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Research Article

Relationship between MRI Findings of Posterior Lumbar Elements and Different Stages of Non-specific Low Back Pain

Zhang J[1], Hao Y[2]* and Liu K[1]

[1]Department of Radiology, North District of Suzhou Municipal Hospital, Suzhou 215008, People's Republic of China

[2]Department of Orthopaedics, North District of Suzhou Municipal Hospital, Suzhou 215008, People's Republic of China

***Corresponding author:** Yufeng Hao, Department of Orthopaedics, North District of Suzhou Municipal Hospital, Suzhou 215008, People's Republic of China

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Abstract

Background: The purpose of this study was to investigate the relationship between the MRI findings of posterior lumbar elements and different stages of non-specific low back pain.

Methods: A total of 63 patients with low back pain underwent lumbar MRI examinations were divided into acute group (<1 month), sub-acute group (1~3 months) and chronic group (>3 months) according to the time of onset. 14 healthy subjects underwent lumbar MRI examinations served as a control group. The distribution differences of thicknesses, cross-sectional areas (CSA) of bilateral lumbar multifidus muscles (LMM) in L4/5 level, extent of fat infiltration in multifidus muscles, subcutaneous/paraspinal muscles edema and facet joint degeneration symptom in four groups were recorded and compared.

Results: Thicknesses CSAs of LMM, facet joint degeneration symptom had no statistically difference within four groups. Extent of fat infiltration in multifidus muscles between chronic group and control group had statistically difference, and the incidence of subcutaneous/paraspinal muscles edema in chronic group was significantly higher than that in the other three groups.

Conclusions: Extent of fat infiltration in multifidus muscles and subcutaneous/paraspinal muscles edema are probably associated with chronic low back pain. The relationship between the MRI findings of posterior lumbar elements and acute, sub-acute groups are not clear.

Keywords: Low Back Pain; Multifidus Muscles; Magnetic Resonance Imaging

Introduction

Low back pain (LBP) refers to the pain or discomfort in the back or lumbosacral, which may or may not be associated with radiating pain in the lower extremities. It is characterized by self-healing and recurrence. LBP can not only lead to a decline in the individual's physiological function, increase the risk of suffering from other diseases, cause psychological problems, reduce the quality of life, but also greatly increase the social economic burden and labor loss [1,2]. On the classification of LBP has not been unified. According to the anatomical site can be divided into anterior longitudinal ligament disease, vertebral disease, spinal disorders, etc. According to whether there are clear pathological changes can be divided into specific low back pain and non-specific low back pain. LBP can also be classified by duration as acute (pain lasting less than 1 month), sub-acute (1 to 3 months), or chronic (more than 3 months) [3,4]. The aim of this research was to investigate whether there are differences in the MRI findings of posterior lumbar elements between patients of non-specific low back pain in different stages.

Methods

General materials

The investigated subjects in this study include 150 patients with low back pain underwent lumbar MRI examinations in our hospital seen between March 2016 and March 2017, 103 of them had pain in one or both of the lower extremities. Patients with a history of surgery and trauma, intraspinal lesions, rheumatic lesions, spondylolisthesis, disc herniation or image quality does not meet the standard, were excluded. A total of 63 patients were included in the study eventually. These patients were divided into acute group (n=20, 8 men and 12 women, age range 22 to 76 years), sub-acute group (n=22, 9 men and 13 women, age range 24 to 73 years) and chronic group (n=21, 8 men and 13 women, age range 23 to 69 years) according to the time of onset. 14 healthy subjects (7 men and 7 women, age range 34 to 71 years) underwent lumbar MRI examinations served as a control group.

Examinations

Examinations were performed on a 1.5T MR machine (Siemens sonata, Germany). Examination protocols included: (1) Sagittal T1-weighted images [repetition time (TR) 613 ms, echo time (TE) 11 ms, section thickness 4mm, intersection spacing 0.4mm, field of view 640 × 640 mm]: (2) Sagittal T2-weighted images [TR 2460 ms, TE 134 ms, section thickness 4mm, intersection spacing 0.4mm, field of view 640 ×640 mm]: (3) Sagittal fast spin echo T2-weighted images [TR 4330 ms, TE 77 ms, section thickness 4mm, intersection spacing 0.4mm,

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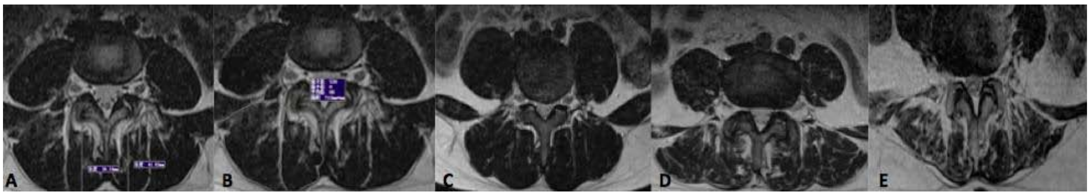

