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Degenerative Changes of the Vertebral Endplates and Subchondral Bone with MODIC Changes

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ABSTRACT

Background: Due to Non specificity of pain and variable aetiologies for low back ache, it is a complicated task for diagnosis and treatment. MRI helps for final diagnosis of LBA, as it gives excellent soft tissue resolution, imaging of the bone marrow and vertebral endplate signal changes (MODIC), which is a gold standard. Aim: The present study is aimed at knowing the prevalence of MODIC changes and extent of degenerative changes in vertebral end plate and Subchondral bone. **Methods:** Results of MODIC changes, anteroposterior, lateral view radiography findings and MRI end plate changes in sagittal T1W, T2W and STIR sequences was entered into spread excel sheet along with Disc changes study findings. **Results:** Out of 74 patients diffuse involvement seen in 87.8% of patients, anterior involvement seen in 9.4% and posterior involvement seen in 2.7% respectively. On assessment of Disc Degeneration (DD), Out of 34 patients, 19(55.8%) had DD III, 13(38.2%) had DD IV, 1(2.9%) had DD II and 1(2.9%) patient had DD I. On assessment of Disc Hernia (DH), Out of 34 patients, 21(61.7%) had DH II, 7(20.5%) had DH I, 4(11.7%) had DH III, 1(2.9%) had DH IV and 1(2.9%) had DH V. **Conclusions:** MODIC changes can clearly be detected in MRI and also wide spectrum disc abnormalities can be easily diagnosed in MRI.

Keywords: Disc Abnormalities, MODIC changes, MRI.

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INTRODUCTION

Worldwide among adult population, the most common reason for musculoskeletal disorder is Low back ache (LBA). LBA carries tremendous weight in socioeconomic considerations, with a prevalence of up to 84%.[1] Based on etiology, causes of low back ache are broadly categorized as degenerative disc disease, infective, congenital, neoplastic and non traumatic spondylolisthesis. Most common cause of LBA is disc abnormalities including disc degeneration, disc bulging, disc protrusion, disc extrusions, nerve root compression and annular tears as the cause of backache.[2]

Lumbar spine is the most common part being affected; MODIC changes can be detected often. Lumbar region faces great compression and shear forces when compared to other spinal regions.[3,4] Repeated friction or damage to spine cause greater inflammatory response to injury; progresses with time and alters the morphology of vertebral endplates which in turn leads to poor regenerative abilities and are susceptible to minor injuries.

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Due to Non specificity of pain and variable aetiologies for low back ache, it is a complicated task for diagnosis and treatment.[5] Plain Radiography can help us to find out evaluation of fracture, bony deformity including degenerative changes, sacroiliitis, disk and vertebral body height, assessment of bony density, architecture and para spinal collections.[6,7] MRI helps for final diagnosis of LBA, as it gives excellent soft tissue resolution, imaging of the bone marrow and vertebral endplate signal changes (MODIC), which is a gold standard.[8]

Before the advent of Magnetic Resonance Imaging conventional radiography was universally accepted as the imaging modality to diagnose the cause of back ache. These dynamic markers in vertebral endplate are only visualized in Magnetic Resonance Imaging.

The present study is aimed at knowing the prevalence of MODIC changes and extent of degenerative changes in vertebral end plate and Subchondral bone.

MATERIALS & METHODS

This is a prospective study was carried out from October 2018 to February 2019 at Government General Hospital, Anantapuramu. A total of 120 patients presented with low back pain were referred to Department of Radiology were included in this study.

Inclusion criteria:

- Both sexes of age group between 21-70 years.
- Those who are willing to undergo radiography and MRI.

Exclusion criteria:

- Pregnantwomen
- Patients with Fracture vertebrae, infective pathology and spinaltumors
- Patients with implants.
- Previously operated patients for spinalsurgery.

Data from all the patients was collected pertaining to age, sex, socioeconomic status, relevant personal history, family history, history of trauma. These patients were advised to undergo Plain radiography and MRI to identify exact cause of low back ache. Radiograph of the spine is performed with a 500 mAs Alengers machine using a 14 x 17 inch cassette with 70-100 kV and 15-50 mAs. MRI lumbosacral spine is taken using a 1.5 Tesla Philips 16 channel. Different sequences that performed were T1-sag, T2-sag, T2-axial and STIR – sag.

