High-dose i.v. contrast in CT scanning of the postoperative lumbar spine.

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High-Dose IV Contrast in CT Scanning of the Postoperative Lumbar Spine

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Evaluation of the postoperative lumbar spine is sometimes difficult because of obliteration of epidural fat by hypertrophic scarring. We examined 70 patients using a high-dose intravenous contrast technique in an attempt to distinguish hypertrophic scarring from herniated disk. The CT interpretation was confirmed in all 17 patients who had follow-up operations. Thirteen had herniated disk material associated with scar and four had hypertrophic scarring only. The latter four patients underwent reoperation because of concomitant foraminal or spinal canal stenosis seen on CT. Twelve of the herniated disks had the expected appearance of a nonenhancing mass surrounded by a rim of enhancing scar tissue. In the 13th patient, homogeneous enhancement of the herniated disk was seen. It is thought that chronically herniated disks, such as this one, may incite enough surrounding scar to give the CT appearance of an enhancing disk. Finally, marginal enhancement in the anulus fibrosus region was seen in over 90% of disk spaces examined. Although an anatomical explanation cannot be given at present, this phenomenon is thought to represent a normal finding.

Evaluation of the lumbar spine has been revolutionized by high-resolution CT [1–3]. In patients with failed back surgery, CT will often disclose treatable lesions, such as bony canal stenosis, foraminal encroachment, facet disease, or recurrent disk herniation. However, CT evaluation for recurrent disk herniation is often difficult because of obliteration of epidural fat by hypertrophic scarring or fibrosis [4]. The clinical differentiation of epidural fibrosis from reherniated disk is also difficult, although a slowly progressive course suggests scarring and an acute presentation favors disk. Distinguishing these two entities is important because surgery is more likely to be beneficial in cases of recurrent disk herniation [5–6].

High-dose, IV, enhanced CT scanning has recently been used in postoperative patients to distinguish hypertrophic scar from recurrent disk herniation [6–10]. The avascular disk is said not to enhance, whereas scar tissue does. We examined 70 postoperative lumbar spine patients to further assess the value of this technique.

Materials and Methods

In the past 18 months, 120 patients referred for recurrent lower-back and leg pain after lumbar spine surgery were studied with unenhanced CT scans. IV contrast enhancement was performed on 70 of these patients in whom it was difficult to rule out recurrent disk herniation because of extensive postoperative scarring on unenhanced scans. The average age of the patients was 45 years (range, 24–73 years) and the time between surgery and the CT examination varied from 1 week to 12 years (average, 3 years). Most patients had only one previous operation, 10 had undergone laminectomy twice, and seven had been operated on three times.

All examinations were done with nonangled 5-mm thick slices at 3–4-mm intervals on a high-resolution scanner (Toshiba TCT-20, GE 8800). Care was taken to ensure that the enhanced scans through the area of concern were performed at the same levels and in the same planes as the unenhanced studies. Enhanced scanning began after an intravenous

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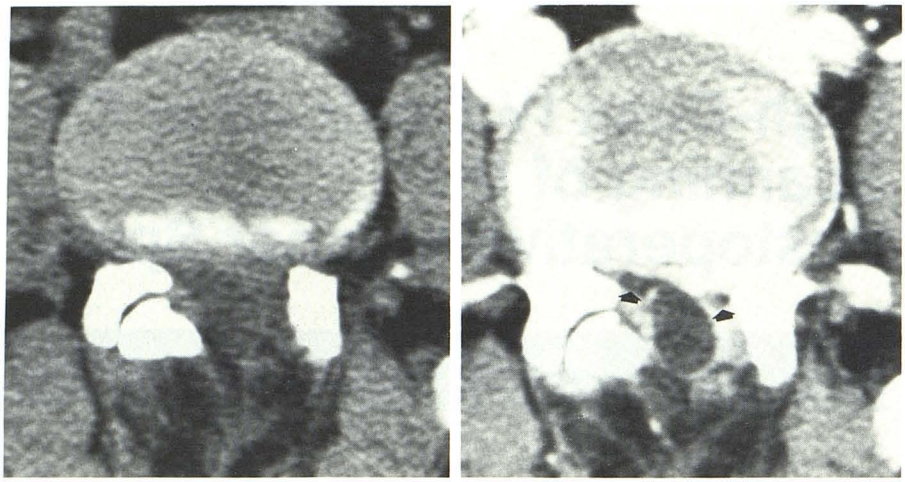