Figure 1: T2 axial images obtained at the L4-L5 level, show the multifidus muscles. (A): The bilateral multifidus muscle thickness measurements, 41.03mm on the left and 38.19mm on the right. (B): The CSA of the right multifidus muscle was 713mm^2. (C) Multifidus muscle shows grade I fat infiltration, intramuscular spaces revealed few fat signals showing as a single line. (D) Multifidus muscle shows grade II fat infiltration, more fat signals were revealed in the intramuscular spaces. (E) Multifidus muscle shows grade III fat soakage, intramuscle spatium fat revealed featheriness distribution.

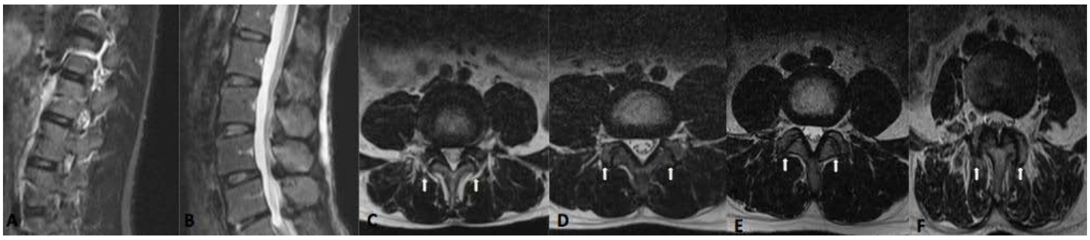

Figure 2: T2 sagittal images show the subcutaneous/paraspinal muscles edema (A-B). (A): No high signal in the subcutaneous or paravertebral muscles. (B): High signal appears in the subcutaneous. T2 axial images show the facet joint degeneration symptom (C-F). (C): The facet joint degeneration level was grade 0 (arrow). (D): The facet joint degeneration level was grade 1 (arrow). (E): The facet joint degeneration level was grade 2 (arrow). (F): The facet joint degeneration level was grade 3 (arrow).

Table 1: Criteria for grading degeneration of the facet joints.

Grade	Criteria
0	Normal facet joint space (2-4 mm width)
1	Narrowing of the facet joint space (<2mm) and/or small osteophytes and/or mild hypertrophy of the articular process
2	Na Narrowing of the facet joint space and/or moderate osteophytes and/or moderate hypertrophy of the articular process and/or mild subarticular bone erosions
3	Narrowing of the facet joint space and/or large osteophytes and/or severe hypertrophy of the articular process and/or sever subarticular bone erosions and/or subchondral cysts

Table 2: Patient demographics.

	Different disease stages				Statistical value	P value
	Acute group	Sub-acute group	Chronic group	Control group		
Age (years)	46.0±13.8	47.2±15.0	49.6±13.0	51.4±9.6	F=0.564	0.641
Gender (male/female)	8/12	9/13	8/13	7/7	χ^2=0.672	0.88

field of view 512 × 521 mm]: (4) Axial T2-weighted images [TR 3200 ms, TE 119 ms, section thickness 4 mm, intersection spacing 0.4mm, field of view 640 × 640 mm].

Image characteristics

Two experienced musculoskeletal radiologists judged MRI characteristics and made diagnoses by consensus.

The MRI signs to be observed included: (1) Thickness of lumbar multifidus muscles. Between the 4th-5th middle introvertebral disc sections on the T2WI transverse segment, the thicknesses of bilateral multifidus muscles were measured from the back edge of the lower arthro-process to the dorsal interface of subcutaneous lipid and muscle. The largest radius vector was chosen as the thickness of the multifidus muscle. (2) The cross-sectional area (CSA) of multifidus muscles [5]. The CSAs of bilateral multifidus muscles were measured at axial T2-weighted image by constructing polygon points around the outer margins of the muscles. (3) Extent of fat infiltration in multifidus muscles. The extent of fat infiltration was defined as grades I, II and III: grade I, intramuscular spaces revealed few fat signals (or none) showing as a single line or dot form; grade II, more fat signals were revealed in the intramuscular spaces, but no signals were shaped like grid or feather patterns; grade III, signals were shaped like grid or feather patterns (Figure 1) (4). Subcutaneous/paraspinal muscles edema. High signal appears in the subcutaneous or paraspinal muscle area on sagittal fat suppression T2WI (5). Facet joint degeneration symptom. Four grades of the facet joint degeneration were defined using criteria similar to published by Weishaupt et al. [6]: grade 0, normal; grade 1, mild degenerative disease; grade 2, moderate degenerative disease; and grade 3, severe degenerative disease (Figure 2). The criteria for grading are given in Table 1.

