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[Original Article]

THE PREDICTIVE FACTORS FOR THE RESORPTION OF A LUMBAR DISC HERNIATION ON PLAIN MRI

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Abstract : Previous studies have noted the morphologic changes of lumbar disc herniation (LDH) in conservative treatment and predictive value of the resorption of LDH by using contrast-enhanced MRI. However, there are few reports that note the predictive value of plain, non-enhanced MRI. Therefore, no definite predictive factors for the resorption of LDH have been detected on plain MRI. Thirty-four patients with lower limb pain receiving conservative treatment were followed for more than 6 months. MRI was performed every 3 months. The findings of the first MRI in the patients who finally had resorption of LDH (R-group, 21 patients) were compared with those of the patients who exhibited no resorption of LDH (N-group, 13 patients). The MRI evaluation included the signal intensity of LDH, migration of LDH. The transition of the visual analogue scale (VAS) of lower limb pain was also compared. The R-group had significantly more patients with iso-signal intensity in comparison to the signal intensity of the nucleus pulposus observed on T1 weighted images (WI) and high-signal intensity in comparison to the signal intensity of the annulus fibrosus observed on T2 WI, whereas the N-group had more patients with the high-signal intensity on both T1 and T2 WI. The R-group had significantly more patients with migration. The VAS significantly improved at 3 and 6 months in both groups. However, no statistically significant difference was detected between the 2 groups. It is very valuable that the results clearly indicate the predictive factors on plain MRI concerning the resorption of LDH. The study also showed that lower limb pain would gradually improve even in the patients who exhibited no resorption. Therefore, it is important in the treatment of LDH to observe the clinical symptoms carefully without overestimating MRI findings.

Key words : lumbar disc herniation, MRI, conservative treatment, resorption

INTRODUCTION

Most patients with radicular lower limb pain due to a lumbar disc herniation (LDH) recover within several months with conservative treatment¹⁻¹¹). MRI is very useful to evaluate the condition of a spinal lesion and to design a treatment strategy for the lesion. Contrast-enhanced MRI following plain, non-enhanced MRI is very useful to diagnose an epidural tumor¹²⁻¹⁴), while it is not routinely used for LDH except when it is necessary for discrimination

of an epidural tumor. Some reports note the morphologic changes of LDH in conservative treatment and the predictive value of the resorption of LDH by using contrast-enhanced MRI^{5,16}). However, there are few reports that note the predictive value of plain MRI^{5,7}). Therefore, no definite predictive factors concerning the resorption of LDH have been detected on plain MRI.

The aim of this prospective clinical study is to determine the predictive factors on plain MRI concerning the resorption of LDH.

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MATERIALS AND METHODS

Thirty-four patients with hemilateral radicular lower limb pain due to LDH who were receiving conservative treatment were followed for more than 6 months. The patients had been diagnosed by following criteria ; with hemilateral lower limb pain at a single nerve root innervation area as a subjective symptom, with a lower limb pain reproducibility by lumbar flexion motion and with the pain reproducibility by femoral nerve stretch test or straight-leg raising test as objective findings. Neurological findings had been also evaluated to diagnose as objective findings. We had finally confirmed for all of the patients that the MRI findings of LDH had explained the subjective symptoms and the objective findings. Exclusion criteria had been as follows ; spondylosis, degenerative spondylolisthesis, spondylolysis (with or without spondylolisthesis), tumor, inflammatory diseases, LDH with bilateral nerve root involvement and patient history of lumbar operation. Magnetom Symphony 1.5 Tesla MRI system (Siemens, Germany) was employed for the MRI evaluation. The MRI sequence that we used was TR 649 ms/ TE 14 ms for T1-weighted sagittal images, TR 4,000 ms/ TE 96 ms for T2-weighted sagittal images, TR 512 ms/ TE 13 ms for T1-weighted axial images and TR 5,940 ms/ TE 99 ms for T2-weighted axial images. Section thickness was 3.5 mm for all of the sagittal images and was 4.0 mm for all of the axial images. MRI was performed every 3 months. The findings of the first MRI in the patients who exhibited resorption of LDH (R-group, 21 patients) were compared with those of the patients who exhibited no resorption of LDH (N-group, 13 patients). Resorption of LDH was defined that a herniated disc material completely disappeared around the outermost annulus

