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Radio Diagnosis

MRI EVALUATION OF DEGENERATIVE DISEASE OF SPINE PRESENTED WITH BACK PAIN & NEUROLOGICAL MANIFESTATION IN JHARKHAND

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ABSTRACT

AIMS AND OBJECTIVE: It is a cross-sectional and observational study to evaluate the characterization, extent, and changes associated with the degenerative disc disease by Magnetic Resonance Imaging.

MATERIALS AND METHODS: A total 95 patients of back pain with age group between 15 to 90 years were studied on 1.5 Tesla Magnetic Resonance Imaging machine & diagnosed as disc degenerative disease. MRI findings like lumbar lordosis, lost cervical curvature, Schmorl's nodes, decreased disc height, annular tear, herniation, bulge, protrusion and extrusion were observed. Narrowing of the spinal canal, lateral recess and neural foramen with compression of Spinal cord and nerve roots observed. Ligamentum flavum thickening and facetal arthropathy was also observed.

RESULT: Females were more commonly affected in Degenerative Spinal Disease & most of the patients show loss of lumbar lordosis. Decreased disc height was common at L5-S1 level. Mostly multiple disc involvement was seen per person. L4 - L5 disc was the most commonly involved. Annular disc tear found at various cervical as well as lumbar region. Disc herniation, disc extrusion, narrowing of spinal canal, narrowing of lateral recess, compression of neural foramen, ligamentum flavum thickening, nerve root compression, disc buldge, Posterior osteophytes, Anterolisthesis, End plate changes and facetal arthropathy was also common at Multiple Lumbar as well as Cervical disc level. spondylolisthesis are less common. Incidental hemangioma were also noted at C6, T6, T9 & T12 level. Schmorls node at T11, L1, L2 & L3. Wedge shaped collapse of L1 vertebra was found.

CONCLUSION: Disc degeneration is the common cause of back pain in Jharkhand. Plain radiograph can be helpful in visualizing gross anatomic changes in the intervertebral disc. But, MRI is the standard imaging modality for detecting disc pathology due to its advantage of multiplanar imaging capability, excellent spinal soft-tissue contrast and precise localization of intervertebral discs changes; and lack of radiation.

KEYWORDS : Degenerative disc disease, disc dehydration, intervertebral disc; Back pain, MRI images.

INTRODUCTION:

The back pain is very common among the people of middle age group in both sexes. Degenerative change is considered as a response to insults, such as mechanical or metabolic injury (Metabolic Syndrome), rather than a disease. [1] Intervertebral disc degeneration (DD) is generally considered as the first step of spinal change and undergoes destructive changes with age. It is typically followed by the loss of water and proteoglycan content of the nucleus, annulus tears, gradual formation of osteophytes, disc narrowing, and spinal canal stenosis [2, 3] , and low back pain [4–7], is a major public health problem that negatively influences activities of daily living and quality of life in those affected. Back pain secondary to degenerative disc disease is a condition that affects young to middle-aged persons with peak incidence at approximately 40 years.

Back pain is an exceedingly common problem, with a lifetime prevalence of 70% to 85% [8]. This condition is the most common cause of disability in people ages 45 years or younger. The etiology of back pain is multifactorial and is influenced by genetics[9],age [10-12],sex[10] and mechanical stresses[10,13].

MRI is the standard imaging modality for detecting disc pathology due to its advantage of lack of radiation, multiplanar imaging capability, excellent spinal soft-tissue contrast and precise localization of intervertebral disc changes. Imaging plays a critical role in the diagnosis of low back pain.

PATHOLOGY

Usually, the disc degenerative changes affect hydration and elasticity of the cartilaginous endplate, nucleus pulposus and annulus fibrosus, with changes most markedly in the nucleus pulposus. A loss of water-holding proteoglycans and type II collagen within the nucleus pulposus whereas increase of type I collagen within the annulus fibrosus; which results in disc dehydration. The disc becomes friable, precipitates fissures and progressive structural degradation.