Statistical analyses

SPSS 17.0 (SPSS, Chicago, IL, USA) was used for statistical analysis. Continuous variables were expressed as mean ± standard, and discontinuous variables were expressed as the number of cases. For the comparison of gender and subcutaneous/paraspinal muscles edema between groups, the Pearson X^2 test was used to determine

Table 3: Comparison of thickness and CSA of bilateral multifidus muscle between groups in different disease stages (mm, cm^2).

MRI signs	Different disease stages				F value	P value
	Acute group	Sub-acute group	Chronic group	Control group		
Right multifidus muscle thickness	36.97±6.27	38.55±5.81	36.77±5.22	38.71±8.14	2.099	0.552
Left multifidus muscle thickness	36.83±6.10	38.77±6.39	37.56±6.08	39.63±8.36	2.036	0.565
The CSA of right multifidus muscle	6.70±1.47	7.05±1.98	6.65±1.23	8.03±3.08	3.485	0.323
The CSA of left multifidus muscle	6.62±1.31	6.89±1.72	6.38±1.05	7.24±2.90	1.536	0.674

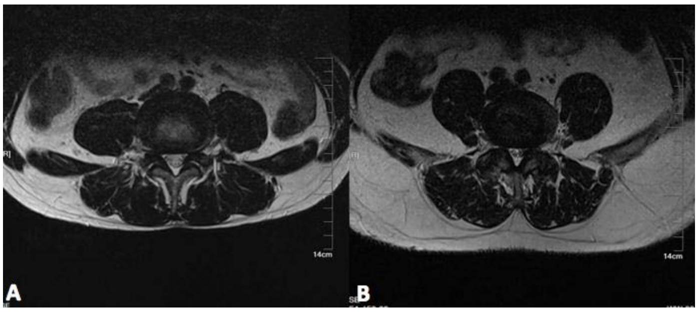

Figure 3: T2 axial images obtained at the L4-L5 level, show the multifidus muscles. (A) A 52-year-old healthy male volunteer. Multifidus muscle shows grade I fat soakage, intramuscular spaces revealed few fat signals showing as a single line. (B) A 63-year-old chronic LBP male patient. Multifidus muscle shows grade II fat soakage, more fat signals were revealed in the intramuscular spaces.

Table 4: The incidence of fatty infiltration and subcutaneous/paraspinal muscles edema between groups in different stages (n).

	n	Fatty infiltration			Subcutaneous/ paraspinal muscles edema	
		Grade I	Grade II	Grade III	Edema	No edema
Acute group	20	7	12	1	6	14
Sub-acute group	22	9	9	4	5	17
Chronic group	21	3	14	4	14	7
Control group	14	10	4	0	3	11

the significance of the difference. The significance differences in the fat infiltration and facet joint degeneration symptom between groups were determined with Fisher exact tests. Variance analysis was used for the comparison of age. The differences of the multifidus muscle thickness and CSA between groups were examined with a multiple sample comparative sum of ranks Kruskal-Wallis test. A P≤0.05 was considered statistically significant.

Results

Table 2 highlights the demographic data for groups in different disease stages. There were no statistically significant differences in age and gender between groups.

Table 3 shows the comparison of thickness and CSA of bilateral multifidus muscle between groups in different disease stages. The results of the thickness and CSA of bilateral multifidus muscle showed that at L4-L5 level. No statistical differences were found in the thickness and CSA between groups.

The incidence of fatty infiltration and subcutaneous/paraspinal muscles edema between groups were shown in Table 4. On analysis of the fatty infiltration between four groups, only chronic group showed statistical difference with control group (P=0.005). There were no statistical differences between other groups (P>0.05), (Figure 3).

The incidence of subcutaneous or paraspinal muscles edema in chronic group was significantly higher than other three groups (P=0.029, 0.006, 0.013). No difference in the incidence of subcutaneous or paraspinal muscles edema between the other three groups (P>0.05).

Table 5 shows the incidence of facet joint degeneration symptom between groups in different stages. Analysis demonstrated that there were no statistically significant differences in the bilateral facet joint degeneration symptom between four groups (P<0.05).