fibrosus on MRI. There were no statistically significant differences between the R and N groups in age, gender, months after the onset and the visual analogue scale (VAS) at the first medical examination (Table 1). In addition, no statistical significant difference in distribution of LDH was detected between the groups (Figure 1). The MRI evaluation included the signal intensity of LDH, migration of LDH. An independent orthopaedic doctor performed the MRI evaluation twice at an interval of 1 week. The intraobserver reliability was 0.95. If different findings between the first and the second MRI evaluation were obtained, the first finding was applied. The transition of the VAS of lower limb pain at every medical examination was also evaluated.

Signal Intensity of LDH

The signal intensity of LDH on the T1 weighted images was compared to that of the nucleus pulposus in the intervertebral disc concerned. The signal intensity of LDH on T2 weighted images was compared to that of the annulus fibrosus in the intervertebral disc concerned. The pattern of the signal intensity on T1 and T2 weighted images was classified into 5 types (Table 2). In type 1, LDH shows iso-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows high-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images (Figure 2A). In type 2, LDH shows iso-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images (Figure 2B). In type 3, LDH shows high-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1

Table 1. Contents of R and N groups

	R group (21)	N group (13)
Age (mean±SD)	54±14	50±10
Gender		
male	13	9
female	8	3
Months after the onset (mean±SD)	4.1±2.2	4.6±4.5
VAS at 1st med. exam. (mean±SD)	64.5±19.5	63.8±21.3

N.S.

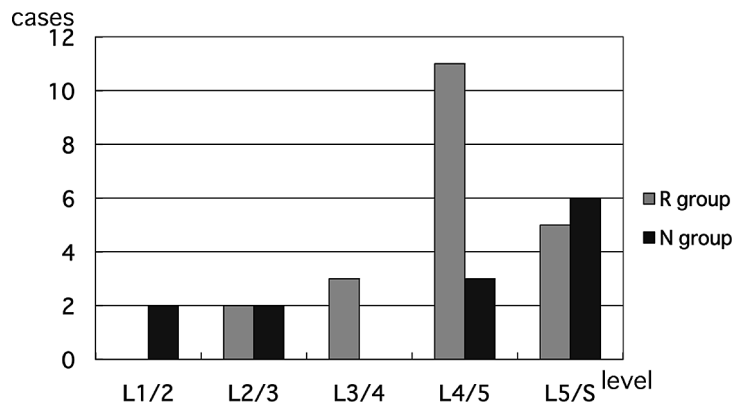


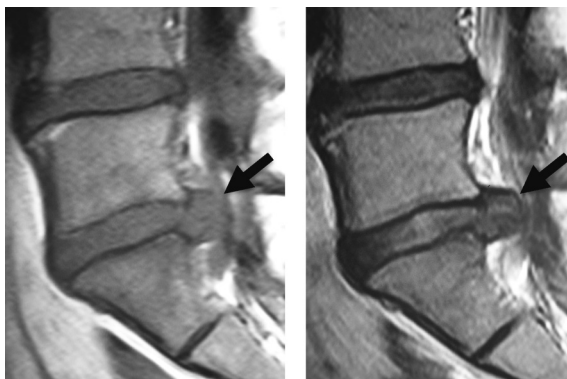
Fig. 1. Distribution of LDH in R and N groups. No statistical significant difference in distribution of LDH was detected between the groups (Chi-square test).

