

Intervertebral Disc Characteristic on Progressive Neurological Deficit

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Abstract

Objective: To examine the intervertebral disc characteristic on magnetic resonance imaging (MRI) in lumbar herniated disc (LHD) patients with progressive neurological deficit.

Methods: Patients were collected retrospectively from Dr. Hasan Sadikin General Hospital Database from 2011–2013 with LHD, had neurological deficit such as radiculopathy and cauda equine syndrome for less than four weeks with a positive sign confirmed by neurological examination and confirmatory with MRI examination.

Results: A total of 14 patients with lumbar herniated disc disease (10 males, 4 females) suffered from progressive neurological deficit with an average age of (52.07±10.9) years old. Early disc height was 9.38±0.5 mm and progressive neurological deficit state disc height was 4.03±0.53 mm, which were significantly different statistically ($p < 0.01$). Symptoms of radiculopathy were seen in 11 patients and cauda equine syndrome in three patients. Modic changes grade 1 was found in five patients, grade 2 in eight patients, grade 3 in one patient, Pfirrmann grade 2 in eleven patients and grade 3 in three patients. Thecal sac compression 1/3 compression was seen in four patients and 2/3 compression in ten patients.

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Conclusions: Neurosurgeon should raise concerns on the characteristic changes of intervertebral disc in magnetic resonance imaging examination to avoid further neural injury in lumbar herniated disc patients.

Keywords: Lumbar herniated disc, magnetic resonance imaging, progressive neurological deficit

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Introduction

Significant impacts of the implementation of the National Health Insurance scheme were seen in the annual increase of the incidence of low back pain (LBP) with a considerable loss of working time and socioeconomic burden. Increased older age population and changes in the intervertebral disc characteristics that are associated with repetitive minor trauma at endplate can cause low back pain (LBP). Although imaging studies showed that disc degeneration strongly correlate with LBP, not all of disc degeneration are symptomatic.¹⁻⁷

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Intervertebral disc is a structure that has a viscoelastic and avascular nature which makes it possible for the degeneration process to change the anatomy of the disc. Early phase noticeable by proteoglycan depletion and reduce of water content, changes osmotic pressure. Therefore, early diagnosis of disc degeneration is critical for the success of any modality of treatment strategy.^{8,9}

The etiologic factors of nociceptive and disability caused by pathological disc is still currently debatable.^{2,10} A common belief is that changes the diffusion of water will result in structural changes in nucleus pulposus, annulus and end plate that are altered the internal disc stability.^{11,12} Magnetic resonance imaging (MRI) is highly accurate in detecting abnormality of the disc, but the relationship between findings on MRI and clinical course

remains controversial.^{5,6,13,14}

Methods

Ethical approval for the current study was granted by the Ethics Committee of the Faculty of Medicine, Universitas Padjadjaran. The patients were collected retrospectively from Dr. Hasan Sadikin General Hospital Database for the period of 2011–2013 by including those with a diagnosis of LHD, a history of radiculopathy and cauda equine syndrome with progressive neurological deficit within less than four weeks with concomitant neurologic examination that correlated with the same nerve root being affected and a confirmatory cross-sectional imaging study demonstrating a herniated disc at the level and side corresponding to their symptoms. The exclusion criteria comprised of malignancy, significant deformity, prior back surgery and other established contraindications to elective surgery.

Lumbar spine MRI were acquired using magnets operating at field strength of 1.5 Tesla with axial and sagittal T1 weighted, T2 weighted. Images were collected as printed

films and then digitized using computer system. All images were identified for patient confidentiality. Patients received either a standard open discectomy or decompression of the involved nerve. Disc Height was defined as the disc height measured as the distance between the inferior endplate to the superior endplate at middle vertebral body line performed by MRI and plain lumbal radiograph for repeated examinations.^{15,16} The assessment included the followings: disc morphology, thecal sac modified compression by the disc fragment characterized as non, <1/3, 2/3, or >2/3 as a relative term for canal compromise secondary to disk herniation; disc degeneration described by Pfirrmann; endplate marrow abnormality according to the Modic classification in which Modic 1 refers to edema-like signal intensity, Modic 2 refers to fat-like signal intensity and Modic 3 refers to sclerosis-like signal intensity (Fig. 1 and 2).^{5,17-20}

Data analyses were performed using SPSS version 13 for Windows (SPSS, Inc, Chicago, IL, USA). Data are presented as the number of subjects in each group or mean±SD. Each independent variable was compared using the t test.

