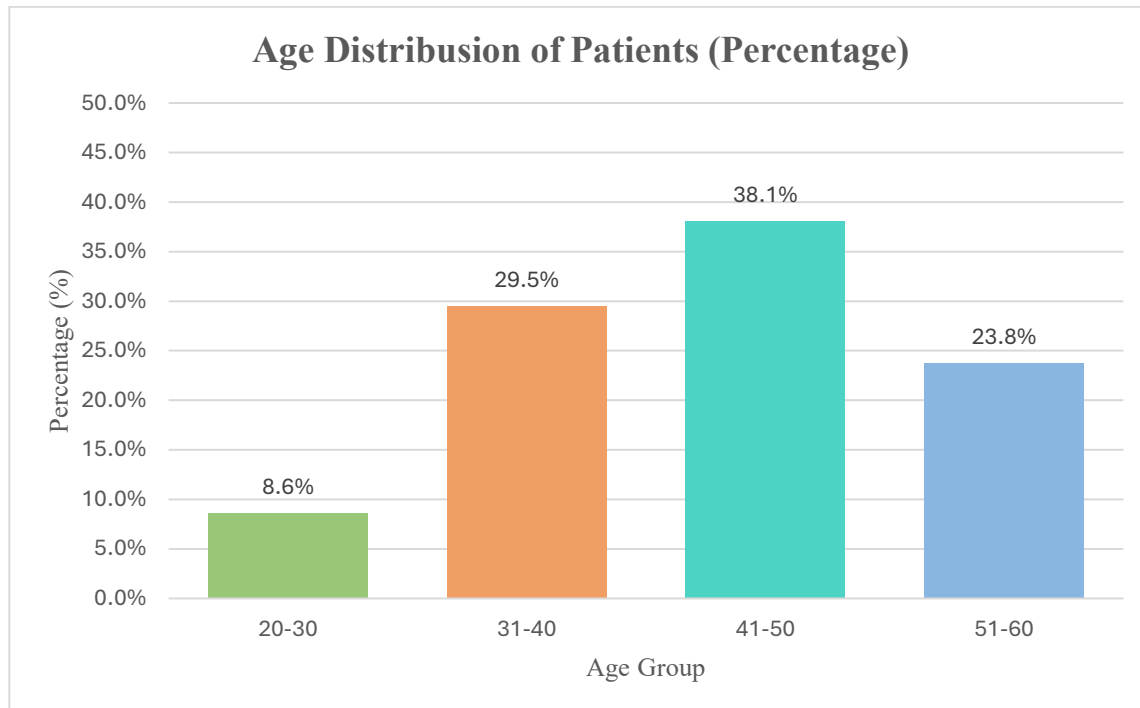


Figure 4: Age Categories

Figure 4 represent the distribution of patients ages in our study, categorized into four age groups. Among 105 patients, 8.9% were between

the ages of 20 to 30, 29.5% fell within the 31 to 40 age range, 38.1% were aged 41 to 50, and 23.8% were between 51 to 60 years old.