Results of MODIC changes, anteroposterior, lateral view radiography findings and MRI end plate changes in sagittal T1W, T2W and STIR sequences was entered into spread excel sheet along with Disc changes study findings.

RESULTS

Out of 120 patients presented with low back pain, 74 (61.6%) were males and remaining 46 (38.3%) were females. Most of the patients were presented with low back ache in the age group of 31-60 years, i.e., 91 (75.8%) patients out of 120. 17.5% (21 out of 120 patients) of patients were observed in the age group of 21-30 years.

Among different types of MODIC changes, type II, type II/III was noted predominantly. Out of 44 patients with MODIC changes, 17 (38.6%) patients who had type II/III and 12 (27.2%) patients who had type II were observed in majority, followed by 7 (15.9%) patients with type I/II, 6 (13.6%) patients with type III and 2 (4.5%) patients with type I (Image 1,2,3).

74 (61.6%) out of 120 patients, 34 (28.3%) out of 120 patients and 34 (28.3%) out of 120 patients had endplate involvement, disc degeneration (DD), disc hernia (DH) respectively.

Table 1: Endplate involvement in relation to MODIC changes

	I	II	III	I/II	II/III	Total
Anterior	0	5 (71.4%)	2 (28.5%)	0	0	7 (9.4%)
Posterior	0	0	2 (100%)	0	0	2 (2.7%)
Diffuse	4(6.1%)	24 (36.9%)	4(6.1%)	8(12.3%)	25(38.4%)	65 (87.8%)
Total	4(5.4%)	29(39.1%)	8(10.8%)	8(10.8%)	25(33.7%)	74 (100%)

Table 2: Disc Degeneration in relation to MODIC changes

	I	II	III	I/II	II/III	Total
DD I	0	0	0	1(100%)	0	1(2.9%)
DD II	0	0	0	1(100%)	0	1(2.9%)
DD III	0	7(36.8%)	2(10.5%)	3(15.7%)	6(31.5%)	19(55.8%)
DD IV	1(7.6%)	3(23.0%)	3(23.0%)	1(7.6%)	5(38.4%)	13(38.2%)
Total	1(2.9%)	11(32.3%)	5(14.7%)	5(14.7%)	11(32.3%)	34(100%)

Table 3: Disc Hernia in relation to MODIC changes.

	I	II	III	I/II	II/III	Total
DH I	0	3(42.8%)	0	4(57.1%)	0	7(20.5%)
DH II	1(4.7)	8(38.0%)	3(14.2%)	2(9.5%)	7(33.3%)	21(61.7%)
DH III	0	0	0	1(25%)	3(75%)	4(11.7%)
DH IV	0	0	0	0	1(100%)	1(2.9%)
DH V	0	0	0	0	1(100%)	1(2.9%)
Total	2(2.7)	11(14.7%)	3(8.8%)	7(9.4%)	12(35.2%)	34(100%0

Table 4: ShowingMultiplicity of disc changes

Multiplicity	Endplate involvement(n=74)	Disc Degeneration (n=34)	Disc Herniation (n=34)
Multiple	63 (85.1%)	26(76.4%)	22(64.7%)
Single	11(14.8%)	8(23.5%)	12(35.2%)

On assessment of endplate involvement, Out of 74 patients diffuse involvement seen in 87.8% of patients, anterior involvement seen in 9.4% and posterior involvement seen in 2.7% respectively. Anterior and posterior were predominantly MODIC III type. Out of 65 diffuse types, 25(38.4%) showed MODIC II/III changes, 24 (36.9%) had MODIC II, 8(12.3%) showed MODIC I/II, 4(6.1%) had MODIC I and III of each [Table 1].

On assessment of Disc Degeneration (DD), Out of 34 patients, 19(55.8%) had DD III, 13(38.2%) had DD IV, 1(2.9%) had DD II and 1(2.9%) patient had DD I. DD I & II patients had MODIC I/II. In DD III patients MODIC II (36.8%) and MODIC II/III (31.5%) were predominant. In DD IV patients MODIC II/III (38.4%), MODIC II (23%) and III (23%) were predominantly [Table 2].

