SJIF Impact Factor: 5.464

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 6.
Issue: 12
Page N. 01-07
Year: 2022

Original Article www.wjahr.com

MODIC CHANGES AND THEIR ASSOCIATION WITH INTERVERTEBRAL DISC CHANGES SEEING BY MRI IN PATIENTS WITH LOW BACK PAIN

Hussein Harfoush[1]*, Fawaz Baddour[2] and Mohammed Abdulrahman[3]

[1,2]Department of Radiology, Tishreen University, Faculty of Medicine, Latakia, Syria.
[3]Department of Neurosurgery, Tishreen University, Faculty of Medicine, Latakia, Syria.

Received date: 28 September 2022 **Revised date:** 18 October 2022 **Accepted date:** 08 November 2022

***Corresponding Author: Dr. Hussein Harfoush**

Department of Radiology, Tishreen University, Faculty of Medicine, Latakia, Syria.

ABSTRACT

Introduction: The characterization of Modic changes visible by magnetic resonance imaging(MRI) in the lumbar spine in patients with low back pain, and the definition of their patterns and distribution according to gender, age, and lumbar motion segment, and the proportions of their association with degeneration of the adjacent intervertebral discs and the morphological changes in them, is very important in order to reach a more accurate diagnosis, which may change the direction of management and treatment plan for these patients. **The Aim of the Research:** Characterization of Modic changes visible by MRI in the lumbar spine in patients with low back pain, and investigating the relationship between them and other variables in the adjacent cartilaginous disc (disc degeneration, intervertebral disc shape), and determining the proportions of the distribution of these changes according to gender, age, lumbar motion segment, and the most common Pattern in patients with low back pain. **Materials and Methods:** A total of 156 patients were enrolled. Gender, age, lumbar motion segment, grade of paravertebral disc degeneration, and intervertebral disc shape, respectively, were documented. Modic changes and their relationship with the mentioned variables were studied using a descriptive cross sectional study. **Results:** A total of 18 patients had type I changes, 124 patients had type II changes, and 14 patients had type III changes. In total, 213 affected lumbar motion segments were seen, L1/L2 (5 segments), L2/L3 (17 segments), L3/L4 (27 segments), L4/L5 (48 segments) and L5/S1 (116 segments). Type I changes were mainly seen under the age of 50. The descriptive cross-sectional study showed that gender, age, lumbar motion segment, paravertebral disc degeneration, and intervertebral disc shape were associated with different patterns of Modic changes. **Conclusion:** Type II changes are the most common, followed by type I changes. Modic changes occur mostly in L4/L5 and L5/S1; It was found that the age of youth, males, and disc protrusion were associated with the changes of the first type.

KEYWORDS: Modic changes, Motion segment, Intervertebral disc degeneration, Intervertebral disc shape, Low back pain.

I. INTRODUCTION

Low back pain (LBP) is one of the most disabling conditions in the world, in addition to being associated with high medical expenses and significant psychological and social consequences,[1] which leads to huge economic burden in developed countries.[2] More than 80 percent of people will experience an episode of LBP at some point in their lives regardless of gender,[3,4,5] and although LBP is one of the most common symptoms leading to a visit to a doctor,[6] effective treatment is limited by failure to identify the underlying disease in the vast majority of patients who seek care.[7] Modic changes (MCs) are changes in the signal of the vertebral endplates and the adjacent subchondral vertebral marrow visible on MRI that are differentiated into three types based on their signal change in T1 and T2 MRI weighted images.[8,9,10] MCs in the lumbar spine are closely associated with LBP.[10,11,12,13] So that, it was necessary to draw attention to these pathological changes that can be diagnosed in all their forms through MRI, and to show their distribution in our society in particular, and their relationship to degenerative lumbar intervertebral disc changes, and intervertebral disc shape in the lumbar spine, in order to reach the optimal diagnosis that may change the direction of management and treatment plan in these patients.

II. MATERIALS AND METHODS

Information of each patient with typical Modic changes were entered in the study after receiving the informed consent from the patient.

Study design
Observational Descriptive Study (Cross-sectional).

Duration of the study
14 months between 1/6/2021 and 31/7/2022.

Inclusion criteria
Patients with LBP who underwent lumbar MRI at Radiology department in Tishreen University Hospital, with both T1 and T2-weighted images and were diagnosed with typical MCs in lumbar endplates.

