Investigating a Possible Link between MRI Findings of Lumbar Disc Degeneration and Modic Changes in the Patients with Chronic Low Back Pain

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Abstract

Background: In the patients with chronic low back pain (CLBP), a variety of Magnetic Resonance Imaging (MRI) abnormalities may be present that may not be necessarily associated with clinical complaints. We aim to investigate the relationship between MRI findings of lumbar disc degeneration and Modic changes in the patients with CLBP.

Materials and Methods: We carried out a cross-sectional study on MRI scanning of 60 cases with CLBP. We used Pfirrmann classification and Modic changes (MC) for grading of lumbar disc degeneration and vertebral endplate signal changes, respectively. We studied these two indices in three lower lumbar intervertebral disc and adjacent endplates in cooperation with an expert radiologist and at the last, we analyzed and compared their relationships with each other.

Results: Our patients had equal sex distribution and mean age of 50.8±13.6-year-old and Body Mass Index (BMI) of 27.3±4.7. MC type II was the most common change throughout lumbar region. We found a positive effect of age on disc degeneration (not MC) in all three levels. In our study, BMI had no significant effect on these two indices. There was also significant correlation between these two indices in especially two lower lumbosacral spaces.

Conclusion: We found that age was a determinant factor for lumbar disc degeneration. A significant positive correlation was also found between disc degeneration and MC especially in two lower lumbosacral disc spaces. In other words, these two variables may in fact be a manifestation of a single degenerative process.

Keywords: Disc degeneration; Modic changes; Low back pain; Magnetic resonance imaging

Introduction

Low back pain is one of the most common causes of referral to a physician and at the same time is among the costliest health problems in developed societies [1]. Chronic low back pain (CLBP) is the most common cause of disability in people under the age of 45 years old, the third most common cause of surgery, and the fifth cause of hospitalization in developed countries like United States [2]. In 1986, about $20 billion was spent on back pain in this country [3]. In the patients with refractory and CLBP, Magnetic Resonance Imaging (MRI) may be helpful in identifying underlying anatomy and illness, although many of MRI findings may not be necessarily related to clinical complaints [4,5]. Two of the most common MRI findings in these patients are Modic changes and degenerative disc disease (DDD). Although, these two indices occur in two distinct regions, both arise from degenerative process [6]. According to our knowledge, although there are numerous papers on these two degenerative indices (Modic changes and DDD), there

is a few studies discussed the relationship between the two [7-10]. In this study, we paid attention to this matter to find a possible link between MRI findings of lumbar disc degeneration and Modic changes in the patients with CLBP.

Materials and Methods

After obtaining local institutional review board approval, we carried out a cross-sectional study on 60 cases with chronic low back pain (CLBP) lasted more than three months. Our inclusion criteria were age more than 20 years old, pain located between 12th rib and transverse gluteal fold, and pain duration of more than three months. We excluded those cases with a history of trauma or surgery on lumbar spine, immature patients, patients with significant underlying diseases like autoimmune or malignant diseases, renal failure, immunosuppression, chronic infection, significant drug consumption, and magnetic resonance imaging

(MRI) scanning older than two months. We used Pfirrmann classification for grading of lumbar disc degeneration on T2 weighted images of MRI [11]. According to this classification, disc degeneration was graded from I (normal disc with homogenous structure, clear distinction of nucleus and annulus, high signal intensity, and normal intervertebral height) to V (inhomogeneous black structure with no distinction of nucleus and annulus, decreased signal intensity, and collapsed height). For classifying vertebral endplate signal changes, we used the original paper published by Modic et al. [12]. In Modic type I, decreased signal intensity and increased signal intensity are observed along the adjacent vertebral endplates on T1 and T2 images, respectively. In Modic type II, increased signal intensity is present on both T1 and T2, while in Type III, decreased signal intensity exists on both images. These changes are assumed to be a result of fibrovascular, fatty, and bone sclerosis replacement, respectively [13]. We studied these two indices in three lower lumbar intervertebral disc and adjacent endplates in cooperation with an expert radiologist and at the last, we analyzed and compared their relationships with each other.

Statistical analysis

The descriptive statistics were expressed in terms of frequency, mean, standard deviation and appropriate tables and charts. We used Spearman correlation test to examine the correlation between variables and Chi-square or Fisher test to compare qualitative variables. To analyze the distribution of ordinal variables in two groups and more than two groups, Mann Whitney and Kruskalwallis tests were used, respectively. P value of 5% was considered significant statistically.

Results

We studied 60 patients with equal sex distribution and with mean age of 50.8±13.6-year-old and Body Mass Index (BMI) of 27.3±4.7. Equal gender distribution was a completely incidental event. The main pathologic disease among our patients included lumbar spinal stenosis (38.3%), lumbar disc herniation (33.3%), spondylolisthesis (13.3%), non-specific CLBP (11.7%), and thoracic hyper-kyphosis (3.4%). Prevalence of Modic changes (MC) were type I (3.3%), type II (8.3%), and type III (1.7%). MC type II was the most common change throughout lumbar region, although in 87.7% of the patients, there was no evidence of any MC at all. The most common grade of disc degeneration among our patients in L3-L4, L4-L5, and L5-S1 were grade 1 (31.7%), grade 3 (33.3%), and grade 3 (41.7%), respectively.