Table 2. Classification by the signal intensity of LDH (WI : weighted image)

Type	T1 WI*	T2 WI**
1	iso	high
2	iso	iso
3	high	high
4	high	iso
5	low	iso

*The signal intensity of LDH on the T1 weighted images was compared to that of the nucleus pulposus in the intervertebral disc concerned.

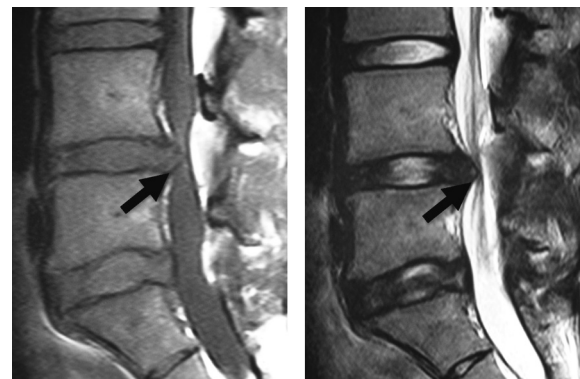
**The signal intensity of LDH on T2 weighted images was compared to that of the annulus fibrosus in the intervertebral disc concerned.



T1 WI

T2 WI

Fig. 2A. Type 1. LDH shows iso-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows high-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images.



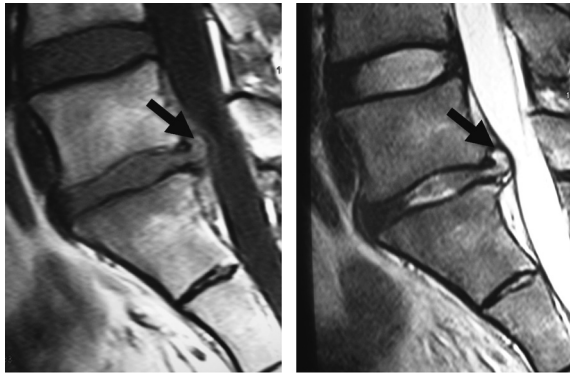
T1 WI

T2 WI

Fig. 2B. Type 2. LDH shows iso-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images.

weighted images and shows high-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images (Figure 2C). In

type 4, LDH shows high-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal inten-



T1 WI

T2 WI

Fig. 2C. Type 3. LDH shows high-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows high-signal intensity in comparison to the signal intensity of the annulus fibrosus on T1 weighted images.

sity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images (Figure 2D). In type 5, LDH shows low-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images (Figure 2E).

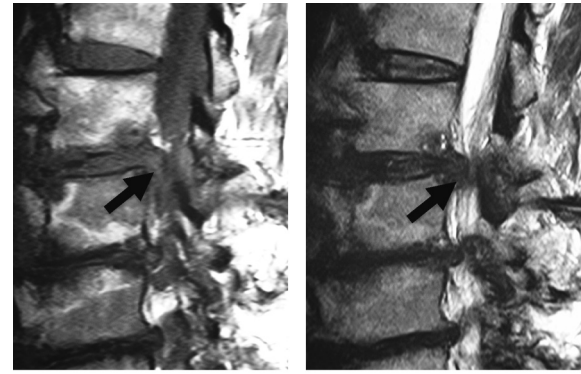
Migration of LDH

The migration of LDH was defined that a herniation mass cranially or caudally reached more than quarter height of the vertebra. Thereafter, the patients were divided into 2 types, namely, those with or without migration (Figure 3).