Exclusion criteria
1. Patients with tumors.
2. Vertebral fractures within diseased vertebrae.
3. Spondylolisthesis within diseased vertebrae.
4. Schmorl's nodes within diseased vertebrae.
5. Previous surgery on lumbar spine.
6. Scoliosis in lumbar spine.
7. Patients with tuberculosis.

Materials
The study included Patients suffered from LBP who did lumbar MRI scan on 1.5 tesla MRI device at Tishreen University Hospital, Latakia and diagnosed to have Modic changes.

Sample size
A total of 156 patients were enrolled, 91 females, and 56 males.

Modic changes
According to classification criteria proposed by Modic et al,[9] Modic changes were classified under three types:
Type I: low signal on T1WI, high signal on T2WI.
Type II: high signal on T1WI, iso or slightly high signal on T2WI.
Type III: low signal on T1WI, low signal on T2WI. Figure (1).

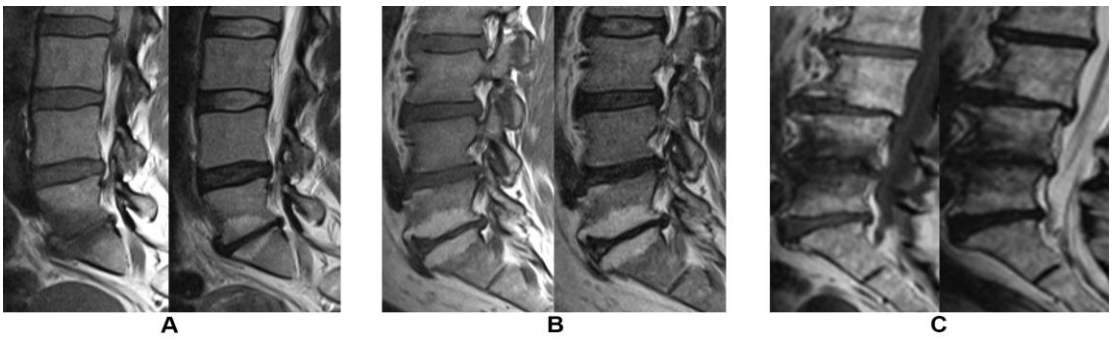

Figure 1: Typical Modic changes in lumbar vertebral spine. A. Type I changes; B. type II changes; C. type III changes.[14]

Age
Patients were divided into 3 age groups:
1. Young adults: Equal or less than 44 years.
2. Middle-Aged adults: 45-59 years.
3. Old-ages adults: 60 years or more.

Disc degeneration
According to Pfirrmann et al.[15] classification, Disc degenerateion cases were divided into 5 grades (Figure 2).

B

MRI grade	NP	Demarcation between NP and AF	NP intensity	Disc height
I	Homogeneous	Clear	Hyperintense	Normal
II	Inhomogeneous; horizontal white band	Clear	Hyperintense	Normal
III	Inhomogeneous	Unclear	Intermediate	Normal to decreased
IV	Inhomogeneous	Lost	Hypointense	Decreased
V	Inhomogeneous	Lost	Hypointense	Collapsed

Figure 2: Pfirrmann classification of intervertebral disc degeneration. A. Disc degenerative grading by sagittal T2-weighted MRI. B. Disc degeneration graded by homogeneity of the nucleus pulposus, demarcation between the nucleus pulposus and annulus fibrosus, intensity of the nucleus pulposus, and disc height. NP: Nucleus pulposus. AF: Annulus fibrosus.[16]

Intervertebral disc shape

Based on the document done by the multidisciplinary team of the North American Spine Society (NASS), the American Society of Spine Radiology (ASSR), and the American Society of Neuroradiology (ASNR) and published in 2001,[17] and Updated in 2014,[18] it has been agreed to describe the morphology of lumbar intervertebral disc into: Normal, bulged, protruded, extruded and sequestrated (Figure 3).