On assessment of Disc Hernia (DH), Out of 34 patients, 21(61.7%) had DH II, 7(20.5%) had DH I, 4(11.7%) had DH III, 1(2.9%) had DH IV and 1(2.9%) had DH V. DH IV and DH V has shown MODIC II/III changes. DH III showed MODIC II/III (75%) predominantly. DH II patients had MODIC II (38.0%) and MODIC II/III (33.3%) predominantly [Table 3].

Out of 74 patients with endplate involvement, multiple involvementswere seen in63 (85.1%) patients and single involvement was seen in 11 (14.8%) patients. Out of 34 Disc degeneration patients, 26 (76.4%) had multiple disc involvement and 8 (23.5%) had single disc involvement. Out of 34 disc herniation patients, 22 (64.7%) patients had multiple levels involvement and 12 patients had single disc (35.2%) involvement [Table 4].

Figure 1: Showing MODIC III changes

Figure 2: Showing MODIC II changes

Figure 3: Showing MODIC I changes

DISCUSSION

MODIC Changes can be detected in the spine of humans and animals; can be observed in cervical, thoracic and lumbar. In patients with low back ache, the prevalence of modic changes varies from 18 to 62%; each type of MODIC have different ratio.[9,10] Keyvan Mostofi et al did a study on 214 patients, Modic Change type I was observed in more than 78% of study population.[11] Kuisma M et al,[12] observed MODIC changes at L5-S1of type 1 and extensive lesions predominantly have a strong association with pain symptoms and Low back pain.

Among different types of MODIC changes, type II, type II/III was noted predominantly. Out of 44 patients with MODIC changes, 17 (38.6%) patients who had type II/III and 12 (27.2%) patients who had type II were observed in majority, followed by 7 (15.9%) patients with type I/II, 6 (13.6%) patients with type III and 2 (4.5%) patients with type I in the present study.

In similar to our study few studies reported that MODIC type 2 was common and may account for up to 90% of Modic changes.[13,14] Other research studies have shown that MODIC type 1 was the most frequent and may constitute up to 68% of Modic changes.[15]

Out of 65 diffuse types, 25(38.4%) showed MODIC II/III changes, 24 (36.9%) had MODIC II, 8(12.3%) showed MODIC I/II, 4(6.1%) had MODIC I and III of each in this study. de Ross et al,[13] did a study on MODIC changes on MR imaging in 1987, he observed degenerative verterbral endplate and sub chondral bone marrow changes for the first time. Kerttula et al,[16] did a study on 3811 patients with consecutive chronic low back pain for 6 consecutive years to a standard lumbar spine MRI study at a university hospital. They reported that endplate deformation, decreased disc height, and disc signal

intensity changes appear to be essential features of accelerated degenerative process associated with type I MCs. In MODIC changes bony endplates are preserved rather than indistinct or destroyed as seen in an infective process.

Disc degeneration (DD) is the deterioration and remodeling of the physical and chemical properties of the tissue with retrogressive pathologic changes in the cells or macromolecules. The most significant biochemical change to occur in disc degeneration is loss of proteoglycan, which results in dehydration of the disc.[17,18] The etiologies of disc degeneration include age, genetic inheritance, physical loading history and impaired nutrition, all of which can weaken IVDs to such an extent that structural failure occurs during the activities of daily living. Pfirrmann et al grading system gives the degree of disc degeneration on the T2-weighted sagittal MR images.[19,20]

Degeneration, defined by the presence of disc space narrowing, osteophytes, and endplate sclerosis, turned out to be associated with nonspecific low back pain with odds ratios ranging from 1.2 to 3.3, using these parameters lane et al.1993 proposed Radiographic grading of lumbar disc degeneration on lateral views.[21,22] Osteophytes were the most frequent radiographic feature. Osteophytes and endplate sclerosis were more frequent in men than women, but there was no gender difference in the frequency of disc space narrowing.[23]

