Computed tomography and myelography of the postoperative lumbar spine.

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AJNR Am J Neuroradiol 1982, 3 (3) 223-228
http://www.ajnr.org/content/3/3/223
Computed Tomography and Myelography of the Postoperative Lumbar Spine

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Postoperative myelographic changes in the thecal sac, epidural tissues, and bony canal, as well as nerve roots, may be difficult to interpret. A series of 32 postoperative patients, all of whom had a metrizamide myelogram and subsequent lumbar computed tomogram, was reviewed to examine the ability of computed tomography to recognize abnormalities when the myelogram is equivocal or uninterpretable. Criteria to distinguish recurrent herniated disk from postoperative changes are presented, including the demonstration of mass densities similar to and in continuity with the intervertebral disk. In 12 reoperated cases, five recurrent herniated disks and two new herniated disks were diagnosed and confirmed. In 20 nonreoperated cases, no recurrent herniated disks were identified, although two new herniated disks were found at levels not believed clinically significant. Computed tomography after metrizamide myelography appears to be a reliable technique for distinguishing abnormalities in the postoperative spine.

Difficulties in myelographic examination of postoperative lumbar spine are well known. These are caused by previous oil myelography and operation, often superimposed on developmental variation, degenerative changes, and the alteration by acute and chronic disk disease. In particular, recurrent herniated disk or a new disk herniation cannot be accurately or consistently recognized by myelography in the postoperative lumbar spine.

Previous reports [1–6] have demonstrated the usefulness of high resolution computed tomographic (CT) scanning of the lumbar spine with and without metrizamide in various conditions. It would seem that the method might be useful to clarify problems encountered in the postoperative patient as well. We retrospectively studied 32 patients to examine this possibility.

Materials and Methods

Clinical

The study group comprised 32 men and women of average age 45. All had at least one previous myelogram (usually iophendylate) and lumbar surgery, usually a laminectomy, for herniated disk. Many had had several operations and myelograms. Backache and/or sciatica either persisted or recurred in all patients and all had a failure of conservative treatment before a decision to restudy the spine. Twelve patients were reoperated after myelography and CT scanning.

Technical

All patients were studied by metrizamide myelography, followed by a lumbar spine scan on the General Electric 8800 Scanner. Metrizamide at 190 mg/ml concentration in a volume of 10–12 ml was used. Filming was performed immediately in the semierect position, generally without flexion or extension views. Delayed filming was not performed. All CT scans were obtained within 4 hr, usually 1 hr, with the patient supine and the legs...
straight. Most were scanned at L5–S1 and L4–5, with about half at L3–4. Adjacent sections of 5 mm thickness were scanned from about pedicle to pedicle through the disk space. Gantry angle was chosen by localizing film as the closest angle parallel to the disk at the respective levels. No attempt was made to correct for lordosis by changing the patient’s position. Scans were obtained at 120 kVp, 600 mA. Routine image display at 2X magnification was used. No reformatting or sagittal/coronal reconstruction was used. A window width of 500 was generally used, with window levels of about 80–120.

CT Diagnostic Criteria

Herniated disk (figs. 1–5). Disk material was considered herniated if a smooth and rounded mass of the same relative density as disk material was found in relation to the disk or in continuity with it. Measurement of actual CT numbers was not performed since the relative (qualitative) density value was found to be reliable. (In contrast, scarring was noted to produce patterns of mixed density and even radiolucent mass [see figure 8 below].) Herniated disk material was usually posterolateral in the epidural space and distored the thecal sac (figures 1B, 2C, and 5A). Distortion that was near but not directly related to the thecal sac deformity produced by the disk fragment was considered to be produced by scar tissue without herniated disk material (Fig. 2A). Root sleeves were noted to be unfilled (figs. 1B, 2B, 2C, 3B, 4B, 5A) or distorted (figs. 3B and 4B) in cases of demonstrable herniated disk. Root sleeve distortion, per se, was not reliable as a diagnostic criterion of herniated disk material alone because it was also produced by scarring (fig. 6B). Bony irregularities could be readily distinguished from herniated disk material (Figs. 3B and 11B). Recurrent herniated disk was distinguished from new herniated disk that occurred

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**Fig. 1.**—Recurrent herniated disk, proved by surgery. A, Extradural right-sided defect (arrowhead), prominent roots crossing L4–5 disk space, site of previous operation. B, Scan at L4–5 interspace. Herniated disk fragment represented as smooth, rounded mass of disk density in epidural space (arrowheads) accompanied by distortion of dural sac and nonfilling of root sleeve.

