ORIGINAL

Natural history of extruded lumbar intervertebral disc herniation

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Abstract : We studied the natural history of extruded lumbar intervertebral discs using MRI. Forty-nine patients with lumbar disc herniation were included in this study. Ages ranged from 19 to 57. On the T2-weighted sagittal MR image, the signal intensity in the herniated mass was measured and the ratio to that in the original nucleus (i.e, nucleus pulposus from which they extruded) was calculated (signal intensity ratio ; SIR). The relationship with SIR and duration of illness was evaluated. In ten patients who were re-examined by MRI after conservative treatment, the size of the herniation measured by T1-weighted axial MR image was compared before and after treatment. The signal intensity of HNP became higher than that of the original nucleus immediately following herniation and thereafter decreased with time, suggesting that initial hydration of the HNP occurred shortly after herniation followed by dehydration of the HNP. The size of the HNP with a SIR value of 1.2 and higher on T2-weighted MR images decrease with time, however, the HNP with a SIR below 1.2 did not show any size reduction. The SIR of 1.2 and higher is a good indicator predicting spontaneous reduction of the HNP. Dehydration in the HNP may play an important role in the reduction of the lumbar disc herniation. J. Med. Invest. 49 : 40-43, 2002

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INTRODUCTION

Spontaneous reduction of the herniated nucleus pulposus (HNP) in the lumbar spine has been well documented (1-3, 6-8). The proposed mechanisms of spontaneous reduction of the HNP with time included retraction by posterior longitudinal ligament tension, dehydration, resorption by macrophage phagocytosis, lymphatic drainage and immunologic reaction (1-4, 6-7). However, several studies have shown that dehydration is one of the major contributors to reduction of the HNP. For example, Bozzao *et al*. (1) and Saal *et al*. (6), based on qualitative information of MRI signals of the HNP (as judged by the brightness on MRI films), found a spontaneous reduction in the patients whose HNP were bright on T2-weighted images. Since T2-weighted MR images represent water content, these observations suggest that dehydration could be a factor. These authors, however, did not quantify the threshold values of MRI signal intensity that may predict spontaneous reduction of the HNP.

Thus, the purpose of the present study is to quantify signal intensity of HNP as compared to the nucleus where it originated from and to correlate the signal intensity with the reduction in size. Such an

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investigation will enable identification of patients in whom spontaneous reductions of HNP occur.

PATIENTS AND METHODS

All consecutive patients between January 1992 and February 1994 diagnosed with lumbar disc herniation were included in this study, with the following exceptions. Patients suffering from previous symptoms suggesting an earlier HNP were excluded. Patients presenting with non-extruded disc herniations and sequestration on MR images, and/or patients who had other lesions such as spondylolysis, spondylolisthesis, spinal canal stenosis and multiple disc herniations were excluded. Due to these restrictions, forty-nine patients qualified for the present study. There were 32 men and 17 women with a mean age of 36.0 years (range 19 to 57 years; standard deviation = 12.1 years). The HNPs were found at L 3-4 in one case, L 4-5 in 31 cases and L 5-S 1 in 17 cases.

T1-and T2-weighted MR images showing extruded nucleus pulposus were obtained at the time of the first examination. The duration of illness, defined as the time elapsed from occurrence of the leg symptoms to the first MRI examination, for each patient was also recorded. Thirty patients subsequently were elected for surgery and 19 for conservative treatment. We recommended follow-up MRIs to patients in the conservative treatment group. Ten agreed, and nine objected due to the time and cost involved. For the ten patients who agreed, the MRI was taken again after six to 12 months following the first visit, Table 1.

MRI apparatus used in this study had a 0.5 Tesla superconducting magnet (MRT-50, Toshiba, Japan). Spin-echo sequences employed on a condition of 500ms/40ms (TR/TE) for T1-weighted images and 2000ms/120ms (TR/TE) for T2-weighted images, with 6 mm of slice thickness.

Signal intensity of HNP.