Fig. 1.—**A**, Unenhanced CT at L4–L5 level reveals postoperative changes, including obliteration of epidural fat and laminectomy defect. **B**, After IV contrast, there is homogeneous enhancement of scar tissue around thecal sac. Note encasement of L5 nerve root sleeves (*arrows*) by fibrosis.

bolus of 150 ml of Conray 60% (meglumine iothalamate) was administered and while another 150 ml were infused over approximately 5–10 min. One patient, a diabetic, received only 150 ml of Conray 60%.

Seventeen patients subsequently underwent reexploration. The decision to reoperate was based on a combination of clinical symptomatology and CT findings, occasionally supplemented by myelography. In four patients, CT findings of foraminal or spinal stenosis led to reoperation even though fibrosis without evidence of herniated disk was seen.

Results

All 70 patients had postoperative loss of epidural fat planes at the sites of previous surgery. Unenhanced CT scans most often showed epidural fibrosis as a nearly homogeneous soft-tissue density that was sometimes difficult to separate from the thecal sac, although the attenuation of scar was usually higher than that of the sac. After IV contrast administration, dural and epidural enhancement helped delineate anatomic planes (Fig. 1). Scar tissue generally enhanced intensely in a relatively homogeneous pattern and was seen to a variable degree in all postoperative patients, regardless of evidence of a reherniated disk. Another important feature of epidural fibrosis was the lack of significant mass effect; in fact, the sac and adjacent nerve roots were sometimes retracted toward the side of scarring.

Disk herniation was diagnosed in 19 patients and confirmed in the 13 who underwent reoperation. Twelve of the surgically confirmed herniated disks had the appearance of a nonenhancing mass anterior to a rim of enhancing scar tissue (Fig. 2). In six of the 12 patients, herniated disk material could be suspected on the nonenhanced scan. However, the enhanced scan increased our level of confidence significantly. In the 13th case, a suspected extruded disk fragment on the unenhanced study showed homogeneous enhancement from 150–230 H following IV contrast infusion (Fig. 3). Epidural fibrosis has been shown to measure approximately 50–75 H on unenhanced scans [4]. Despite the rather dramatic enhancement, a herniated disk, rather than hypertrophic scar, was suspected because of the globular configuration, the high attenuation prior to contrast administration, and an adjacent gas collection from the degenerated disk. The surgeon encountered a large extruded disk fragment with adjacent fibrosis. The other six patients with suspected disk herniation were treated conservatively.

Inflammatory disease accounted for abnormalities in two patients. One patient had a CT examination 2 months after surgery at L5–S1, which showed diffuse enhancement of the disk with apparent lateral extension of disk material. Erosive changes in the vertebral endplates led to the diagnosis of diskitis (Fig. 4).

Another patient presented with low-back pain, left-sided sciatica, and fever approximately 2 weeks after disk surgery at the L5–S1 level. Enhancement of a diffusely bulging disk at the postsurgical level was seen and thought to represent diskitis. There was also a small, low-attenuation mass with rim enhancement located posterolaterally on the left side (Fig. 5). This was thought to represent a small epidural abscess. The patient's symptoms resolved completely after 2 weeks of IV antibiotics.

We noticed a thin rim of circumferential enhancement of the disk in the expected region of the anulus fibrosus in most of our patients (Figs. 1 and 2). It was difficult to evaluate the L5–S1 level for this type of enhancement because we generally performed nonangled scans in a plane that was usually parallel to the L3–L4 and L4–L5 disk spaces. Of the lumbar disks that could be evaluated both before and after contrast administration, 65 of 70 showed definite "anular enhancement" and two of the remaining five had subtle enhancement. The enhancement pattern was also seen in several asymptomatic and otherwise normal disks above the area of interest when they happened to be included in the scan (Fig. 6).