**Fig. 2.**—Herniated disk, proved by surgery. A, Generalized irregular asymmetry secondary to scarring, with prominent extradural defect at L5–S1 on left (arrowheads). Nonspecific root defects at L4–5 and over L4 (arrow). Site of previous operation was L4–5. B, New herniated disk. CT scan at L5–S1. Smooth, rounded extradural density (arrow) with minor impression on opaque column, which appears narrowed secondary to scarring. This was not a site of previous operation. C, Probable recurrent herniated disk. Scan at L4–5. Very prominent "bulge" of disk at site of previous operation (black arrows). Laminotomy operation defect (white arrow).

**Fig. 3.**—Recurrent herniated disk proved by surgery. A, Poor filling of S1 root sleeves bilaterally (arrowheads). Previous operation was at this level, L5–S1. B, Same level. Rounded mass of disk density in anterolateral epidural space (arrowheads) accompanied by nonfilling of left S1 sleeve and poor filling of the right S1 sleeve (arrow). Prominent edge of vertebral body (asterisk).
at a level not previously explored (fig. 2).

Scar (figs. 6–10). In contrast to herniated disk material, scarring secondary to operative intervention was represented by a replacement of the epidural tissue (usually fat) by denser tissue. The density of the scar tissue was variable and oftenlucent (Figs. 8B and 9B). The scar tended to be a band of irregular shape in the anterior epidural space (Figs. 7B and 10B) or a relativelylucent distortion of the thecal sac (Figs. 2B and 9B). Root sleeves were kinked or deformed in an angular manner also, but not displaced by a mass (figs. 6B, 9B, and 10B). This lack of mass, except in figure 8, was the main distinguishing characteristic of scar tissue.

Stenosis (fig. 11). Stenotic patterns were divided into developmental, central, and lateral in this study. Developmental stenosis resulted from general or focal canal narrowing due to short pedicles, thick laminae, and thick facet joints. The sagittal diameter was reduced. Central stenosis was considered to be acquired laminar thickening and facet enlargement or fusion bone encroaching on the canal centrally. The lateral stenosis pattern refers to narrowing of the peripheral portion of the canal, lateral recess or root exit canal.

Indeterminate (fig. 12). In a small group, the canal was surrounded by dense tissue with no visualization of epidural fat or root sleeves. The density of the tissue was not lucent and scar tissue could not be distinguished from disk material.

Normal (figs. 5C and 7C). In the absence of any of the above criteria, the CT scan findings were considered normal at the level in question.

Results

Myelography

All myelograms were abnormal at least at one level, usually the level in question. At L3–4, the myelogram was

\[\text{Fig. 4.} \text{—Recurrent herniated disk, proved by surgery. A, Nont filling of right S1 root sleeve (open arrow) and widening of left S1 root sleeve (closed arrow). This is site of previous operation, L5-S1. B, Similar findings accompanied by central herniation (black arrows). Widened root sleeve (arrowhead). Laminitomy defect (white arrow).} \]

\[\text{Fig. 5.} \text{—Recurrent herniated disk, proved by surgery. A, Poor S1 root sleeve filling bilaterally (arrowheads) and asymmetry with poor filling at L4–5 (arrow). Previous operations were at L4–5 and L5-S1. B, At L5-S1. Herniated disk material (arrowheads) on right with non-filling of S1 root sleeve but good filling of left S1 root sleeve. C, Normal L4–5 root sleeves are well filled (arrowheads) and disk margin is intact.} \]

\[\text{Fig. 6.} \text{—Scar, not proved by surgery. A, Oblique spot film. Sleeve widening at L5-S1 on left (arrowheads), site of prior operation. B, Same level. Flattening of sleeve (arrowhead) but no mass (not confirmed surgically) probably due to scarring.} \]
usually normal. Myelographic defects ranged from small root sleeve pressure defects, such as splaying and widening, to complete block. The patterns often consisted of unfilled root sleeves, with or without some minor irregularity of the thecal sac. As expected, many patients had extensive "scarring" patterns on examination. The herniated disks tended to produce a single unfilled root sleeve, but the sign per se was not specific for herniated disks. In fact, many levels that demonstrated unfilled roots by myelography alone were noted to show filled roots by CT. Irregular distortion of the thecal sac was a common feature also, and appeared to have little specific predictive value. Examples of myelograms are grouped with CT findings (figs. 1–12).

