Recently, physicians have used magnetic resonance imaging (MRI) to diagnose lumbar degenerative disease. However, the accurate diagnosis of far lateral lumbar disc herniation presents difficulty. At present, one of the most effective diagnostic tool for far lateral disc herniation is disco-enhanced computed tomography (disco-CT). Although only this examination could differentiate disc herniation from other pathological conditions responsible for extreme lateral nerve root entrapment, it is an invasive method.

With the above in mind, we aimed to demonstrate how 3-tesla magnetic resonance myelography (3T MRM) compared to disco-CT could be a useful method for diagnosing far lateral lumbar disc herniation.

**MATERIALS AND METHODS**

**Patient group**

Between May 2010 and October 2011, 25 newly-admitted pa-
patients suspected of suffering from far lateral lumbar disc herniation were referred to our department. Previously, all patients underwent conventional MRI and CT. Among these 25 patients, we finally diagnosed 20 patients of the far lateral lumbar disc herniation by means of clinical findings, 3T MRM and disco-CT. Five patients who were not diagnosed as far lateral lumbar disc herniation were excluded from this study. We performed our clinical evaluations of the operative results on pre- and postoperative visual analogue scale (VAS) scores. We summarized demographic characteristics and clinical variables of the patients in Table 1.

**Disco-CT examinations**

All participating patients underwent disco-CT to detect far lateral disc herniations. We completed each discography at the level responsible for the nerve root entrapment, as suggested by the CT, MRI and the clinical findings. We used the posterolateral approach, under local anesthesia, placing a 3.5-inch, 24-gauge spinal needle across the spinal canal and into the center of the nucleus and injecting up to 3.5 mL of metrizamide (concentration, 180 mgI/mL). Generally, we performed each Disco-CT from L2 to S1, with 5-mm sections, using both bony and soft tissue window settings (16-slice MDCT, Simens, Erlangen, Germany) immediately after discography. We evaluated the results according to the Dallas Discogram description in Table 2.

**3T MRI examinations**

We performed the MRI with a 3-T imager (Magnetom Verio; Siemens Medical Solutions, Erlangen, Germany), using the Medic 3D sequence and obtaining all images with spine-array coils, with the patient in the supine position. For 3D-MRI examinations, we used echo time of 12 ms and repetition time of 22 ms, an a flip angle of 20 degrees, and a matrix of 224×320. All images were completed in 399 seconds. This method is very sensitive to the presence of water in tissues and allows the suppression of adipose tissue, as in a conventional T2 image. The scans provided coronal views, and the slice thickness was 1.5 mm.

Then, we studied each patient to identify the following: 1) compression of the nerve roots and ganglia, 2) signal changes (due to perineural edema and degenerative changes) and thickening of the spinal nerve roots and ganglia. The 3T MRM technique provided a stereoscopic view of the spinal cord and nerve roots, including the dorsal root ganglia; 3T MRM can show both sides of the spinal cord and the nerve roots in one picture.

**Surgical procedure**

We preferred the paramedian approach, because this approach is familiar to us. We operated on 20 patients, who had finally received diagnoses of far lateral disc herniation via these methods. The same neurosurgeon operated on each patient and used the same procedure, to reduce variation in the operative results.

**Statistical analysis**

A professional statistician performed statistical planning and analysis for this study, using SPSS software, version 17.0 for Windows (SPSS, Chicago, IL, USA). We employed independent t-test to evaluate the difference of mean VAS score between 5 patients with nerve root signal changes on MRM and others.

**RESULTS**

**Disco-CT**

Of the 25 cases, disco-CT demonstrated far lateral lumbar disc herniation in 20 patients. The rest of the patients (5/25) had negative findings. The disc levels of 20 patients were 1 at the L2-L3 level, 4 at the L3-L4 level, 12 at the L4-L5 level and 3 at the L5-S1 level. No complications were noticed. According to the Dallas Discogram description, 20 patients had total (>50%) annular degeneration and 5 of them had contrast extension beyond the outer annulus. Pain produced by disc injection was similar or an exact reproduction of the original pain. We could make an accurate diagnosis without much difficulty using these combined diagnostic modalities in conjunction with the clinical features.