DD I & II patients had MODIC I/II. In DD III patients MODIC II (36.8%) and MODIC II/III (31.5%) were predominant. In DD IV patients MODIC II/III (38.4%), MODIC II (23%) and III (23%) were predominantly in this study. Few studies reported that the among patients with degenerative disk diseases of the lumbar spine, the prevalence of Modic changes varies between 19 to 59%,with type 1 and 2 changes being the most common and type 3 and mixed-type changes being relatively rare.[13,15,24] Kjaer et al,[17] studyon 412 patients of 40 years age group stated that among patients with Disc degenerative disease the prevalence of modic changes was 34.1%, whereas in patients without disc degeneration disease the prevalence of modic changes was 9.6%.Toyone et al,[24] reported among patients with disc degenerative disease, 73% had type I modic changes and 11% had type 2 Modic changes. Mitra et al,[25] found a positive trend between the evolution of type 1 Modic changes into type 2 changes and the improvement of symptoms. A research study by de Ross et al and a cross sectional community based study by Teichtahl et al,[26] noted severe disc degeneration such grade 4 and 5 were associated with type II modic changes. A 4 year prospective study by Jensen et al,[27] observed that the greater the range of MCs, the more severe the degeneration of the adjacent segments.

Herniation is defined as a localized displacement of disc material beyond thelimits of the intervertebral disc space. Crock,[28] proposed the concept of "internal disc disruption", suggesting that repeated trauma to the intervertebral disc results in the production of chemical substances in the nucleus pulposus. Diffusion of such toxic chemicals through the vertebral endplate could then result in a local inflammatory reaction.

As per this study, Disc Herniation (DH) IV and DH V has shown MODIC II/III changes. DH III showed MODIC II/III (75%) predominantly. DH II patients had MODIC II (38.0%) and MODIC II/III (33.3%) predominantly. Albert BH et al,[29] observed that incidence of new MC type I was closely related to a previous disc herniation and higher in patients who had undergone surgery for lumbar disc herniation. They also documented most of the new MC were located at L4-L5 or L5-S1, and co localized with a symptomatic disc herniation. A lumbar disc herniation is a strong risk factor for developing Modic changes (especially type 1) during the following year. Same observations were made by Kuisma M et al.[12] Mitra et al,[25] did a study on 44 patients conservatively treated for LBP and/or sciatica and assumed to be had disc herniations. They observed that over a period of 12–72 months 37% converted fully to type 2, 15% converted partially to type 2, 40% into more extensive type 1 changes, and 8% showed no change.

It is frequently stated that only a small proportion (approximately 20%) of patients with LBA can certainly be diagnosed based on a pathoanatomical entity.[30] To clarify the relations between MC and LBA, a series of prospective studies have been conducted.

CONCLUSION

MODIC changes can clearly be detected in MRI and also wide spectrum disc abnormalities can be easily diagnosed in MRI. Depending on age, severity, clinical findings clinicians can opt for MRI for ultimate diagnosis of disc abnormalities and MODIC changes. Radiologist should be able to recognize and differentiate these changes from other bone marrow signal intensity changes that exist in vertebral bodies.

REFERENCES

1. Prof Chris Maher, Prof Rachelle Buchbinder, Non-specific low back pain. The lancet 2016 Feb 4;379(9814):482-91
2. Sathish Babu S et al. MRI in the Diagnosis of Low Backache, International Journal of Anatomy, Radiology and Surgery. 2017 Apr, Vol-6(2): RO37-RO40
3. Kerry J Thompson, Timothy S, Michael Clark, James W : Modic Changes on MR Images as Studied with Provocative Diskography. Radiology. March 2009;250:849- 855.
4. Modic MT: Modic type 1 and type 2 changes. J Neurosurg Spine 2007; 6:150–51
5. Igbinedion BOE and Akhigbe A. Correlations of Radiographic Findings in Patients with Low Back Pain, Niger Med J. 2011 Jan-Mar; 52(1): 28–34