In the diabetic patient who received a 150 ml IV contrast dose, the amount of scar enhancement was minimal, confirming that high doses are probably necessary for optimal results.

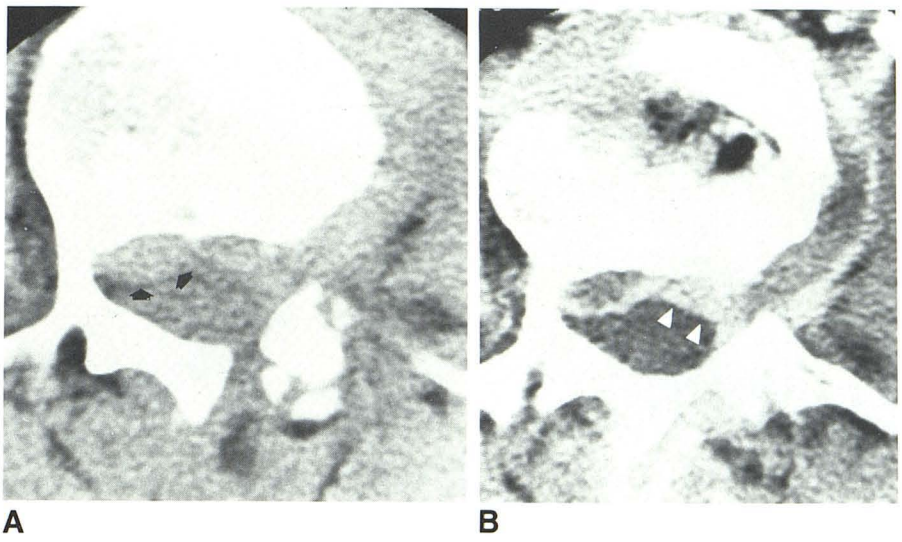

Fig. 2.—**A**, CT without contrast at L2–L3 level shows subtle area of increased attenuation on right side (*arrows*). **B**, Enhanced CT clearly shows avascular disk with surrounding rim of enhancement. Diffuse posterolateral bulge on left side is also seen. Homogeneously enhancing region between the two areas of disk herniation is hypertrophic scar, confirmed at surgery (*arrowheads*). Note contrast enhancement of anular margin.

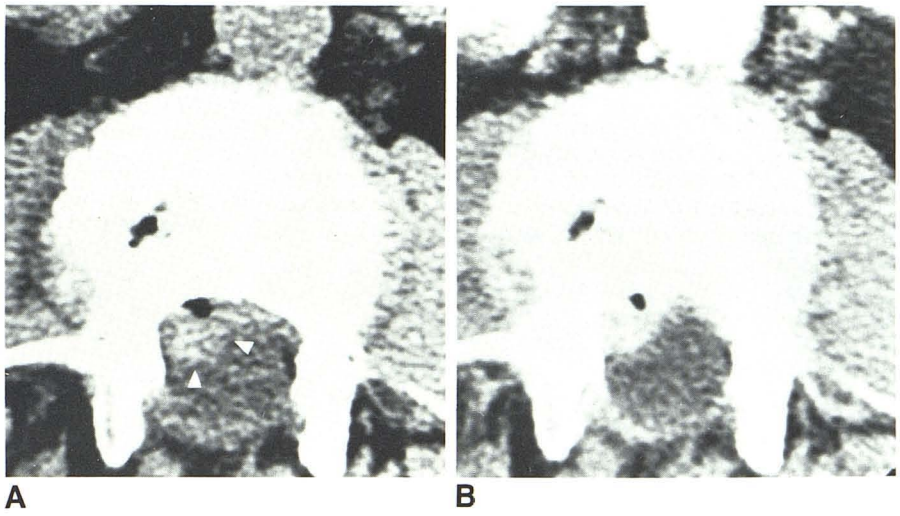

Fig. 3.—**A**, Unenhanced CT at L2–L3 level shows area of increased attenuation (*arrowheads*) on right side with associated gas collection. **B**, Note homogeneous contrast enhancement of same area, a surgically confirmed extruded disk fragment.

