

Frequency of Modic Changes in Degenerative Disc Disease on Magnetic Resonance Imaging of Lumbar Spine

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Abstract

Background: To determine the frequency and distribution of endplate marrow signal intensity changes in patients with low back pain and to analyze their association with age and gender.

Methods: In this cross sectional study patients of ages 27-75 years, who came for MRI of lumbar spine with low back pain or sciatica, were included. The patients with age <25 years and >70 years with history of back surgery, trauma and malignancy were excluded. Imaging was performed on a 1.5 Tesla power magnetic resonance imaging machine. The imaging protocol included T1-weighted and T2 weighted, fast spin echo (FSE) sagittal and axial images. The intervertebral discs were graded as normal, Grade 1, Grade 2, Grade 3 and endplate bone marrow (Modic) changes were classified in three types according to the definitions of Modic et al. Findings were localized by disc segment (L1–L2, L2–L3, L3–L4, L4–L5, and L5–S1) and whether they were in the superior or inferior endplate. Frequencies and percentage was presented for categorical variables like gender, type of Modic change, vertebral level and intervertebral disc degeneration.

Results: Out of 177 patients 49.15% lumbar spine showed positive modic changes while in 50.85% changes were absent. Majority of the patients were between 31-40 years of age. Out of these 61.58% were male and 38.42% were female.

Conclusion: Modic changes are found frequently on MRI of spine in patients with degenerative changes and are associated with history of back ache. It gives useful information regarding the severity of degenerative disk disease.

Key Words: Low back pain, disc degenerative disease, MRI.

Introduction

Degenerative diseases of the lumbar spine have a high medical and socioeconomic impact. The leading symptom is back pain. In the United States too, back

pain is the second leading symptom that prompts visits to physicians. As many as 80% of adults in the United States experience at least 1 episode of low back pain during their lifetime, and 5% experience chronic problems.¹

Diagnosing patients with low back pain is a challenge always faced by the clinicians.³ Lumbar disc prolapse is due to disc degeneration and is most common between 30 and 50 years of age, with a male preponderance, as well as an association with repeated mechanical forces and smoking. It may occur at any level but 95% occur at L4/5 or L5/S1.²

At magnetic resonance imaging (T2W sagittal images) intervertebral disc degeneration is graded as :Normal: No signal changes;Grade 1: Slight decrease in signal intensity of the nucleus pulposus;Grade 2: Hypointense nucleus pulposus with normal disc height;Grade 3: Hypointense nucleus pulposus with disc space narrowing.

In 1988, Modic et al described and validated an MRI-detected vertebral anomaly that can be defined as signal changes in the vertebral bone extending from the vertebral endplate, the so-called Modic changes (MC). MC is strongly linked with disc degeneration (DD).⁴Modic changes have been described as being strongly associated with low back pain.³ According to Modic; the first stage of these changes (type 1) reflects hyper-vascularity of the vertebral body and endplates as a result of inflammation. Type 2 consists of fatty replacements of the red bone marrow, as documented by material harvested during lumbar surgery.⁵ Modic endplate changes are classified into three types:Type 1 changes: Increased marrow signal intensity in T2-weighted MR images and decreased signal intensity in T1-weighted MR images;Type 2 changes: Increased signal intensity in T1- and T2-weighted MR images;Type 3 changes: Decreased signal intensity in T1 -and T2-weighted MR images.

As there is consistent evidence about the association of Modic changes with degenerative disk disease and low back pain and to date in this prospective, very

little documented evidence is available in our local population, therefore by evaluating the frequency and location of Modic changes this study provides useful information regarding the severity of degenerative disk disease which is a leading cause of low back pain.

Patients and Methods

After informed consent from the patients and approval from the ethical review committee, the cross sectional study was carried out for a period of 6 months from September 2010 to February 2011, in the Department of Diagnostic Radiology, Pakistan Institute of Medical Science, Islamabad. Sample size of 177 patients, was calculated by using WHO sample size calculator taking confidence level 95%, anticipated population proportion 34.1%, Absolute precision 7%. Sampling techniques was consecutive (non-probability) sampling. The patients included were both male and female of ages 27-75 years, who came for MRI of lumbar spine with low back pain or sciatica. The patients with age <25 years and >70 years with history of back surgery, trauma and malignancy were excluded. Imaging was performed on a 1.5 Tesla power magnetic resonance imaging machine. The imaging protocol included T1-weighted and T2 weighted, fast spin echo (FSE) sagittal and axial images. The intervertebral discs were graded as normal, Grade 1, Grade 2, Grade 3 and endplate bone marrow (Modic) changes were classified in three types according to the definitions of Modic et al. Findings were localized by disc segment (L1 – L2, L2 – L3, L3 – L4, L4 – L5, and L5 – S1) and whether they were in the superior or inferior endplate. Frequencies and percentage was presented for categorical variables like gender, type of Modic change, vertebral level and intervertebral disc degeneration.