MATERIALAND METHODS:

Total 95 patients were referred from various departments with complaints of back pain & neurological symptoms for MRI in Rajendra Institute of Medical Sciences, Ranchi, Jharkhand. Out of 95; 47 were males and 48 were females.

MRI Imaging Techniques:

MRI of the spine includes a sagittal T1-weighted spin echo sequence, a sagittal T2-weighted spin echo sequence, and axial T2-weighted images. In some cases additional sequences i.e. axial T1-weighted sequences, sagittal fat-suppressed T2-weighted sequences such as short tau inversion recovery (STIR) were done.

Sagittal T1-weighted images: Useful in the assessment of bone marrow. Normally fatty in adults and demonstrates intermediate T1 and T2 signal. Alignment of the vertebra can be best seen in the sagittal T1-weighted images. This is excellent for assessing the degree of neural foramina stenosis due to the high contrast between fat and nerve roots.

Sagittal T2-weighted images: It provides excellent contrast between cerebrospinal fluid (CSF) and the surrounding structures & thus helps in assessment of the degree of spinal stenosis at multiple levels on a single image. It is also useful for assessment of the intervertebral discs height, disc morphology and disc abnormalities. Fluid sensitive sequences such as STIR is used for detecting areas of bone marrow edema.

Axial T2-weighted images: It gives a level-by-level assessment of the relationship between the thecal sac and the surrounding bony and ligamentous structures. This is particularly helpful for assessing spinal stenosis and narrowing of the lateral or subarticular recesses. It is also used in assessing the facet joints and ligamentum flava.

OBSERVATION:

As the disc degenerative diseases are very common among middle aged males as well as females. Most common site was Lumbar followed by Cervical, Cervicolumbar, Thoracic and Dorsolumbar respectively. (Table- 1). Among total 95 cases most common site was Lumbar region 53.68% (n=51) followed by Cervical, Cervicolumbar,

thoracic and Dorsolumbar; 25.26% (n=24), 15.78% (n=15), 3.15% (n=3) and 2.1% (n=2) respectively.

There were different types of lesion noted in MRI study of Spine (Table-2). Among the lesion most common was disc dehydration 96.84% (n=92) followed by neural root compression, cord compression (Image A & B), osteophytes, hemangioma and anterolisthesis, schmorl's nodes, facetal arthropathy and collapse; 60% (n=57), 31.57% (n=30), 25.26% (24), 7.36% each (n=7), 6.31 %(n=6) 4.21% (n=4) and 2.1% (n=2) respectively.

Table- 1: Site wise involvement.

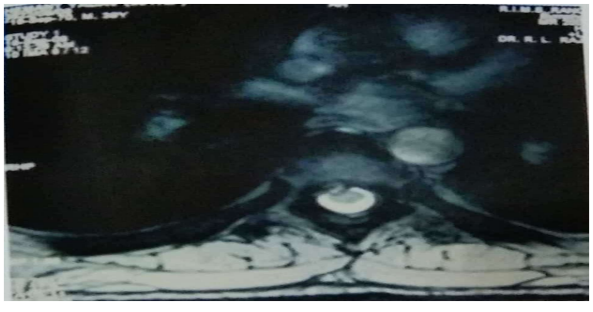
Sl.No	Site of Involvement	Male	Female	Total	Percentage
1	Lumbar	27	24	51	53.68%
2	Cervical	08	16	24	25.26%
3	Cervicolumbar	08	07	15	15.78%
4	Thoracic	03	00	03	3.15%
5	Dorsolumbar	01	01	02	2.1%

Table- 2: Types of lesion wise distribution

Sl.No.	Types of lesion	Male	Female	Total	percentage
1.	Disc dehydration	44	48	92	96.84%
2.	Neural Root Compression	30	27	57	60%
3.	Cord Compression	17	13	30	31.57%
4.	Osteophytes	10	14	24	25.26%
5.	Hemangioma	01	06	07	7.36%
6.	Anterolisthesis	02	05	07	7.36%
7.	Schmorl's Nodes	01	05	06	6.31%
8.	Facetal Anthropathy	02	02	04	4.21%
9.	Collapse	01	01	02	2.1%

Image- A: T2WI Sagittal View Showing herniated nucleus pulposus causing compression upon Spinal Cord.

