THE USE OF NUCLEAR MAGNETIC RESONANCE IN THE DIAGNOSIS OF LATERAL CANAL ENTRAPMENT

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The use of nuclear magnetic resonance (NMR) in the diagnosis of radicular pain due to lateral canal stenosis in 21 patients is reported. NMR was able to distinguish normal intervertebral discs from degenerate discs, and NMR evidence of reduction of epidural fat was more reliable than radiculography in identifying lateral root entrapment. NMR is an important advance in the investigation of lumbar radiculopathies.

The importance of lateral canal stenosis as a cause of root entrapment is becoming increasingly recognised, especially in the older patient (Macnab 1977; Crock 1981; Getty et al. 1981b). Radiculography is often unhelpful in demonstrating such entrapment (Lee, Kazam and Newman 1978; Getty et al. 1981a; Critchley 1982). Computerised tomography (CT) has greatly improved imaging of the lateral canal, has made imaging of soft tissues within the canal possible (Haughton, Syvertsen and Williams 1980; Isherwood and Antoun 1980) and has been considered the procedure of choice in the investigation of lumbar radicular pain. However, the diagnosis of radiculopathy by CT scanning remains no better than by electromyography (Getty et al. 1981a; Heithoff 1984).

A detailed examination of the lumbar spine using CT may result in a radiation dose per patient of between 4.8 and 7 rads (Isherwood and Antoun 1980). Nuclear magnetic resonance is a harmless, non-invasive method of imaging (Steiner 1982; Saunders and Orr 1983). The aim of this present study was to evaluate multiplanar NMR as a method of investigating the lumbar spine, with particular reference to the lateral recess, and to compare its diagnostic precision with that of more conventional methods such as radiculography and computerised tomography.

MATERIALS AND METHODS

Twenty-one patients presenting to the Back Unit with a clinical picture of lateral root entrapment were included in the study. There were 12 men and 9 women. Their mean age was 49.6 years (range 30 to 68 years), and the length of history ranged from 6 months to 16 years (mean 9.1 years). Four patients had previously undergone spinal surgery. All the patients had histories of either unilateral or bilateral radicular pain, but most (17) had no limitation of straight leg raising. In five patients neurological signs appeared only after walking.

Computerised tomography, using an IGE 8800 CT/T machine, was performed on all patients by one of us (DF). Five cuts were taken at each vertebral level, three being taken through each root canal.

NMR was performed at a field strength of 0.15 Tesla using the steady state free precession technique, which has been described previously (Moore and Holland 1980; Kean et al. 1983). NMR images were taken in transverse, coronal, sagittal and parasagittal planes, the latter being taken 2 cm on each side of the midline.

Radiculography was performed in 16 of the 21 patients, using water-soluble contrast media; in two of the remaining patients, radiculography was not performed for medical reasons. All patients had anteroposterior, lateral and oblique lumbar radiographs taken. Discography was not routinely performed, but was carried out in five patients, a total of 14 levels being examined.
Table I. Results of investigations

<table>
<thead>
<tr>
<th></th>
<th>Radiculogram</th>
<th>Computerised tomography</th>
<th>Nuclear magnetic resonance</th>
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<tbody>
<tr>
<td>Number of patients investigated</td>
<td>16</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td><strong>Abnormalities detected</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degenerate disc</td>
<td></td>
<td>2</td>
<td>17*</td>
</tr>
<tr>
<td>Disc prolapse</td>
<td>5</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Spinal stenosis</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Arachnoiditis</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lateral root entrapment†</td>
<td>1</td>
<td>10</td>
<td>8</td>
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</table>

* Degenerate intervertebral discs were detected by an absence of signal due to the loss of the water-holding ability of the nucleus.
† Computerised tomography predicted entrapment due to a measurable narrowing of the lateral canal: nuclear magnetic resonance demonstrated an entrapment with loss of signal from the epineural fat.

RESULTS (Table I)

Of the 16 patients who underwent radiculography, seven showed no abnormality other than a small central disc bulge. In five patients entrapment other than a small central disc bulge. In five patients entrapment was suspected, in three, anteroposterior spinal protrusion was suspected; in three, anteroposterior spinal stenosis was suspected. In five patients entrapment was suspected, and in the remaining patient, lateral canal stenosis was suspected.

By contrast, computerised tomography demonstrated abnormalities in all but four patients. There were only two where discs were implicated as the cause of root entrapment. In addition to the three cases of stenosis detected on radiculography, one further case of stenosis was detected. Lateral canal stenosis was detected at one or more levels in 10 patients. There was one case of arachnoiditis demonstrated by both radiculography and CT.