RESULTS

MRI findings

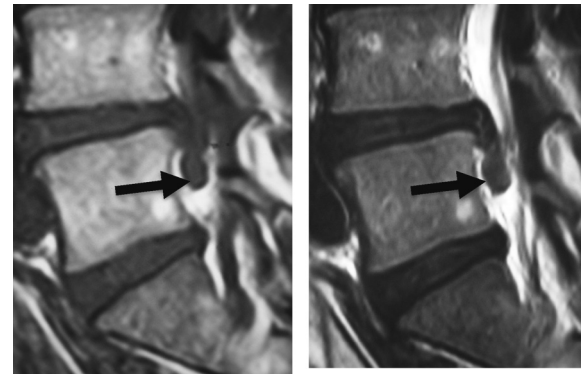
LDH finally resolved in all of the patients with the signal intensity of type 1 and 5. In contrast, LDH remained in all of the patients with the signal intensity of types 2, 3 and 4. The R-group had significantly more patients with iso-signal intensity in comparison to the signal intensity of the nucleus pulposus observed on T1 weighted images and high-signal intensity in comparison to the signal intensity of the annulus fibrosus observed on T2 weighted images (type 1), whereas the N-group had more patients with high-signal intensity on both T1 and T2 weighted images (type 3) ($P < 0.0001$, Chi-square test) (Figure 4A). There were significantly more patients with migration in the R-group than the N



T1 WI

T2 WI

Fig. 2D. Type 4. LDH shows high-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images.



T1 WI

T2 WI

Fig. 2E. Type 5. LDH shows low-signal intensity in comparison to the signal intensity of the nucleus pulposus on T1 weighted images and shows iso-signal intensity in comparison to the signal intensity of the annulus fibrosus on T2 weighted images.

group ($P < 0.01$, Fisher exact probability test; Figure 4B).

Transition of the VAS

The VAS significantly improved at 3 and 6 months in both the R- and N-groups. However, no statistically significant difference was detected between the groups (Repeated measures ANOVA; Figure 5).

DISCUSSION

LDH finally resolved in all of the patients with the signal intensity of types 1 and 5. In contrast, LDH remained in all of the patients with the signal

intensity of types 2, 3 and 4. Type 1 might indicate that LDH mostly involves the nucleus pulposus. Types 2 and 5 might indicate that LDH mostly

involves the annulus fibrosus. The annulus fibrosus might tends to remain in comparison with the nucleus pulposus. Therefore, the resorption of LDH might rarely occur in Types 2 and 5. Types 3 and 4 might indicate that the structure of LDH has changed, such as in the granulation or myxoid change.

There were significantly more patients with migration in the R group than in the N group. LDH tends to be in contact with epidural tissue during migration. Therefore, the resorption of LDH might easily occur in the patients in association with migration. Two patients of type 5 with migration exhibited resorption of LDH. The result indicates that the resorption of LDH might easily occur in the patients with migration even if they are in type 5.

There are many reports that have noted the clinical value of MRI for evaluating LDH resorption^{9,14-19}. Some reports describe the morphologic changes of LDH associated with conservative treatment and the predictive value of the resorption of LDH by using contrast-enhanced MRI^{15,16}. However, it is not routine to use con-

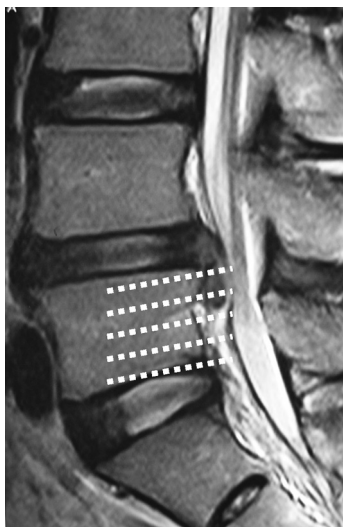


Fig. 3. The migration of LDH was defined that a herniation mass cranially or caudally reached more than quarter height of the vertebra.