CT Scanning

Table 1 summarizes the CT findings in all 32 patients. Tables 2 and 3 divide them into reoperated and nonreoperated groups, respectively. The operative findings at the principal level are indicated in table 4. In 12 patients who were reoperated, five recurrent herniated disks were identified and four were surgically confirmed. The fifth patient, who had a recurrent herniated disk, also had a new herniated disk at an adjacent level, which was believed to account for his symptoms and confirmed surgically. Two other patients had new herniated disks that were also surgically confirmed. Although the total number of patients is
A B

Fig. 10.—Scar, not operatively confirmed. A, Dural sac distortion and nonfilling of right S1 sleeve (arrowheads); previous operation at L5–S1. B, Same level. Moderate anterior epidural tissue thickening and loss of fat density. Sleeve on right (arrow) is normal. Left S1 sleeve does not fill as well.

A B

Fig. 11.—Lateral recess stenosis, confirmed by surgery. A, Poor filling of S1 sleeves bilaterally, worse on left (arrowheads). Site of previous operation was L5–S1. B, Same level. “Spur” arises from superior articular process of S1 related to spur that arose from posterior and lateral aspect of vertebral body (arrows). S1 sleeve (arrowhead) displaced posteriorly.

small, CT myelography appears to be quite specific and accurate in the assessment of the recurrent or new herniated disk, provided that criteria for identification are adhered to strictly.

CT also appears to be accurate in demonstrating normal-appearing disk in the presence of confusing myelographic deformities. Many normal levels were, in fact, discovered by CT. Given the number and range of myelographic abnormalities, more difficulty was expected. This appears to be in part due to improved root sleeve visualization by CT scanning.

TABLE 1: CT Diagnosis: All Patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>L5–S1</th>
<th>L4–5</th>
<th>L3–4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent disk herniation</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>New disk herniation</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Scar</td>
<td>8</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Developmental stenosis</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Central stenosis</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Lateral stenosis</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Normal</td>
<td>13</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

TABLE 2: CT Diagnosis: Reoperated Patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>L5–S1</th>
<th>L4–5</th>
<th>L3–4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent disk herniation</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>New disk herniation</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scar</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Developmental stenosis</td>
<td>0</td>
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<td>Central stenosis</td>
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</tr>
<tr>
<td>Normal</td>
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<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

The number of indeterminate scans was small, a total of four levels only. It appears that this pattern, which may reflect scarring essentially, is not frequently encountered, despite the fact that patients were referred from many different sources.

In the group not reoperated, no recurrent herniated disks were found by myelography or CT. One patient had a new herniated disk at L4–5, but it was not believed clinically
significant. Roughly the same proportion of abnormalities was found in both groups, operative and nonoperative (tables 2 and 3).

**Discussion**

Myelographic abnormalities in the postoperative patient have consistently led to difficulty in interpretation [7-9]. Postoperative changes compound those produced by developmental and degenerative abnormalities. High-resolution CT evaluation after metrizamide myelography appears to offer clarifying information. This preliminary report supports the contention that the recurrent or new herniated disk can be demonstrated by high-resolution CT after metrizamide myelography and distinguished from scar alone. Provided that criteria of herniated disks are strictly adhered to as described above, accuracy is high.

Adjacent sections 5 mm thick were most often used to obtain data, but occasionally 2 mm overlap of a 5 mm section was necessary to demonstrate the continuity of disk material to the disk itself. Thin sections in the order of 1.5 mm on the General Electric unit were not used because of the constraints of time and image noise and were not believed to be necessary to demonstrate the findings. CT scanning without metrizamide would not have been diagnostic since herniated disk material would have been difficult to distinguish from scar, but also secondary changes on the thecal sac and root sleeves would have been much more difficult to delineate.

It is of interest that scarring does not produce a mass of disklike density in close relation to the disk space. More experience is necessary to determine whether this potentially useful distinction is valid.

Spinal stenosis in its various forms may be a component of many spine diagnostic problems, and may itself produce symptoms typical of herniated disk [10-13]. Methods prior to CT scanning do not appear to have recognized its importance.

In conclusion, CT scanning after metrizamide myelography seems to be a valuable technique to differentiate pathologic anatomy in the postoperative spine. Not only does it aid greatly in the diagnosis of the herniated disk, but it helps identify normal levels in light of confusing myelographic patterns.

**REFERENCES**