On the T2-weighted sagittal MR image, we established regions of interest (ROI) in the center of the HNP and in the center of nucleus from which it extruded (original nucleus), (Figure 1). Signal intensity of the ROI was measured, and the ratio of the signal intensity (SIR ; Signal Intensity Ratio) in the herniated mass to that of the original nucleus was calculated. In this study, we attempted

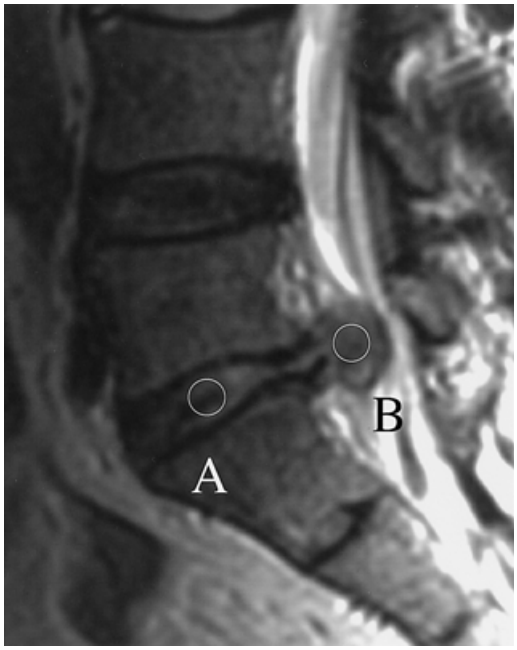

Fig. 1 Establishment of the region of interest (ROI) in the herniated nucleus pulposus and nucleus pulposus where herniation occurred.

Table 1 Data of follow-up MRI study in ten patients, and their comparisons with reference to initial MRI data.

Case	Sex	age (yrs)	SIR	extruded mass/spinal canal		follow-up / initial (%)
				initial (%)	follow-up (%)	
1	F	50	0.70	25.0	26.5	106.0
2	F	50	0.65	20.0	20.0	100.0
3	F	26	0.20	15.0	14.5	96.7
4	M	20	0.53	25.5	25.0	98.0
5	M	25	0.60	28.0	27.5	98.2
6	M	38	1.15	18.0	15.0	83.3
7	M	40	1.50	37.5	4.5	12.0
8	M	27	1.37	21.0	5.5	26.2
9	F	38	2.50	16.5	3.0	18.2
10	F	35	1.50	29.0	0.0	0.0

to clarify the natural history of herniated nucleus pulposus. Therefore, the SIR of the HNP was compared with the original nucleus, not with the normal disc such as the disc at L1/2 level. The relationship between the duration of illness and SIR was also examined.

Volumetric evaluation.

On the T1-weighted axial image, the percent space-occupying ratio (SOR) of the herniation to the spinal canal was calculated by using imaging software, Figure2. The SOR between initial and follow-up MRIs were compared by calculating percent reduction ratio as 100-(SOR on follow-up scan/SOR on initial scan× 100).

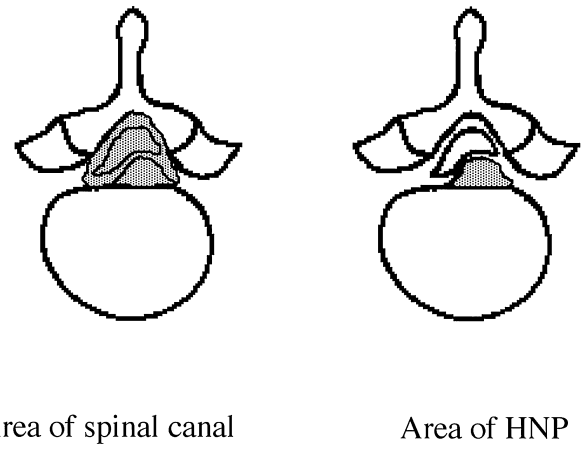

Fig. 2 Measurements of areas of spinal canal and HNP. The space-occupying ratio was calculated as follows : area of HNP/ area of spinal canal×100%.

RESULTS

Signal intensity of HNP.

As shown in Figure1, the SIR was measured. The signal intensity of the disc and the original disc in Figure 1 looks very similar, and its SIR is calculated as 1.1. The SIR more than 1.0 means the signal intensity of the HNP is higher than that of the original disc, suggesting the HNP is hydrated following the herniation. In case the SIR shows below 1.0, the signal of the HNP is lower than that of the original disc, indicating the HNP is suggested to dehydrate. The duration of illness ranged from 1day to 200 days and exhibited a logarithmic decrease in the SIR values, Figure 3. The relationship between the duration of illness and the SIR was found to be statistically significant ($p<0.05$). The result showed that the signal intensity of HNP became higher than that of the original nucleus shortely after herniation occurred and thereafter tended to decrease with time, suggesting that the hydration in disc herniations occurred immediately following event and dehydration in the HNP may progress over time.