Table 1 Patients Characteristics

Sex	Age	Level	Symptoms	DH early (mm)	DH prog (mm)	Bulging Type	Modic	Pfirmman	Thecal Sac
M	64	L345	Rad.	10	5.3	protruded	1	3	2/3
M	67	L345	Rad.	9	4.3	protruded	1	3	2/3
F	32	L5S1	Rad.	10	5.7	protruded	1	3	1/3
F	33	L5S1	Rad.	9.5	4.4	prostruded	1	3	1/3
F	50	L5S1	CES	9.2	3.7	protruded	1	3	2/3
M	62	L345	Rad.	10.3	3.4	extruded	2	3	2/3
M	62	L345	Rad.	9.2	3.2	extruded	2	3	2/3
F	45	L45S1	CES	9	4.7	protruded	2	2	2/3
M	45	L45S1	Rad.	8.9	4.5	extruded	2	2	1/3
M	56	L45	Rad.	9	3.3	extruded	3	3	2/3
M	58	L45	Rad.	10.3	4.8	protruded	2	2	2/3
M	59	L345	CES	9.2	3.2	extruded	2	3	2/3
M	47	L345	Rad.	8.8	3.1	extruded	2	3	2/3
M	49	L23	Rad.	9	2.9	extruded	2	3	2/3

Notes: DH= disc height, F= female, M= male, L= lumbar; Early= first radiological examination, Prog= progressive neurological deficit tim, Rad.= radiculopathy, CES= cauda equina syndrome

Table 2 Study Results

Variables	Value
Patients	14
Sex	F=4/M=10
Age (years old)	52.07± 10.9
Level	
L23	1
L345	6
L45	2
L45S1	2
L5S1	3
Symptom	
Radiculopathy	11
Cauda equina synd	3
DH early (mm)	9.38 ± 0.5
DH progressive (mm)	4.03 ± 0.53
Bulging type	
Protruded	7
Extruded	7
Modic	
Grade 1	5
Grade 2	8
Grade 3	1
Pfirmman	
Grade 1	0
Grade 2	11
Grade 3	3
Thecal sac compression	
Normal	0
1/3	3
2/3	11

Results

A total 14 patients with lumbar herniated disc disease (10 males, 4 females) suffering from progressive neurological deficit with average age of (52.07±10.9) years old between January 2012 and December 2013 were evaluated retrospectively. Early disc height of 9.38±0.5 mm and progressive disc height of 4.03±0.53 mm were found, which were significantly different (p<0.01). One, six, two, two and three

patients had LHD at the L2-3,L3-4-5,L4-5,L4-5-S1,L5-S1 levels. Symptoms of radiculopathy were found in 11 patients and cauda equine syndrome in three patients. Protruded disc was seen in 7 patients and extruded type in 7 patients. Modic changes grade 1 was revealed in five patients, grade 2 in eight patients and grade 3 in one patient. Pfirmman grade 2 was found in eleven patients and grade 3 in three patients. Thecal sac compression 1/3 compression was observed in three patients and 2/3 compression in eleven patients.

Discussion

With the increasing size of aging population, a higher prevalence of clinical disability related to disc degeneration disease is seen. Lumbar herniated disc was the most common cause of low back pain and it was observed as a major aspect of disc degeneration around the globe. Advances in the development of neuroimaging technology allows an excellent noninvasive means of imaging for the entire lumbar spine. The contrast, sensitivity and also the multi planer images help clarifying the disc anatomy within or adjacent spine. Intervertebral disc characteristic of the lumbar spine has been play important role in development of low back pain. Recent studies have reported the usefulness of routine use of MRI in evaluating of nerve root compression and relation with clinical symptoms.¹⁷

By gender, men were more prone to LDH, which is a warning for society. The findings of our study are consistent with those of other studies.⁵ This results showed that men are more susceptible to disc degeneration when compared to women, which is most likely due to increased mechanical stress and injury.