Clinical Details

Bar graph showing combined symptomatic distribution

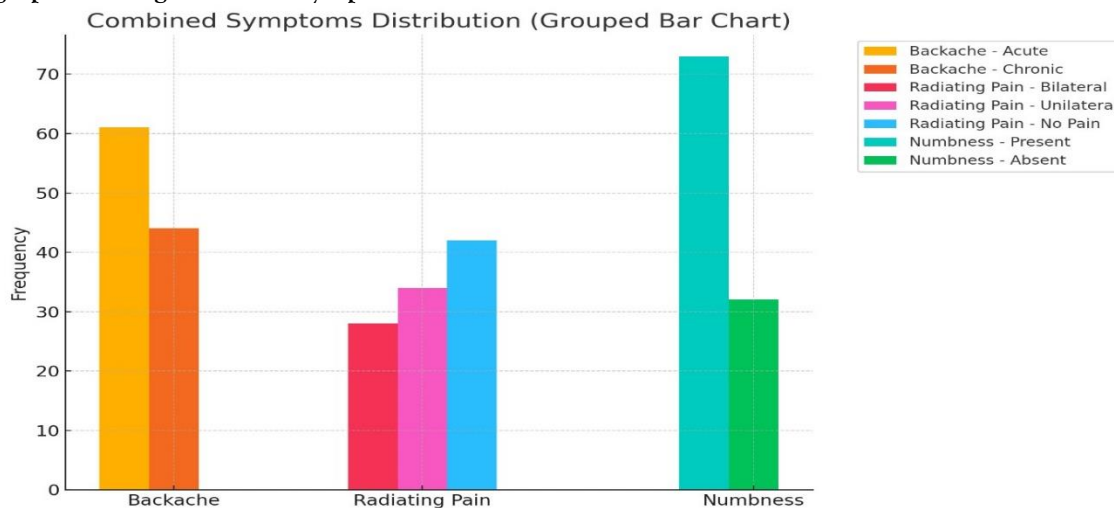


Figure 5: Symptoms experienced

The figure 5 summarizes the prevalence of each symptom within the studied group. The most prevalent symptom is “backache” reported by all individuals in the sample, in which acute

backache is 58.1% and chronic backache is 41.9%. Other symptoms include numbness (69.5%), bilateral leg pain (26.7%) and Unilateral (32.4%).

Magnetic Resonance Imaging findings

Bar graph showing frequency of lumbar disc herniation type

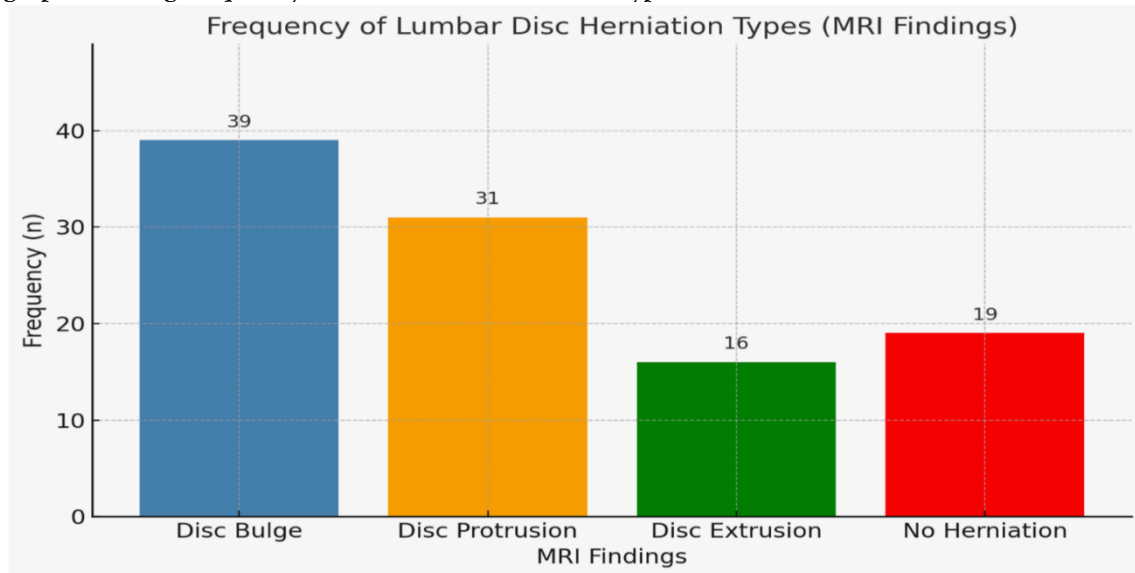


Figure 6: Magnetic resonance imaging findings

4.3.2 Figure 6 shows frequency of patients diagnosed with lumbar disc herniation. In our study total individuals are 105 and 86 are affected

with disc herniation remaining 19 had no disc herniation. The type of herniation which is involved is disc buldge 39 (37.1%), protrusion 31 (29.5%) and extrusion 16 (15.2%).