Discussion

Many of our findings confirm what has been previously reported; namely, that epidural fibrosis and recurrent disk can be differentiated after IV contrast enhancement [6–10]. Scarring at the operative site was seen in every patient and appeared as a homogeneously enhancing area, sometimes associated with retraction of the thecal sac. Hypertrophic scar occasionally presented as a mass, but usually with only minimal displacement of the thecal sac or nerve roots. Braun et al. [11], in their study of asymptomatic postoperative patients, commonly found retraction of the dural tube toward the side of fibrosis. Scarring without herniated disk was confirmed in four of our patients who underwent reexploration for recurrent symptoms and had CT evidence of foraminal or spinal canal stenosis. They did not undergo reoperation if only scarring was diagnosed on the enhanced CT.

In the patients with surgically confirmed reherniated disk, 12 of 13 scans showed the disk as a nonenhancing mass surrounded by overlying scar, confirming the findings of Schubiger and Valavanis [6], Teplick and Haskin [7], and Braun et al. [10]. However, we also present a case in which suspected herniated disk material enhanced homogeneously. A similar CT appearance has been previously reported by only one other group of investigators, and then only after a high-dose, slow-drip technique with late CT scanning (40 min after contrast injection) [12]. In has not been reported using the high-dose bolus technique. In our case, surgical exploration revealed a disk fragment surrounded by an appreciable amount of scar. Review of a myelogram done 2 years earlier showed the disk fragment, but the patient had undergone only decompressive laminectomy for spinal stenosis at that time. Although no definitive explanation for enhancement of the disk can be given, perhaps the chronically herniated disk incited enough surrounding fibrosis to cause partial-volume averaging and give the appearance of an enhancing disk fragment.