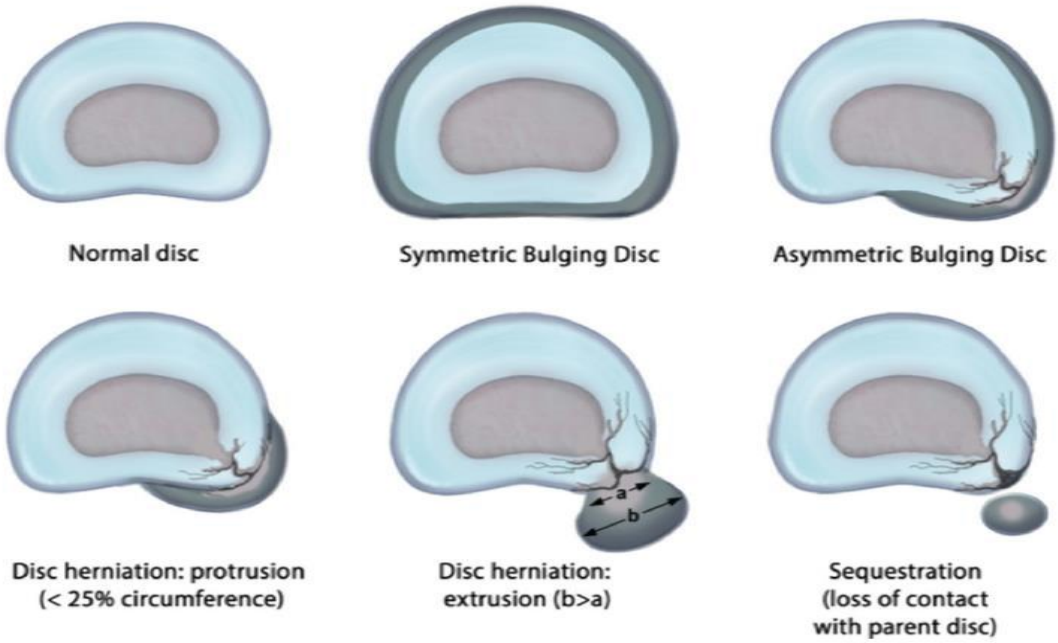

Figure 3: Summary of Disc nomenclature Based on 2014 Consensus Document.[19]

Data analysis

All data were evaluated by neurosurgeon and radiology specialist.

Data were analysed using IBM SPSS statistics (version 20). Firstly Chi-Square or Fisher Exact test was used to study the relation between qualitative variables, and P-value < 0.05 indicates that data have statistical indication.

III. RESULTS

The research aims to show the proportions of the three types of Modic changes between patients suffering low back pain and the relationship with gender, age, lumbar motion segments, adjacent disc degeneration and the adjacent intervertebral disc shape. Eventually, we made a comparison with four global studies[9,20,21,22]

In our study we have included 156 patients, 91 females and 65 males.

Sex ratio: F:M = 1.4:1

The relation between Modic changes and gender

Modic changes type I were higher in males with proportion 66.7%.

In contrast, Modic changes type II and III were higher in females, with proportion 62.1% and 57.1% respectively.

Male patients were related to type I and females were related to type II with P-value = 0.03 (Table 1).

Table 1: Distribution of different types of Modic changes with gender.

Sex	Modic Changes			Total	P-value
	I	II	III		
Male	12(66.7%)	47(37.9%)	6(42.9%)	65	0.03
Female	6(33.3%)	77(62.1%)	8(57.1%)	91	
Total	18	124	14	156	
P-value	0.001	0.001	0.5		

The relation between Modic Changes and Age

Patients' age in our study were between 21 and 82 years. The most common age is 45-59 years in 84 cases. The second age group is equal or up to 60 year.

Modic changes type I were higher in ages equal or less than 44 year.

In contrast, type II Modic changes were higher in ages 45-59 years with P-value=0.01 (Table 2).

Table 2: Distribution of different types of Modic changes with age.

Age Group	Modic Changes			Total	P-value
	I	II	III		
≤44	10(55.6%)	23(18.5%)	2(14.3%)	35	0.01
45-59	6(33.3%)	71(57.3%)	7(50%)	84	
≥60	2(11.1%)	30(24.2%)	5(35.7%)	37	
Total	18	124	14	156	
P-value	0.01	0.04	0.01		

The relation between Modic Changes and Affected lumbar motion segments

In our study, 213 lumbar motion segments are affected in 156 patients.

L4-L5 and L5-S1 are the most affected segments with any type of Modic changes with P-value= 0.002 (Table 3).

Table 3: Distribution of different types of Modic changes with involved motion segments.

Motion Segment	Modic Changes			Total	P-value
	I	II	III		
L1 – L2	0(0%)	4(2.3%)	1(5.9%)	5	0.002
L2 – L3	1(4.8%)	14(8%)	2(11.8%)	17	
L3 – L4	2(9.5%)	22(12.6%)	3(17.6%)	27	
L4 – L5	4(19%)	37(21.1%)	7(41.2%)	48	
L5 – S1	14(66.7%)	98(56%)	4(23.5%)	116	
Total	21	175	17	213	
P-value	0.001	0.005	0.02		

The relation between Modic Changes and Degeneration of adjacent lumbar intervertebral disc dut to Pfirrman classification

Our study revealed that Modic changes of any type are related to significant degeneration grades of adjacent disc with P-value=0.0001 (Table 4).