Discussion

LBP is one of the most common diseases that confuse humans. Some patients with LBP can experience the acute, sub-acute to chronic phase. Most LBP patients may recover quickly and there is no loss of function. 60%-70% of the patients can recover within 6 weeks, 80 - 90 % may improve within 12 weeks. If the LBP lasts for 12 weeks, recovery would become very slow and difficult [7]. About 85% of patients with low back pain are unable to obtain a specific and definite pathological anatomy diagnosis, which is called non-specific low back pain. It is very common in sports medicine and clinics, which lacks effective diagnostic methods and treatment methods [8]. Given the effects of human physiological characteristics and body weight on the level of L4/5 disc, all measurements in this study were performed at the central level of L4/5 disc. This paper aims to explore the relationship between the MRI findings of posterior lumbar elements

Table 5: The incidence of facet joint degeneration symptom between groups (n).

	n		Grade 0		Grade I		Grade II		Grade III	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Acute group	20	20	0	0	12	10	8	9	0	1
Sub-acute group	22	22	0	0	13	11	6	8	3	3
Chronic group	21	21	0	0	7	10	10	7	4	4
Control group	14	14	1	1	5	7	8	6	0	0

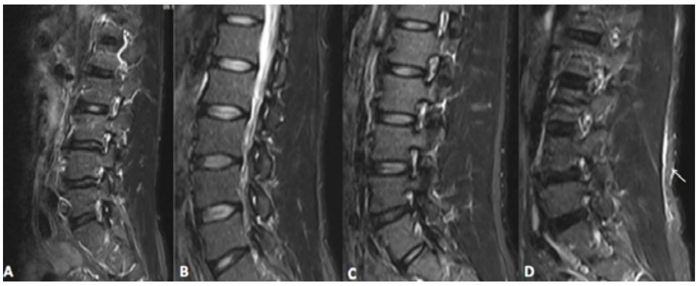

Figure 4: T2 sagittal images show the subcutaneous/paraspinal muscles edema in four groups. (A) Control group, (B) acute group and (C) sub-acute group show no high signal in the subcutaneous or paravertebral muscles; and (D) chronic group shows high signal in the subcutaneous.

and different stages of non-specific low back pain.

LMM are important for providing segmental stability and they function as dynamic stabilizers of the lumbar spine [9]. About 88.9% of people suffering from LBP present LMM with atrophy [10]. Therefore, our study selected the thickness and CSA of the multifidus and the extent of fatty infiltration in the multifidus to evaluate the muscular structure changes of patients with LBP. Unexpectedly, only extent of fatty infiltration in the chronic group was higher than that in the control group. The thickness and CSA showed no significant difference between four groups. Some studies have shown that the disease duration less than 3 months, the atrophy of LMM can be not obvious. In patients with LBP more than 3 months, the multifidus muscle can be atrophy. However, the normal muscle tissue was covered with fibrous tissue and fatty tissue, the area did not decrease within the muscle fascia boundary [11]. That's why the extent of fatty infiltration in chronic group was higher than that in the control group. We also find that proportions of grade II and III of fatty infiltration in acute group and sub-acute group (65.0%; 59.1%) were significantly higher than control group (28.6%), and lower than chronic group (85.7%). We speculate that the LMM of acute group and sub-acute group also show atrophy. Differing from the disuse atrophy, it's caused by sudden contraction and persistent paralysis of LMM, resulting in disorder of muscle metabolism.

In the clinic, subcutaneous or paravertebral muscle edema suggests the myofascitis, which can result in asepsis exudate, edema, fibrosis and adherence of intertissues. Some scholars thought fluid signal in lumbar muscle and fascia is the main sign of lumbar muscle strain [12]. At the same time, the detection rate of superficial fascia is higher than that of deep fascia [13,14]. In our study, the fluid signals were found more frequently in chronic group than in the other three groups ($P<0.05$). This demonstrates that myofascitis appears more in chronic lumbago, which most likely relates to the subcutaneous or paravertebral muscle edema.

The lumbar facet joint is dominated by branches of the dorsal branch of the spinal nerve adjacent to the segment. The facet joint is the stable structure of the spine [15]. Its degeneration may lead to the instability of the lumbar spine, which causes the lumbar spine to undergo a stabilization-instability-re-stabilization process. Lumbar instability is one of the causes of LBP [16]. The accumulation of low-level wounds can lead to facet joint abnormalities, resulting in aseptic inflammation, which may be caused by the propagation of the dorsal branch of the spinal nerve.

Unexpectedly, bilateral facet joint degeneration symptom at the L4-L5 level showed no significant difference between four groups, which is in contrast to the literature. We speculate that the small sample used likely influenced these results. Only additional studies examining various clinical groups will establish whether there is relationship between facet joint degeneration symptom and LBP.

The results presented in this study should be considered cautiously because of the small sample size and the possible methodological bias of a single-center study. At the same time, other limiting factors for low back pain (social psychological, etc.) were not evaluated in this study and should be considered in continuing investigations.

Conclusions

The value of this study lies in applying MRI to demonstrate the relationship between posterior lumbar elements and different stages of non-specific low back pain. Fatty infiltration, subcutaneous/paraspinal muscles edema can be the influencing factors of chronic low back pain, which was guiding significance for clinical diagnosis and treatment. The MRI findings of posterior lumbar elements were no significantly related to acute or sub-acute low back pain.

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