Although all patients underwent NMR imaging in at least two planes, only two patients underwent imaging in all four planes. Transverse imaging was performed in 12 patients. In all but two, epidural fat and fat in the lateral recess was well visualised (Figs 1 and 2). It was possible in some cases to demonstrate differences in the fat laterally between the two sides, suggesting root entrapment (Figs 3 and 4). It was possible to predict anteroposterior stenosis in two patients (Figs 5 to 8) and this was confirmed by CT, although due to the different landmarks in NMR and CT no correlative measurements could be made.

Coronal imaging was performed in 12 patients. In four, images were taken at the level of the vertebral bodies, and in these patients it was possible to visualise disc material and to see a reduction in the signal from discs which were degenerate. Images taken at canal level showed fat in the lateral recess outlining the nerve roots. In four patients it was possible to demonstrate a unilateral reduction of this fat in keeping with the clinical findings of radiculopathy (Figs 9 to 12).

Sagittal imaging was performed in all patients, but
Spinal stenosis in the anteroposterior diameter (Figs 5 and 6) compared with a normal canal (Figs 7 and 8). The fat posterior to the cord defines its posterior limit.

Figures 9 and 10—Coronal sections taken through the vertebral bodies demonstrating discs at the L3-4 and L4-5 levels with reduced signal from the L5-S1 disc space. Figures 11 and 12—Coronal section through the spinal canal demonstrating pedicles (dark grey) and fat (arrows), which are well seen in the lateral recess.
Normal sagittal section demonstrating disc material between vertebral bodies at all levels.

Sagittal section showing normal discs above L4-5 with an abnormal disc at this level (reduced signal). It also demonstrates the fusion site.

Parasagittal sections taken 2 cm from the midline. Figures 17 and 18—NMR demonstrates fat around the nerve roots in the lateral recesses. Figures 19 and 20—A reduction of fat is seen around the L5 root on the right behind a sequestrated L5-S1 disc. In this case the laterally placed entrapment was missed on radiculography. The operative findings agreed with the NMR prediction.
in two the images obtained were technically unsatisfactory. It was possible to demonstrate disc material in all the remaining 19 patients (Figs 13 and 14). In two, normal discs were seen at all levels; in these two patients, all other investigations—CT, plain films and radiculography—also were normal. In all other patients, abnormal discs were detected at one or more levels. Of the five patients who underwent discography, the NMR findings agreed with the discographic findings at the 14 levels examined (Figs 15 and 16). There were four normal and 10 abnormal discs.

Parasagittal views, 2 cm from the midline, were obtained in 11 patients. In all 11, these images enabled us to demonstrate fat in the lateral canals on both sides. A reduction of fat was demonstrated in nine patients at one or more levels (Figs 17 to 20); in six of these the findings were in accordance with the CT prediction of lateral canal stenosis. Of the remaining three patients, the first had undergone two previous spinal operations and showed arachnoiditis on CT and radiculography; NMR demonstrated a small amount of fat around one S1 root, but no other fat was seen; the absence of fat around the cord in all planes was noticeable. In the second patient, both radiculography and CT demonstrated an anteroposterior stenosis whilst parasagittal NMR demonstrated a radiculopathy. In the third patient, although all other investigations were normal, sagittal NMR showed an abnormal L5–S1 disc and parasagittal views showed reduced fat around the S1 root on the left, agreeing with the clinical findings.

**DISCUSSION**

NMR is a non-invasive multiplanar method of imaging, which makes it possible to identify degenerate discs, as predicted by Hawkes et al. (1981).

The coronal view is capable of demonstrating reduction of epidural fat in the lateral recess, and the parasagittal views even more so. This reduction correlates well with both the CT scan and clinical findings of lateral recess stenosis; it also avoids the problems often encountered in correlating the canal measurements obtained by computerised tomography with the clinical signs of nerve root compression.

The transverse images show fat distribution epidurally and around the nerve roots. Modic et al. (1983) demonstrated disc protrusions. Our failure to do so may relate both to the small number of true protrusions in this series and also to the fact that many of the transverse images were not performed exactly at the level of the disc.

**In conclusion,** it would appear that NMR has a valuable role to play in the diagnosis of lumbar spinal abnormalities and that its characteristics are particularly valuable in imaging lateral recess stenosis, a well-recognised area of diagnostic difficulty.

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**REFERENCES**