Table 4: Distribution of different types of Modic changes with Pfirrmann classification.

IVD Degeneration Grade	Modic Changes			Total	P-value
	I	II	III		
II	3(14.3%)	3(1.7%)	0(0%)	6	0.0001
III	7(33.3%)	63(36%)	3(17.6%)	73	
IV	9(42.9%)	83(47.4%)	6(35.3%)	98	
V	2(9.5%)	26(14.9%)	8(47.1%)	36	
Total	21	175	17	213	
P-value	0.01	0.02	0.003		

The relation between Modic changes and adjacent intervertebral disc shape according to described morphologies of intervertebral disc presented in 2014

Modic changes have a high frequency with both protrusion and extrusion with P-value=0.001 (Table 5).

Table 5: Distribution of different types of Modic changes with Intervertebral disc Shape.

Intervertebral disc shape	Modic Changes			Total	P-value
	I	II	III		
Normal/Bulged	2(9.5%)	12(6.9%)	0(0%)	14	0.001
Protruded	10(47.6%)	65(37.1%)	5(29.4%)	80	
Extruded	7(33.3%)	92(52.6%)	12(70.6%)	111	
Sequestrated	2(9.5%)	6(3.4%)	0(0%)	8	
Total	21	175	17	213	
P-value	0.06	0.08	0.002		

IV. DISCUSSION AND COMPARING WITH WORLD STUDIES

The relation between Modic Changes and Gender

Male patients were related to type I and females were related to type II.

Males have more physical activities than females which lead to application of more strength on vertebral column in comparison with females, so that micro fractures in males couldn't be perfectly repaired and that causes micro fractures and co-inflammatory edema for longer

time. While in females, micro fractures have enough time to heal making type I to transform rapidly to type II then type III.

Our study has the same result as Chen et al. study 2019[20] but Chao Hanl et al. study 2017[22] showed that type I Modic changes is more common in females and that could be due to the low number of patients included (47 patients) (Table 6).

Table 6: Comparing the results of the research with the results of international studies regarding to distribution of the research sample by gender.

Comparative Studies	Sample Size	Ratio of infected males to females with type 1	Ratio of infected males to females with type 2	Ratio of infected males to females with type 3
Chinese Study 2019(Chen et al.)	153 cases (204 motion segment)	23/12 (65.7/34.3)%	49/61 (44.5/55.5)%	Didn't registered
Chinese Study 2017 (Chao Hanl et al.)	47 cases (58 motion segment)	6/10 (37.5/62.5)%	8/17 (32/68)%	2/4 (66.7/33.3)%
Our study 2022	156 cases (213 motion segment)	12/6 (66.7/33.3)%	47/77 (37.9/62.1)%	6/8 (42.9/57.1)%

The relation between Modic Changes and Age

Modic changes type I were higher in ages equal or less than 44 year.

In contrast, type II Modic changes were higher in ages 45-59 years.

This result may be due to the younger ages of beginning of degenerative process which starts with type I MC, then the degeneration develops with growing.

Chen et al. study 2019[20] revealed the same result as our study (Table 7).

Table 7: Comparison with international studies with regard to the distribution of the research sample by age groups.

Comparative Studies	Most Frequent Age Group with Modic Type I	Most Frequent Age Group with Modic Type II	Most Frequent Age Group with Modic Type III
Chinese Study 2019(Chen et al.)	Youth group (≤44 yr) 15 cases (42.9%)	Middle-aged (45-59 yr) 50 cases (45.5%)	Didn't registered
Our study 2022	Youth group (≤44 yr) 10 cases (55.6%)	Middle-aged (45-59 yr) 71cases (57.3%)	Middle-aged (45-59 yr) 7 cases (50%)

The relation between Modic Changes and Affected lumbar motion segments

L4-L5 and L5-S1 are the most affected segments with any type of Modic changes. We refer that to the fact that those two segments are under the highest pressure in lumbar spine.

The same result is in MD et al. 1988 study[9] and Chen et al. 2019 study[20] (Table 8).

Table 8: Comparison of the results of the study with the results of international studies regarding the distribution of the research sample on the lumbar motion segments.