**3T MRM**

Using an assessment scale (nerve root compression, signal change), 4 observers (1 board-certified radiologists and 3 board-certified neurosurgeon) evaluated all patients by 3T MRM and independently checked the pathologic changes in all patients. Only when the all of observers agreed to diagnose of far lateral disc herniation, the definitive diagnosis was reached. Using

### Table 1. Demographic characteristics and clinical results summary

| Parameter                                    | Value          |
|----------------------------------------------|----------------|
| No. of patients (male : female)              | 20 (11 : 9)    |
| Mean age in year                             | 59.1 (25-73)   |
| Affected disc level                          |                |
| L2/3                                         | 1              |
| L3/4                                         | 4              |
| L4/5                                         | 12             |
| L5/S1                                        | 3              |
| Affected side (right : left)                 | 10 : 10        |
| Average of preoperative VAS score            | 7.5            |
| Average of postoperative VAS score           | 2.6            |

**VAS : visual analogue scale**

### Table 2. Dallas discogram description

| Pain       | Degeneration (annulus) | Annular disruption (contrast extension) |
|------------|------------------------|-----------------------------------------|
| P-Pressure | 0-No change            | 0-None                                  |
| D-Dissimilar| 1-Local (<10%)        | 1-Into inner annulus                    |
| S-Similar  | 2-Partial (<50%)       | 2-Into outer annulus                    |
| R-Exact reproduction | 3-Total (>50%)   | 3-Beyond outer annulus                  |
3T MRM, we diagnosed a far lateral lumbar disc herniation (nerve root compression) in 20 cases. Surprisingly, 3T MRM showed same results as disco-CT did and we demonstrated a case (Fig. 1). In addition, we detected signal changes due to damaged nerve roots in 5 patients (Fig. 2). The 3T MRM also showed the dorsal root ganglion and nerve roots, with surrounding bony structures and disc materials.

**Evaluation of the clinical usefulness of MRM**

For evaluation of 3T MRM, we checked VAS score difference and signal change. The patients with signal changes and thickening of the spinal nerve roots had higher preoperative VAS scores than other patients did. However, this information had no clinical value \((p=0.185)\). We found complete matching, and observer agreement, between high resolution images of 3T MRM and disco-CT for diagnosing far lateral disc herniation.

**DISCUSSION**

The condition of far lateral lumbar disc herniation usually requires surgical treatment, conservative management is only occasionally successful \((10%)^{10,19}\). Abdullah et al.\(^1\) first accurately described the symptoms of lateral lumbar disc herniation, as others did later\(^4,6,18,25,31\). The symptoms comprise minimal lumbar pain and lower limb pain in the area innervated by the compressed root, often with accompanying sensorial and/or motor deficits. Symptoms alone do not differentiate this type of hernia from other hernias or compression syndromes. Therefore, diagnostic certainty is possible only with instrumental investigation.

Lindblom\(^15\) developed the discography technique in the early 1940s, partially in the hope of diagnosing such lesions. Although discography gained some popularity in the 1950s and 1960s, physicians have not utilized it widely. With the advent of thin-section, high-resolution CT, physicians can confidently diagnose the more common posterolateral and midline disc herniations without the use of intravenous or intrathecal contrast enhancement. CT may suggest the more unusual extraforaminal disc herniation, but CT done after discography allows the physician to make the diagnosis\(^5,14,17,36,38,39\). Myelography is neither sensitive nor specific. Discography is more useful than myelography, it played an ancillary role in the diagnosis of lateral lumbar disc herniation in the past; however, it is an invasive and low specificity procedure that is not always conclusive\(^1\).

Although conventional MRI provide more information than CT scan, definitive diagnosis of far lateral disc herniation through conventional MRI is still difficult. Recently, Heo et al.\(^13\) reported that in 9 of 10 patients \((90.0\%)\), nerve root compression by the herniated disc in the extraforaminal area was clearly demonstrated that in 9 of 10 patients \((90.0\%)\), nerve root compression by conventional MRI is still difficult. Recently, Heo et al.\(^13\) scan, definitive diagnosis of far lateral disc herniation through a new procedure that is not always conclusive.

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lateral disc herniation. This may be due to poor resolutions of MRI such as 1.5 T MRI or less. Until now, no studies have reported regarding the usefulness of MRM images in assessing far lateral discs. At present, one of the most effective diagnostic tool for far lateral disc herniation is disco-enhanced computed tomography (disco-CT). We found complete matching, and observer agreement, between high resolution image of 3T MRM and disco-CT for diagnosing far lateral disc herniation. Therefore, we conducted a prospective study to evaluate the value of 3T MRM comparing with disco-CT.

CONCLUSION

Our results suggest that 3T MRM images can easily detect far lateral lumbar disc disease as well as disco CT. Using this diagnostic tool, we can make it easy to diagnose the far lateral lumbar disc herniation without confirmation with invasive disco-CT.

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