Image- B: T2WI Axial View Showing herniated nucleus pulposus causing compression upon Spinal Cord.



DISCUSSION:

Patients presented with back pain, tingling, numbness and difficulty in walking were examined by MRI, which shows various types of lesion. Among them disc dehydration was commonest followed by neural root compression, cord compression, osteophytes, hemangioma, schmorl's nodes and collapse.

There are several studies which show various types of lesion along with involvement of vertebral bodies, intervertebral discs, facet joints, ligamentum flava and vertebral body end plates.

The vertebral bodies consist of an outer layer of cortical bone, which is low signal intensity on T1- and T2-weighted imaging and surrounds the inner trabecular bone. Trabecular bone is normally high signal on T1- and T2-weighted sequences in adults due to its fatty marrow.

Intervertebral discs Interposed between the vertebral bodies. These discs form the anterior articulation of the vertebral column and have two components: the outer annulus fibrosis (AF) and the inner nucleus pulposis. The annulus fibrosis is a dense fibrocartilaginous structure comprised of 15 to 20 layers of obliquely oriented fibers that run from the inferior endplate of the suprajacent vertebral body to the superior endplate of the subjacent vertebral body [14]. These fibers are primarily comprised of type 1 collagen [15]. This portion of the intervertebral disc normally demonstrates low T1 and low T2 signal. The nucleus polposus is composed of a loose type 2 collagen matrix and is 70% to 90% water and proteoglycans [15]. The nucleus pulposus demonstrates high T2 and low T1 signal, due to its high water content. A low T2 signal band can be seen centrally within the nucleus pulposus in patients over the age of 30 and represents a fibrous band or cleft [16]. These discs contact the vertebral body endplates, which are made up of hyaline cartilage on the vertebral body side and fibrocartilage along the disc [14].

Facet Joints shows degenerative changes independent of the presence of degenerative disc disease [17]. Findings of degenerative disease in the facet joints include joint space narrowing, subchondral erosions and cystic change, osteophyte formation, and synovial cyst formation. Weishaupt et al utilized these features to develop a grading system for facet disease on MRI [16].

The joint spaces of the facet joints normally measure 2 to 4 mm and demonstrate isointense to high T2 signal [18].

Multiple ligamentous structures contribute to the stability of the spinal column. They are anterior longitudinal ligament, the posterior longitudinal ligament, Ligamentum Flava, the interspinous ligament, and the supraspinous ligament. Of particular interest when considering degenerative disease of the spine are the ligamentum flava ; paired ligaments that extend between the lamina of adjacent vertebral bodies. These are normally thin and low signal on T1- and T2- weighted images.

Intervertebral discs transition through three phases[19]:-

1. The growth phase: Synthesis of aggrecan and procollagens and increased type 2 collagen. Between the age of 0 to 15 years.
2. The maturation phase: Reduction in the synthesis and volume of type 2 collagen in the nucleus pulposus from approximately 15 to 40 years of age.
3. The final stage: Degeneration, characterized by increased fibrosis with decreasing type 2 collagen and increasing type 1 collagen after the age of 40 years.

This disc degeneration, as well as annular fissures and apophyseal osteophyte formation, in the absence of disc height loss, have been termed spondylosis deformans and are considered normal aging processes [20-22].

On MRI Images:

Apophyseal osteophytes: Low T1 and T2 outgrowths along the anterior and lateral margins of the endplates.

Disc degeneration: Loss of T2 signals in the nucleus pulposus. Annular fissures: Small areas of T2 hyperintensity in the posterior annular fibrosus . More extreme changes, including severe disc fissuring, disc height loss and endplate erosion; a pathologic process termed as intervertebral osteochondrosis [20-22].