Comparative Studies	Sample Size	The percentage of the most affected segment by the first type	The percentage of the most affected segment by the second type	The percentage of the most affected segment by the third type
American Study 1988(Michael T. Modic, MD et al.)	474 cases (117 motion segment)	L4-L5,L5-S1 (35% each)	L5-S1 (42.3%)	Didn't study
Chinese Study 2019(Chen et al.)	153 cases (204 motion segment)	L5-S1 (42.9%)	L5-S1 (50.9%)	Didn't registered
Our study 2022	156 cases (213 motion segment)	L5-S1 (66.7%)	L5-S1 (56%)	L4-L5 (41.2%)

The relation between Modic changes and degeneration of adjacent lumbar intervertebral disc due to Pfirrman classification

Our study revealed that Modic changes of any type are related to significant degeneration grades of adjacent disc.

This result may be due to the fact that disc degeneration causes structural changes in the disc which increase with the progression of disc degeneration grade. In turn this lead to impairment in distribution of loads between disc and adjacent vertebrae, which leads increasing in micro fractures in endplates and beginning of Modic changes. Vice versa, Modic changes leads to decrease of nutrition of the disc and subsequently disc degeneration.

We see the same result in Chen et al. 2019 study[20] and Li-Peng Yu et al. 2012 study[21] (Table 9).

Table 9: Comparison of the results of the study with the results of international studies regarding the distribution of the research sample to the degenerated adjacent lumbar intervertebral discs.

Comparative Studies	The highest type I Modic change ratio	The highest type II Modic change ratio	The highest type III Modic change ratio
Chinese Study 2019(Chen et al.)	Fourth grade disc degeneration (34.3%)	Fifth grade disc degeneration (49.1%)	Didn't registered
Chinese Study 2012(Li-Peng Yu et al.)	Fourth grade disc degeneration (66.7%)	Fourth grade disc degeneration (83.3%)	Didn't study
Our study 2022	Fourth grade disc degeneration (42.9%)	Fourth grade disc degeneration (47.4%)	Fifth grade disc degeneration (47.1%)

The relation between Modic changes and adjacent intervertebral disc shape according to described morphologies of intervertebral disc presented in 2014

Modic changes have a high frequency with both protrusion and extrusion.

Modic changes cause decrease in nutrition of adjacent intervertebral disc with soluble nutrients with distribution process leading to degeneration of disc. This pathological changes cause the annulus fibrosis to be vulnerable causing tears and disc herniation. The herniation itself increases the micro fractures in endplates due to load distribution impairment.

Chen et al. 2019 study[20] has the same result in type I. But differs in type II, where it revealed that type II also accompany higher rate of protrusion not extrusion as in ours. The difference we saw may relate to the differences between communities. That our community stress the lumbar spine a lot and patient don't seek medical advice as soon as they have low back pain. So that our patient reach progressive stages (Table 10).

Table 10: Comparison of the results of the study with the results of international studies regarding the distribution of the research sample to the herniated adjacent lumbar intervertebral discs.

Comparative Studies	The highest type I Modic change ratio	The highest type II Modic change ratio	The highest type III Modic change ratio
Chinese Study 2019(Chen et al.)	Disc Protrusion (65.7%)	Disc Protrusion (52.7%)	Didn't registered
Our study 2022	Disc Protrusion (47.6%)	Disc Extrusion (52.6%)	Disc Extrusion (70.6%)

V. CONCLUSION

MRI is the radiology of choice to diagnose the vast majority of low back pain causes in order to give the best treatment choice to the patient.

MRI is the only radiologic tool that diagnose Modic changes in their three types and their relation with other structures.

Modic changes are one of the causes of low back pain and there is a strong relation between pain and Modic changes.

Type II of Modic changes is the most common type. Ages 45-59 are the most affected with Modic changes between low back pain patients.

There is indication statistically important with P-value<0.05 between type I of Modic changes and male gender, and type II with female gender.

There is indication statistically important with P-value<0.05 between Modic changes and lower two lumbar motion segments.

There is indication statistically important with P-value<0.05 between Modic changes and significant grades of degeneration of adjacent intervertebral disc.

There is indication statistically important with P-value<0.05 between Modic changes and existence of protrusion and extrusion of adjacent intervertebral disc.