Bar graph showing lumbar disc herniation by spinal level

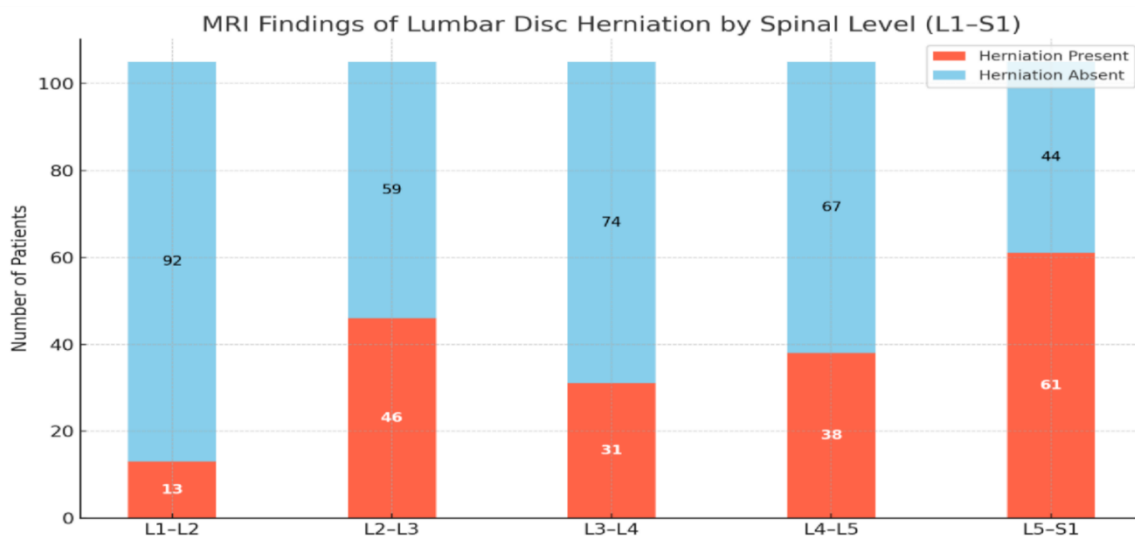


Figure 7: Analysis of lumbar disc herniation by spinal level

Figure 7 summarizes MRI findings of lumbar disc herniation by spinal level (L1-S1). The most affected spinal level is L5-S1, which is frequently involved by all individuals in the sample, making up 58.1% of the total.

Table 1 shows the location of disc herniation

In our study of total 105 individuals there are 86 patients with lumbar disc herniation, the paracentral type was the most frequently observed (52.3%), followed by central (25.6%) and lateral herniation (17.4%). Far lateral herniations were rare (4.7%).

Table 1: Location of Disc Herniation

Location of Herniation	Frequency	Percentage
Central	22	25.6%
Paracentral	45	52.3%
Lateral	15	17.4%
Far Lateral	4	4.7%
Total	86	100%

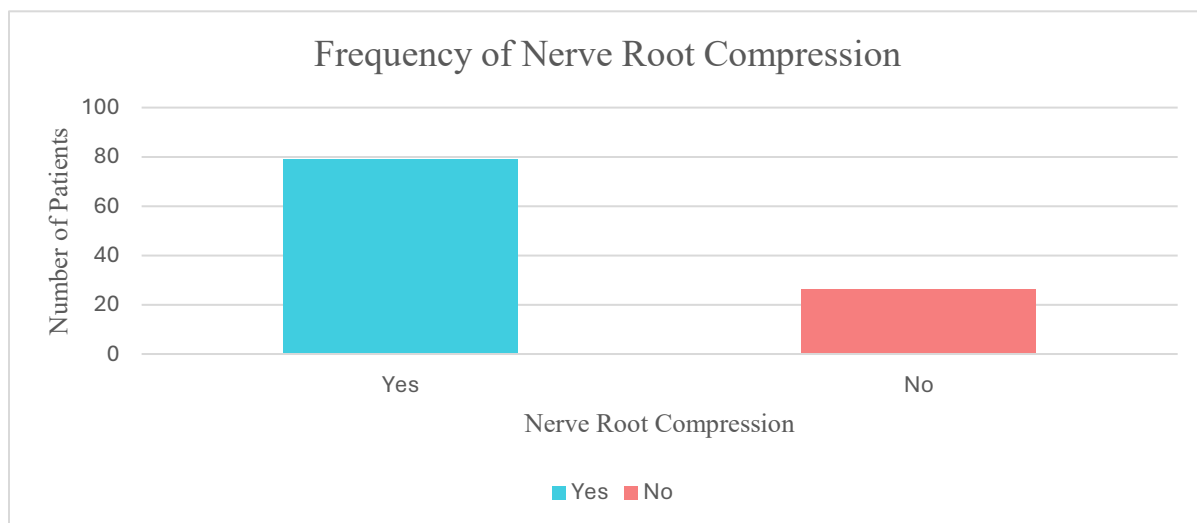


Figure 8: Analysis of lumbar disc herniation through nerve root compression

Bar graph showing the frequency of nerve root compression

Figure 8 Shows the nerve root compression in our study of 105 individuals out of which 76 has nerve root compression and remaining 26 has not.