Results

In this study, a total of 177 patients were recruited after fulfilling the inclusion/exclusion criteria. Out of 177 patients endplate marrow changes were found in 49.15% (n=87), while in 50.85% (n=90) changes were found absent. (Table 1). Majority of the patients 37.29% (n=66) were between 51-60 years of age, 23.16% (n=41) between 41-50 years, 15.83% (n=28) between 61-70 years, 12.99% (n=23) between 31-40 years while only 10.73% (n=19) between 25 - 30 years. Mean and standard deviation was recorded as 38.43+4.32. (Table 2). Majority (61.58%;n=109) were male and 38.42% (n=68) were found female. The upper (n=109) and lower (n=119) aspect of the endplate were

affected similarly. The L4-5 and L5-S1 vertebral levels were most commonly involved, having 64.97 % and 73.45% endplate changes respectively (Table 3). The fatty pattern was most common with the sclerotic pattern being rare. Endplate marrow changes most of them occurred at the anterior aspect of endplate, particularly at L4-5 and L5-S1 levels (Table 4&5). Modic changes occur more frequently with aging, evidence of their degenerative etiology. Type 1 Modic changes showed increased marrow signal intensity in T2-weighted MR images and decreased signal intensity in T1-weighted MR images; Type 2 Modic changes revealed increased signal intensity in T1- and T2-weighted MR images; Type 3 changes had decreased signal intensity in T1 -and T2-weighted MR images (Figure 1 -3).

Table 1: Frequency of Modic changes in degenerative disc disease on magnetic resonance imaging of lumbar spine (n=177)

Modic Changes	No. of patients	%
Yes	87	49.15
No	90	50.85
Total	177	100

Table 2: Age distribution of the patients (n=177)

Age (in years)	No. of patients	%
25-30	19	10.73
31-40	23	12.99
41-50	41	23.16
51-60	66	37.29
61-70	28	15.83
Mean and S.D.	38.43+4.32	
Total	177	100

Table 3: Frequency of intervertebral disc level and grade of disc degeneration

Intervertebral disc level	No. of patients	%	Grade of Intervertebral disc Degeneration		
			I	II	III
L1-L2	37	20.90	-	20	17
L2-L3	55	31.07	16	14	25
L3-L4	56	31.64	8	26	22
L4-L5	115	64.97	4	56	55
L5-S1	130	73.45	11	28	91

Table 4: Frequency of vertebral level and type of Modic change (n=177)

Vertebral level	No. of patients	Type of Modic Change		
		I	II	III
L1	10	-	10	-
L2	20	1	19	-
L3	23	-	23	-
L4	52	2	49	1
L5	65	3	61	1
S1	58	2	56	-

Table 5: Location within the vertebral body (n=177)

Vertebral level	No. of patients	Type of Modic Change	
		Superior Endplate	Inferior Endplate
L1	10	2	8
L2	20	9	11
L3	23	10	13
L4	52	20	32
L5	65	30	35
S1	58	38	20

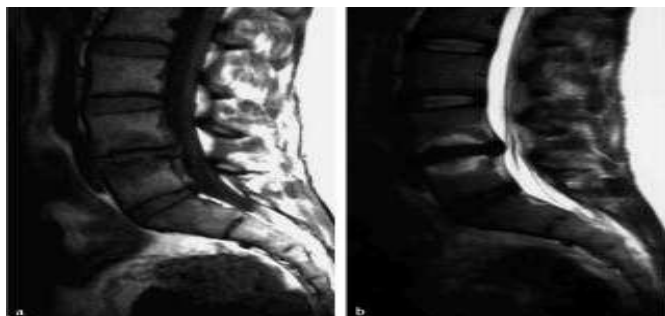


Fig. 1: Modic type 1 changes at L4-L5 in a 29-year-old woman. Sagittal T1-weighted (a) and sagittal T2-weighted (b) images. There is decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images, indicating bone marrow edema associated with acute or subacute inflammation. The patient also has a right central disc protrusion