VI. REFERENCES

1. Theodorou DJ, Theodorou SJ, Kakitsubata S, Nabeshima K, Kakitsubata Y: Abnormal conditions of the diskovertebral segment: MRI with anatomic-pathologic correlation. AJR Am J Roentgenol, 2020; 214: 853 - 61.10.2214/AJR.19.22081.
2. Vos T, Flaxman AD, Naghavi M. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet, 2012; 380: 2163–96.
3. Rubin DI. Epidemiology and risk factors for spine pain. Neurol Clin, 2007; 25(2): 353–371.
4. Berg-Johansen B, Han M, Fields AJ, et al. Cartilage endplate thickness variation measured by ultrashort echo-time MRI is associated with adjacent disc degeneration. Spine, 2018; 43(10): E592.
5. Licciardone JC. The epidemiology and medical management of low back pain during ambulatory medical care visits in the United States.Osteopath Med Primary Care, 2008; 2(1): 1-17.
6. Andersson GB. Epidemiological features of chronic low-back pain. Lancet, 1999; 354: 581–5.
7. Deyo RA, Weinstein JN. Low back pain. N Engl J Med, 2001; 344: 363–70.
8. De Roos A, Kressel H, Spritzer C, et al.MR imaging of marrow changes adjacent to end plates in degenerative lumbar disk disease. AJR Am J Roentgenol, 1987; 149: 531–34.
9. Modic MT, Steinberg PM, Ross JS, et al. Degenerative disk disease: assessment of changes in vertebral body marrow with MR imaging. Radiology, 1988; 166: 193–99.
10. Modic MT, Masaryk TJ, Ross JS, et al. Imaging of degenerative disk disease. Radiology, 1988; 168: 177–86.
11. Kuisma M, Karppinen J, Niinimäki J, et al. Modic changes in endplates of lumbar vertebral bodies **:** prevalence and association with low back and sciatic pain among middle-aged male workers. Spine, 2007; 32: 1116–22.
12. Jensen TS, Karppinen J, Sorensen JS et al Vertebral endplate signal changes (Modic change): a systematic literature review of prevalence and association with non-specific low back pain. Eur Spine J, 2008; 17: 1407–1422.
13. Kjaer P, Korsholm L, Bendix T, Sorensen JS, Leboeuf-Yde C Modic changes and their associations with clinical findings. Eur Spine J, 2006; 15: 1312–1319.
14. Herlin C, Kjaer P, Espeland A, Skouen JS, Leboeuf-Yde C, et al. Modic changes—Their associations with low back pain and activity limitation: A systematic literature review and meta-analysis. PLOS ONE, 2018; 13(8): e0200677.
15. Pfirrmann CWA, Metzdorf A, Zanetti M, et al. Magnetic resonance classification of lumbar intervertebral disc degeneration. Spine, 2001; 26(17): 1873–8.
16. Chen CM, Sun LW, Tseng C, Chen YC, Wang GC Surgical outcomes of full endoscopic spinal surgery for lumbar disc herniation over a 10-year period: A retrospective study. PLOS ONE, 2020; 15(11): e0241494.
17. Fardon, David F. MD* and; Milette, Pierre C. MD†. Nomenclature and Classification of Lumbar Disc Pathology: Recommendations of the Combined Task Forces of the North American Spine Society, American Society of Spine Radiology, and American Society of Neuroradiology. Spine: March, 2001; 1, 26, 5: E93-E113.
18. Fardon DF, Williams, AL, Dohring EJ, *et al.* Lumbar Disc Nomenclature: Version 2.0: Recommendations of the Combined Task Forces of the North American Spine Society, the American Society of Spine Radiology, and the American Society of Neuroradiology. *Spine J*, 2014; 14(11): 2525–2545.
19. Brant and Helms' Fundamentals of Diagnostic Radiology fifth edition, 2019.
20. Chen Y, Bao J, Yan Q, Wu C, Yang H, Zou J. Distribution of Modic changes in patients with low back pain and its related factors. Eur J Med Res, 2019; 9, 24(1): 34. doi: 10.1186/s40001-019-0393-6. PMID: 31597571; PMCID: PMC6784341.
21. Yu LP, Qian WW, Yin GY, Ren YX, Hu ZY. MRI assessment of lumbar intervertebral disc degeneration with lumbar degenerative disease using the Pfirrmann grading systems. PLoS One, 2012; 7(12): e48074. doi: 10.1371/journal.pone.0048074. Epub 2012 Dec 20. PMID: 23284612; PMCID: PMC3527450.
22. Han, Chao & Kuang, Ming-jie & Ma, Jian-xiong & Ma, Xin-long. Prevalence of Modic changes in the lumbar vertebrae and their associations with workload, smoking and weight in northern China. Scientific Reports, 2017; 7: 46341. 10.1038/srep46341.