In this study, the authors found the disc height reduced significantly before the surgery. This supports the hypothesis of the previous study.⁶ The previous study showed that more than 50% decrease disc height in painfull degenerative disc. A previous study found that a Modic change includes segmental instability and strongly correlation with progression of neurological symptoms.¹⁸ However, another previous studies showed that Modic changes in the degenerative process of disc in relation to back pain and associated with aggravation of neurological deficit.¹⁹ In this study, the authors found that grade 2 of modic changes were found in 57% of subjects, meaning a high number of increased modic changes as reactive bone and granulation tissue are found

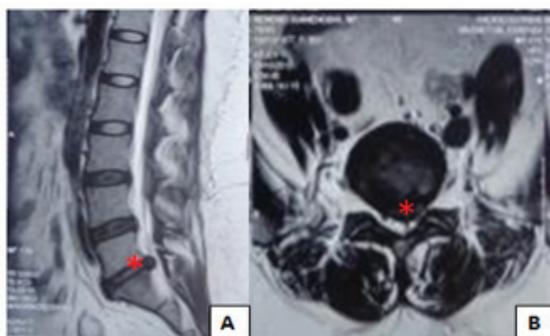


Fig. 1 Lumbar Herniated Disc on Sagittal T2 Weighted Image , A) Axial T2 Weighted Image (red asterixs)

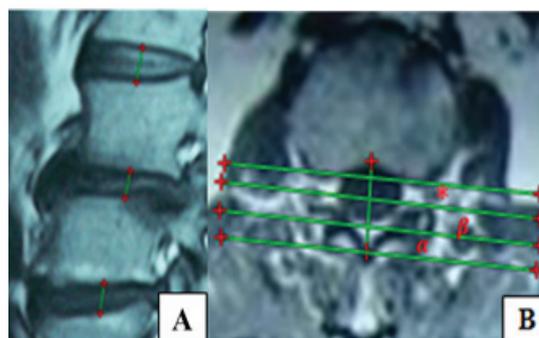


Fig. 2 Disc Height Measurement and Modic Changes B) Thecal sac Compression Measurement 1/3 (asterix), 2/3 (β) and $>2/3$ (α)

in early phase of degenerative process.²⁰

A previous study has reported Pfirman grading use in assessing disc degeneration on MRI, and it associated with increasing back pain.¹⁹ Current findings of this study could support the extension of this hypothesis since the majority of participants had disc degeneration of Pfirman grade 2, i.e. w11 patients (78%), which is similar to the results of the study by Hansen *et al.*¹⁹ A previous study by Albert *et al.*²⁰ reported that MRI change findings in the lumbar intervertebral disc have a significant association with age, indicating LBP. The study shows that the average age of lumbar herniated disc patients is more than 50 years old, i.e. 52.07 ± 10.9 years old. People of that age seems to be vulnerable because of the decrease in the elasticity and water content of the nucleus with age.^{3,15}

Our current study found that lumbar level 345 was observed in six patients (43%). This is due to the fact that lumbar spine carries most of the body weight. Thecal sac compression or canal was found to be 2/3 compromised in 11 patients (71%), which is similar to what was revealed in the study by Lurie *et*

*al.*⁵ These consistent findings suggest that compromised canal may denote as the guide point of neurological deficit that is related to LHD perioperatively.

In lumbar degenerative disc patients, the intervertebral disc has a wide range of presentations including changes in disc height, endplate, and within the disc, simultaneously. In contrast, the current study shows that changes in the intervertebral disc morphology relates to progressive neurological deficit.

There are several limitations to our study. Although MRI has become the gold standard for imaging of LDH due to its ability to capture vertebral bone and soft tissue pathology, it is quite expensive that the use is limited due to funding considerations. Furthermore, the small sample size in this study may make the estimates for these subgroups imprecise. Therefore, further studies specifically designed to evaluate these future are needed t.

In conclusion, neurosurgeon should raise concerns on the characteristic changes of intervertebral disc in magnetic resonance imaging examination to avoid further neural injury in lumbar herniated disc patients.

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