6. Humaira Lateef and Deepak Patel, What is the role of imaging in acute low back pain? Curr Rev Musculoskelet Med. 2009 Jun; 2(2): 69–73.
7. Chiodo A. Acute low back pain. In: Low back pain guideline update. University of Michigan Health System; 2003.
8. Han C, MaX , Ma J et al Distribution characteristics of Modic changes of lumbar endplate and its relationship with low back pain Chinese journal of reparative and reconstructive surgery. 2009 Dec;23(12):1409-12.
9. Karchevsky M, Schweitzer ME, Carrino JA, Zoga A, Montgomery D, Parker L Reactive endplate marrow changes: a systematic morphologic and epidemiologic evaluation. Skeletal Radiol. 2005;34:125–129.
10. Toyone T, Takahashi K, Kitahara H, Yamagata M, Murakami M,Moriya H Vertebral bone-marrow changes in degenerative lumbar disc disease: an MRI study of 74 patients with low back pain J Bone Joint Surg Br. 1994;76:757– 764.
11. Keyvan Mostofi, Babak Gharaei Moghaddam, Morad Peyravi. Late appearance of low back pain relating to modic change after lumbar discectomy.Journal of Craniovertebral junction and spine. 2018;9(2):93-95.
12. Kuisma M, Karppinen J, Niinimaki J et al. MODIC changes in endplates of lumbar vertebral bodies: prevalence and association with low back and sciatic pain among middle-aged workers. Spine 2007;32:1116-22.
13. de Ross A, Kressel H, Spritzer C et al. MR imaging of marrow changes adjacent to end plates i degenerative lumbar disk disease. Am J Roentgenol. 1987;149:531-34.
14. Schmid G, Witteler A, Willburger R et al. Lumbar disk herniation : correlation of histologic findings with marrow signal intensity changes in vertebral endplates at MR imaging. Radiology. 2004;231:352-58.
15. Braithwaite I, White J, Saifuddin A et al. Vertebral end-plate (Modic) changes on lumbar spine MRI: correlation with pain reproduction at lumbar discography. Eur Spine J. 1998;7:363-68.
16. Kerttula L, Luoma K, Vehmas T, et al. Modic type I change may predict rapid progressive, deforming disc degeneration: a prospective 1-year follow-up study. Eur Spine J 2012;21:1135–42.
17. Kjaer P, Korsholm L, Bendix T, Sorensen JS &Leboeuf-Yde C Modic changes and their associations with clinical findings. Eur Spine J. 2006;15(9): 1312– 1319.
18. Luoma K, Riihimaki H, Raininko R, Luukkonen R, Lamminen A &Viikari- Juntura E Lumbar disc degeneration in relation to occupation. Scand J Work Environ Health (1998) 24(5): 358–366.
19. Pfirrmann CW, Metzdorf A, Zanetti M, Hodler J & Boos N Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine 2001 26(17): 1873–1878
20. Pfirrmann CW, Dora C, Schmid MR, Zanetti M, Hodler J & Boos N MR image- based grading of lumbar nerve root compromise due to disk herniation: reliability study with surgical correlation. Radiology (2004) 230(2): 583–588.
21. Annette Kettler and Hans-Joachim Wilke Review of existing grading systems for cervical or lumbar disc and facet joint degeneration Eur Spine J. 2006 Jun; 15(6): 705–718.
22. Lane NE, Nevitt MC, Genant HK, Hochberg MC. Reliability of new indices of radiographic osteoarthritis of the hand and hip and lumbar disc degeneration. JRheumatol. 1993;20(11):1911–1918.
23. Pye SR, Reid DM, Smith R, Adams JE, Nelson K, Silman AJ, O'Neill TWRadiographic features of lumbar disc degeneration and self-reported back pain. J Rheumatol. 2004 Apr;31(4):753-8.
24. Toyone T, Takahashi K, Kitahara H et al. Vertebral bone-marrow changes in degenerative lumbar disc disease : an MRI study of 74 patients with low back pain. J Bone Joint Surg Br. 1994;76:757-64.
25. Mitra D, Cassar-Pullicino VN, McCall IW. Longitudinal study of vertebral type -1 end plate changes on MR of the lumbar spine. Eur Radiol. 2004;14:1574-81.
26. Teichtahl AJ, Urquhart DM, Wang J, et al. Lumbar disc degeneration is associated with modic change and high paraspinal fat content: a 3.0T magnetic resonance imaging study. BMC MusculoskeletDisord 2016;17:439.
27. Jensen TS, Kjaer P, Korsholm L, et al. Predictors of new vertebral endplate signal (Modic) changes in the general population. Eur Spine J 2010;19:129–35.
28. Crock HV. Internal disc disruption : a challenge to disc prolapsed fifty years on. Spine 1986;11:650-53.
29. Albert BH, Manniche C. Modic changes following lumbar disc herniation. Eur Spine J. 2007 Jul;16(7):977-982.
30. Waddell G 1987 Volvo award in clinical sciences: a new clinical model for the treatment of low-back pain. Spine. 1987;12:632– 644.

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