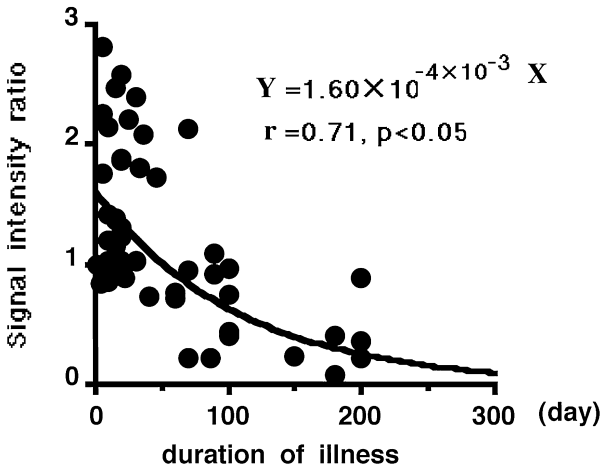

Fig. 3 Relationship between duration of illness and signal intensity ratio.

Volumetric evaluation.

Ten patients who underwent a follow-up MRI after their first visit were regrouped into three categories, based on the SIR values of the initial T2-weighted MR images. Five patients had low-SIR (0.8 or less); four had high-SIR (1.2 and higher) and one had in-between the two (iso-SIR : between 0.8 and 1.2). The size of the HNP of the four patients in the high-SIR group decreased (Reduction ratio : 73.8 to 100%) at the time of follow-up examination. The other two groups did not show any significant changes in the reduction ratio (range-6.0 to 16.7%). However, in these patients the follow-up between the two MRI sessions was longer than the patients in high-SIR group, Table 1. The reduction ratio in high-SIR group was significantly greater than that in iso-and low-SIR groups, (unpaired t-test, $p<0.01$).

DISCUSSION

In certain patients spontaneous reduction of lumbar HNP has occurred following conservative treatment (1-3, 6-8), e.g. 48% cases with a reduction of more than 70% (1), and 14 of 21 patients (2). The present study has also demonstrated this to be true. The spontaneous reduction of the herniated mass observed

in the present study showed a significant correlation with SIR at the first presentation. HNPs in high-SIR group (SIR>1.2) showed spontaneous reduction in size with time.

The HNPs in high-SIR group showed increased water content compared with the nucleus pulposus of origin. On the other hand, the HNPs presenting with low-SIR lost water following the initial herniation. It seems that disc herniations with high SIR contained a certain amount of water to be dehydrated, while low-SIR masses had already lost water and therefore unable to decrease their volumes further by dehydration. Actually, the correlation between SIR and duration of illness suggested HNP will be hydrated following herniation and thereafter dehydrated with time. Dehydration in the HNP, thus, may play an important role in size reduction of lumbar disc herniation.

Bozzao *et al* (1) and Saal *et al*. (6) reported cases with HNPs showing spontaneous reduction. In their patients, HNP showed high signal intensity on initial T2-weighted MR images and suggested dehydration to be a factor. The authors did not quantify the threshold values of MRI signal intensity that may suggest spontaneous reduction of the HNP. Our results provide a quantitative support to their observations. Thus, SIRs of 1.2 and higher can provide us the information to predict which herniation is likely to decrease with time spontaneously.

Morphologic changes of HNP were found to correspond to clinical outcomes (2, 3), and an excellent outcome without surgery was more likely in patients in whom the degree of herniation reduction was larger. In this study, we clarified that HNP with high-SIR is likely to reduce in size with time and in the other two groups it seems unlikely. Therefore, if patients presenting with HNP are found to be in the high-SIR group, the symptoms may decrease spontaneously without surgery due to the size reduction. Thus, by measuring the SIR, surgeons can predict the clinical outcomes of patients presenting with HNP. Actually, in the present study clinical symptoms such as low back pain and leg pain of all patients in high-SIR group decreased at the final follow-up in corresponding to the reduction in size. The predictive value of our findings could also influence on the health care cost and will be the focus of further studies.

Based on the results in this study, we proposed 1.2 in the SIR to be predictive value of the natural reduction in size of HNP. However, we just reviewed only ten patients. Thus, the value might not be completely correct. Further investigations should be required to elucidate the exact value of SIR, which can predict the natural reduction of HNP.

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