Vertebral Body Endplates has been classified as degenerative endplate changes into three categories by Modic et al [23,24]

Modic Type 1changes: Edematous changes related to subchondral end plate fractures, formation of vascularized fibrous tissue and an acute reparative response. On MRI- Increased T2 and decreased T1 signal in the bone marrow adjacent to the endplate. Modic type 1degenerative signal intensity may suggest infection. For this differentiation diffusion-weighted imaging (DWI) is useful. Modic type 1 intensity show the claw sign on DWI; presenting as linear, well-marginated, paired regions of high signal within the adjoining vertebral bodies at the boundaries between the normal bone marrow and vascularised bone marrow that lies close to the affected disc. A well-defined border response seen in slow progressive degenerative disc disease. Whereas, the infection process progress very quickly and diffusely infiltrated with pathogens or oedema, and the claw sign is absent [25,26]

Modic Type 2 changes: Fatty replacement of normal marrow and are more chronic and stable. On MRI - Increased T1 and T2 signal, with loss of signal on fat suppression sequences.

Modic Type 3 changes: Chronic endplate sclerosis and development of dense woven bone. On MRI - Low signal intensity on both T1- and T2-weighted sequences.

Transitions through these stages are not uniformly progressive, and multiple studies have shown resolution of Type 1 changes or progression from Type 2 change to Type 1 change [24, 27, 28]. Type 1 and Type 3 changes are associated with low back pain and instability, while Type 2 change is frequently seen in degenerative disc disease and is less associated with back pain [29]. The Modic classification system has been shown to have good interrater reliability [30].

More recently, Rajasekaran et al [31] has proposeda classification system for endplate changes based on morphology. This system grades defects in the endplate, with severity based on the area of the endplate involved.

RESULT:

In MRI study of patients presented with back pain; females were more commonly affected in Degenerative Spinal Disease & most of the patients show loss of lumbar lordosis and cervical curvature. Decreased disc height at multiple level were seen but was common at L5-S1 level. Mostly multiple disc involvement was seen per person. L4 - L5 disc was the most commonly involved. Annular disc tear was also found at multiple level i.e. C4-C5, C5-C6 and C6-C7 as well as L3-L4 & L5-S1. Disc herniation, disc extrusion, narrowing of spinal canal, narrowing of lateral recess, compression of neural foramen, ligamentum flavum thickening, nerve root compression and facetal arthropathy was common at multiple level Lumbar as well as Cervical disc. Disc bulge was also common at multiple levels at cervical and lumbar region. (L3 - L4 & L4 - L5 disc and Cervical C4-C5, C5-C6 and C6-C7). Posterior osteophytes were also found at multiple cervical and Lumbar disc level. Anterolisthesis were found in C5 over C6, L4 over L5 & L5 over S1 level. End plate changes were noted at L4, L5, S1, T11 & T12 level. Hemangioma were found at C6, T6, T9 & T12 level. Schmorls nodes at T11, L1, L2 & L3 level. Wedge shaped collapse of L1 vertebra was found.

CONCLUSION:

Degenerative disease of the disc is a common condition that radiologists will encounter frequently in patients of back pain. MRI is a mainstay in the assessment of back pain and degenerative disease of the spine. This paper has reviewed the common findings affecting the vertebral bodies, intervertebral discs, facet joints, and ligamentum flava, as well as the combined effects of these changes on the spinal canal and neural foramina. This common disc disorder mostly associated in our state of Jharkhand with weight bearing for outdoor activity during crop cultivation and daily work. People use to bear weight in their head and shoulder. This mechanical burden to their spine aggravates the condition and increases morbidity.

Various future trends in this study may help to diagnose very early and more accurately in case of disc degeneration i.e. T1 and T2 relaxation mapping and new sequences like sodium MRI, Magic echo and $T1_{\rho}$ are being developed to assess early molecular changes in the intervertebral disc [32].

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