In order to identify lumbar disc herniation, our study used MRI to assess 105 patients. The findings indicate that 86 (81.9%) of the patients had lumbar disc herniation, with the most common spinal level affected being L5-S1

(58.1%). Disc protrusion (29.5%) and disc bulge (37.1%) were the most prevalent forms of disc pathology.

The clinical significance of MRI findings was confirmed by the fact that 75.2% of herniated patients also had associated nerve root compression. The most frequently seen directional pattern (52.3%) was the paracentral herniation type, which is usually linked to severe radicular symptoms.

This information highlights how important MRI is for diagnosing disc herniations, determining their precise type and degree, and evaluating nerve involvement—all of which are necessary for choosing the best course of treatment.

DISCUSSIONS

In our study of involving 105 patients, MRI imaging was used to thoroughly examine the prevalence, distribution, and clinical consequences of lumbar disc herniation. The analysis showed a slightly higher frequency of herniation in males (52.4%) than in females (47.6%), which is consistent with trends reported in earlier research, where male patients often present more frequently due to occupational and physical strain factors (65).

The age-wise distribution in our findings showed the highest prevalence in the 41–50 age group (38.1%), followed by 31–40 (29.5%) and 51–60 (23.8%). This trend closely mirrors findings from other studies, which have consistently shown that lumbar disc herniation is most common in middle-aged individuals. Degenerative changes typically begin in the third decade of life and progress with age, supporting the observed peak in the fourth and fifth decades (66). The imaging analysis showed that disc bulge was the most common abnormality (37.1%), followed by disc protrusion (29.5%) and disc extrusion (15.2%). A smaller proportion (18.1%) of patients showed no clear abnormalities on MRI, which aligns with prior studies that also found a significant number of patients with symptomatic back pain but no visible herniation or structural disruption (67). This emphasizes the importance of correlating imaging findings with clinical symptoms, as mild or central disc changes may not always result in neural compression. Anatomically, the L5–S1 level was the most commonly affected (58.1%), followed by L4–L5 (36.2%). These levels have consistently been reported as the most vulnerable due to their role in spinal flexibility and the high mechanical loads they bear. This pattern supports the widely accepted understanding that degeneration is more frequent in the lower lumbar segments (68). Less commonly involved levels such as L2–L3, L3–L4, and L1–L2 showed lower rates, consistent with previous literature

that attributes their relative sparing to reduced mobility and mechanical stress.

Clinically, low back pain was highly prevalent, with acute cases slightly more common (58.1%) than chronic ones (41.9%). These numbers are comparable to findings from prior clinical cohorts, where acute onset of symptoms often prompts patients to seek early medical attention. Radiating leg pain was reported in 59.1% of cases, distributed as 32.4% unilateral and 26.7% bilateral. This is in line with earlier studies highlighting that nerve root irritation due to herniation frequently causes radiculopathy (69). The paracentral region was most frequently affected (52.3%), followed by the central (25.6%) and lateral types of herniation. Because paracentral herniations tend to compress the traversing nerve roots, they are especially significant, which aligns the prior studies that also shows that paracentral region was mostly affected (63).

Notably, 40% of patients did not report leg pain, a finding also observed in earlier work, which suggests that not all herniations lead to neural compression or inflammation. However, numbness was reported in 69.5% of patients, which is relatively high and suggests more significant sensory nerve involvement. This proportion is similar to that reported in neurologically symptomatic patient groups and may indicate moderate to severe herniation in many cases (70).

CONCLUSION

In conclusion, our research has identified that lumbar disc herniation primarily affects the L4–L5 and L5–S1 levels and seems to be most common in middle-aged people, with a slightly higher incidence in men. Acute low back pain, leg pain, and numbness are typical symptoms that closely match imaging results. These trends demonstrate the degenerative character of disc disease and the value of MRI in early identification and focused treatment.

Future Directions

Future researchers should involve larger and more diverse populations to better understand how age, gender, occupation, and lifestyle affect

lumbar disc herniation. Longitudinal studies are needed to track disc degeneration over time and assess treatment outcomes. Advanced MRI techniques and molecular studies may help in early detection and identifying risk factors. Standardizing clinical and radiological assessments will improve diagnosis and treatment planning. Additionally, evaluating the cost-effectiveness of imaging and therapy options can guide better healthcare decisions, especially in resource-limited settings.

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