Discussion

A great majority of patients seeking treatment for pain in the back are diagnosed with no pathological change, in spite of the most careful clinical examination. ⁶ Disc pathology has been thought to be the primary cause in low back pain (LBP) symptoms. ⁷ Yet specific pathologic findings in the disc that might underlie these symptoms remain uncertain. Despite this, the disc has continued to be a primary target of diagnostic procedures and therapeutic interventions of spine. ⁸

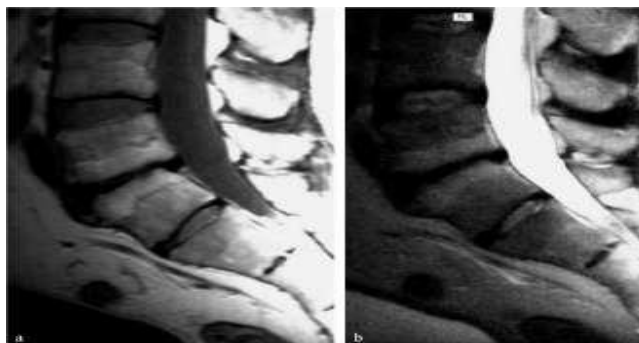


Figure 2: Modic type 2 changes at L4-L5 in a 51-year-old woman. Sagittal T1-weighted (a) and sagittal T2-weighted (b) images. There is increased signal intensity on T1-weighted images and mildly increased signal intensity on T2-weighted images, indicating replacement of normal bone marrow by fat. The patient has a rudimentary L5-S1 disc, with accelerated degeneration at L4-L5

In forensic or medicolegal settings, clinicians frequently are asked to opine as to the significance of various radiographic or advanced-imaging findings. The most common of these are degenerative in nature and appear in the form of reduced disc height, osteophytes, facet joint irregularities and other signs of the normal aging process known most properly as spondylosis deformans. Intervertebral osteochondrosis, or disc degeneration, represents a pathological process affecting chiefly the nucleus pulposus and end plates. ⁸

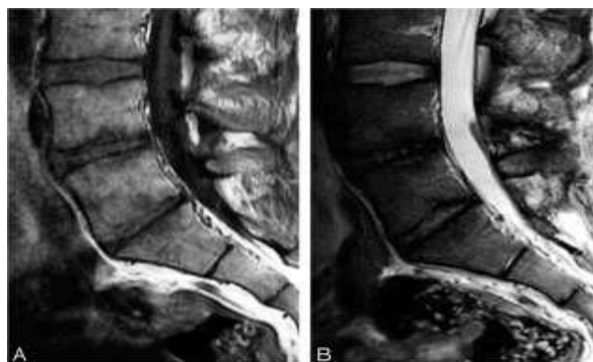


Fig 3. Modic type 3 changes are hypointense on both T1WI (A) and T2WI (B).

It can be seen using plain-film radiography, as well as CT or MRI. These advanced-imaging modalities allow us to follow the progression of degenerative changes over time, but often do not allow us to definitively correlate neck pain or back pain with the spinal degenerative changes imaged. Modic MT is also of the view that early degeneration of the vertebral body endplates cannot be imaged well by CT, but MRI is more effective regarding their diagnosis. Forristall,

who compared MRI and contrast CT to surgical findings, found that overall MRI provided the most information about the state of disc degeneration¹¹.

In our study, we found majority of the patients between 51-60 years of age, i.e. 37.29% (n=66) and 23.16% (n=41) between 41-50 years. These findings are in agreement with the study conducted by Andersson who concluded peak prevalence of low back pain between ages 35 and 55.⁹ We found it more prevalent in men as 61.58% (n=109) males had positive Modic changes in our study, the findings are in agreement with study by Karchevsky M et al which showed significantly more endplate changes in males than females. They hypothesized that it may be related to occupational or recreational activities that vary by gender.¹⁰ Regarding frequency of Modic changes in Degenerative disc disease on MRI of lumbar spine, 49.15% (n=87) were positive for Modic changes while in 50.85% (n=90) these changes were absent. We found these findings consistent with those of Zhang et al.¹¹ Modic changes were more common at L4-L5 and L5-S1 levels seen in 64.97% (n=115) and 73.45% (n=130) respectively. Most commonly found Modic changes were Type II. These are in accordance with finding of Karchevsky et al.¹⁰

Conclusion

1. Bone marrow endplate - Modic changes are a common phenomenon on magnetic resonance imaging of lumbar spine in spinal degenerative diseases.

2. It is strongly linked with low back pain. Evaluating the frequency and location of modic changes provides useful information regarding the severity of degenerative disk disease.

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