Table 1 shows the association between age and BMI with MC and Disc degeneration. As the table shows, the only association we have found is the positive effect of age on disc degeneration in all three levels. This effect could not be found between these indices and Modic changes. Interestingly, BMI has no significant effect on Modic changes or disc degeneration. Table 2 shows the association between MC and grades of disc degeneration in three lower lumbar intervertebral discs. There is significant relationship between these two indices in L4-L5 and L5-S1 levels (P: 0.04 and 0.01, respectively), although a non-significant association also exists in L3-L4 level. This means that with increasing intensity of each of these two, the intensity of the other variable also increases.

Table 1: Association between age and BMI with Modic change and disc degeneration.

Index/Lumbar Level	Age		BMI*	
	r	p	r	p
L3-L4 -Modic change - Disc Degeneration	0.08 0.451	0.53 <0.001	0.59 0.086	0.65 0.513
L4-L5 -Modic change - Disc Degeneration	0.03 0.541	0.76 <0.001	0.05 0.114	0.67 0.387
L5-S1 -Modic change - Disc Degeneration	0.05 0.514	0.67 0.018	0.08 0.039	0.52 0.766

*BMI: Body Mass Index

Table 2: Association between modic changes and disc degeneration.

Grade of Degeneration/Level of Disc	Grade I (%)	Grade II (%)	Grade III (%)	Grade IV (%)	Grade V (%)	Total (%)	P value
L3-L4 -Without Modic Change -With Modic Change	18(34) (14.3)	17(32) 1(14.3)	9(17) 2(28.6)	4(7.5) 1(14.3)	5(9.4) 2(28.6)	53(100) 7(100)	0.08

L4-L5 -Without Modic Change -With Modic Change	4(7.8) 0	14(27.5) 0	16(31.4) 4(44.4)	13(25.5) 3(33.3)	4(7.8) 2(22.2)	51(100) 9(100)	0.04*
L5-S1 -Without Modic Change -With Modic Change	5(8.3) 0	14(25.9) 0	23(42.6) 2(33.3)	10(18.5) 2(33.3)	2(3.7) 2(33.3)	54(100) 6(100)	0.01*

*Statistically significant

Discussion

MC and disc degeneration are subjects that have long been known and there are many articles have been exploring and discussing etiology, pathophysiology and determinant factors affecting their occurrence and severity, but few studies focused on the relationship between these two indices. Reviewing the literature suggests that higher BMI is associated with greater chance of endplate changes. In a study conducted in Finland, lumbosacral MRI scanning was performed on 228 workers to analyze MC and disc degeneration [14]. The authors found that although prevalence of MC and disc degeneration were similar, the main determinants for MC and disc degeneration were different. Age was associated with increase in both these degenerative changes but BMI and whole-body vibration were the main determinants of MC and disc degeneration, respectively. Another study on a mainly twin population also found a positive correlation between BMI and MC [15]. Our study could not show a significant effect of BMI on MC or disc degeneration. In our study, we could only find a positive effect of age on disc degeneration (not MC). These contradictions may be due to differences in sample size and individual characteristics of the patients being studied.

One of the studies that worked on MC and disc degeneration is related to Guo et al. [16] who retrospectively studied the correlation between MC and disc degeneration in lower lumbar area. Similar to our study, they evaluated lower three lumbar segments by MRI scanning. They found that type II MCs was the most common type that mostly situated in L4-L5 region. According to their study, MCs (particularly type II) have positive relationship with lumbar disc degeneration and therefore, could be assumed to be one of the indicators of lumbar disc degenerations. This study was in line with our study and had similar results. Another study that has similar results to ours is Teichtahl's that performed lumbosacral MRI in 72 cases unselected for LBP [17]. The results of this cross-sectional study indicated that lumbar disc degeneration is highly associated with MC and thus used the phrase "whole-organ pathology" for these two indices.

Xiao et al. [18] carried out a relatively large study on 345 patients. They performed MRI scanning of the lumbosacral region in order to assess possible relationship between MC and disc degeneration (by Pfirrmann grade). They identified a positive relationship between the two indices in such a way that MC can reflect the degree of disc degeneration and vice versa. In addition to this large study, we found a larger study also deals with the relationship between these two indices [8]. In this study, the authors performed clinical and para-clinical (lumbar spine MRI) assessment on 2,449 Chinese volunteers in order to investigate their possible associations.

According to our knowledge, this is the largest study on MC and disc degeneration. The authors found that overall incidence of MC was 5.8% that highly associated with aging. They found that aging, smoking, obesity, Schmorl node, degenerated disc, and a previous history of trauma were determinant factors for MC in lower lumbar area and these changes were highly associated with historical LBP (both in severity and symptom duration). If we put all the results of these studies with the results of our own research work, it seems that MC and disc degeneration are two aging indices have a positive relationship with each other and have relatively similar determinants.

Our study had some important weaknesses and strengths. First, the sample size of our study was relatively fewer than that of the similar studies. This flaw certainly leads to reduce the precision of the statistical tests and finally the power of conclusion. Second, the study was conducted at a clinic in a public (not private) hospital. Therefore, the sample tested may not be an appropriate sample for assessing the entire community. But, a great benefit of this study was the presence of an experienced radiologist at the heart of the research team, which has greatly contributed to the increased readability of the study. In conclusion, we found that age was a determinant for lumbar disc degeneration. A significant positive correlation was also found between disc degeneration and MC especially in two lower lumbosacral disc spaces. In other words, these two variables may in fact be a manifestation of a single degenerative process.

Acknowledgement

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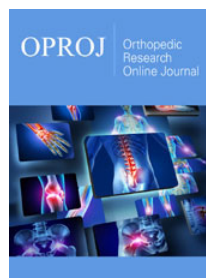
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