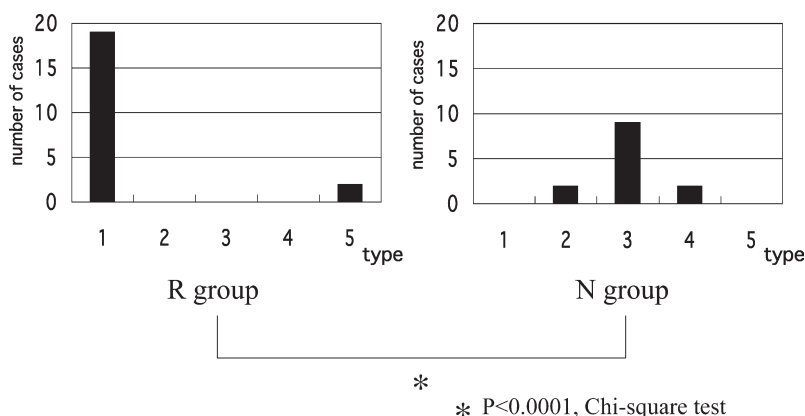


Fig. 4A. Comparison of the types by the signal intensity between R and N groups.

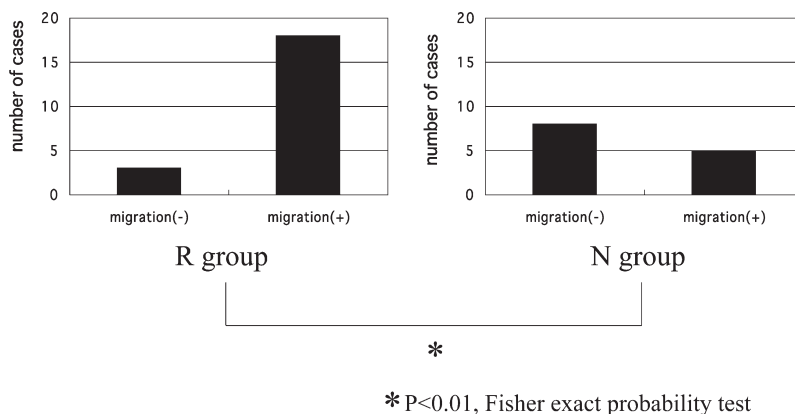


Fig. 4B. Comparison of the number of cases with or without migration between R and N groups.

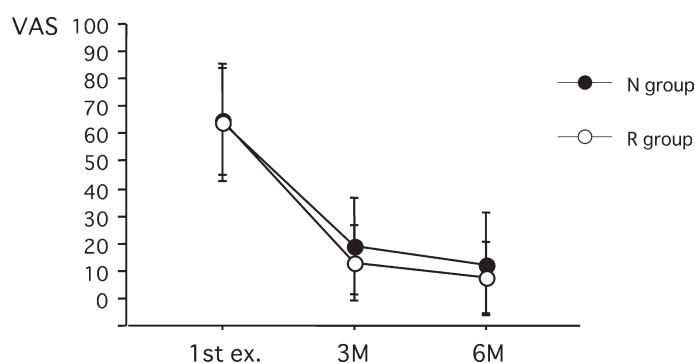


Fig. 5. Transition of the VAS. The VAS significantly improved at 3 and 6 months in both of the 2 groups. However, no statistically significant difference was detected between the groups (Repeated measures ANOVA).

trast-enhanced MRI except in cases that require discrimination from a tumor. Therefore, this study focused on the non-enhanced MRI findings associated with the signal intensity of LDH and the migration of LDH in order to investigate the resorption of LDH. All of the findings are easy to evaluate at an outpatient clinic. It is very valuable that the results clearly indicate the predictive factors on plain MRI concerning the resorption of LDH.

The study also revealed that lower limb pain would gradually improve even in the patients who exhibited no resorption. The discrepancy between the recovery of the lower limb pain and the morphologic changes on MRI might be related to the chemical effect on the nerve root that is caused by the nucleus pulposus. Some reports indicate that a chemical effect on the nerve root that is caused by the nucleus pulposus plays an important role in neuropathology²⁰⁻²². However, the chemical effect for the spinal nerve root cannot be visualized on MRI. Therefore, it is important in treatment of LDH to observe the clinical symptoms carefully without overestimating the MRI findings.

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