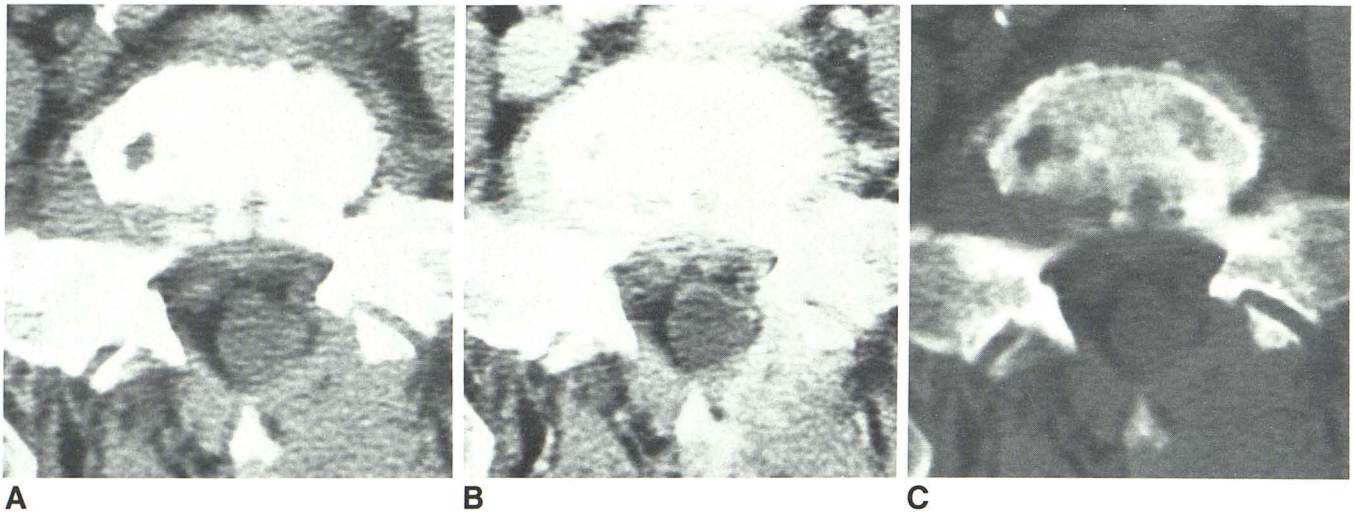

Fig. 4.—**A**, CT without IV contrast at L5–S1 level reveals prominent, diffusely bulging disk with large, right, posterolateral component. **B**, CT with contrast at same level shows enhancement of entire disk. **C**, Bone windows display erosive changes in vertebral endplates, consistent with diskitis.

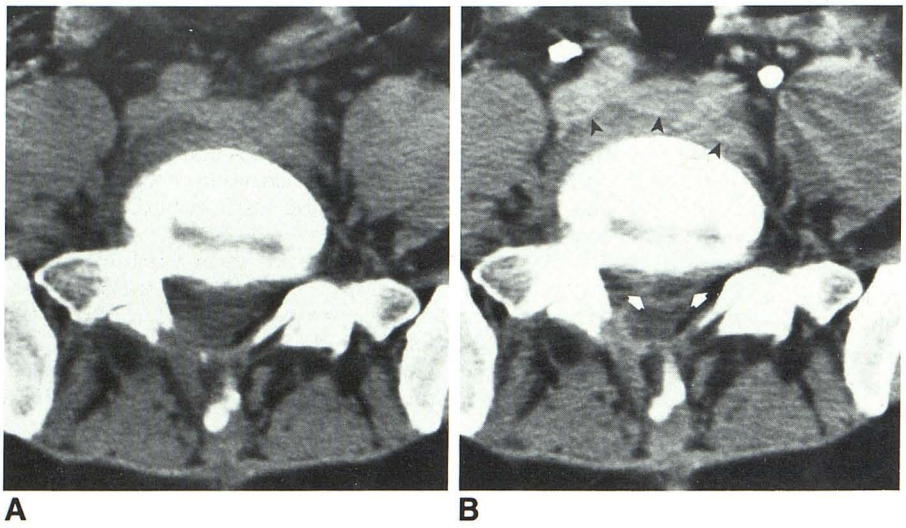

Fig. 5.—**A**, Nonenhanced CT scan at L5–S1 level shows right hemilaminectomy defect and soft-tissue density around thecal sac. **B**, After IV contrast administration, a relatively low-attenuation area with rim enhancement is seen toward left side (*white arrows*). Also, anterior displacement of vascular structures by diffusely bulging disk is noted (*black arrowheads*).

This finding stresses the importance of evaluating the characteristics of the extradural mass, including the attenuation coefficients prior to contrast administration, and not simply its enhancement characteristics. Although scar tissue can appear as a mass displacing the thecal sac or nerve roots [7], it most often has little or no mass effect [4, 11].

Our two patients with diskitis confirm the findings of Teplick and Haskin's two cases [7]. Presumably, inflammatory changes with vascularization causes contrast enhancement of the disk. Our case of probable epidural abscess had an appearance similar to reherniated disk material. In regard to a nonenhancing mass with rim enhancement, we believe that abscess should be considered in the differential diagnosis, particularly in the recently postoperative patient who has other evidence of an inflammatory process. In the appropriate clinical setting, it is also possible that an epidural hematoma could produce similar CT findings.

As opposed to the results of Teplick and Haskin [7], enhancement of the region of the anulus fibrosus has been a consistent CT finding in our patients. There are no anatomical explanations for this phenomenon. Anular material is avascular and there are no presently known vascular structures that could account for this appearance. Perhaps high-dose IV injection of contrast material causes extravascular collection of contrast in anular or perianular spaces. This finding has been helpful in providing better delineation of the posterior disk margin in certain cases.

To determine whether a high dose of contrast material is really necessary, we are currently comparing CT scanning with different amounts of intravenous contrast. Preliminary

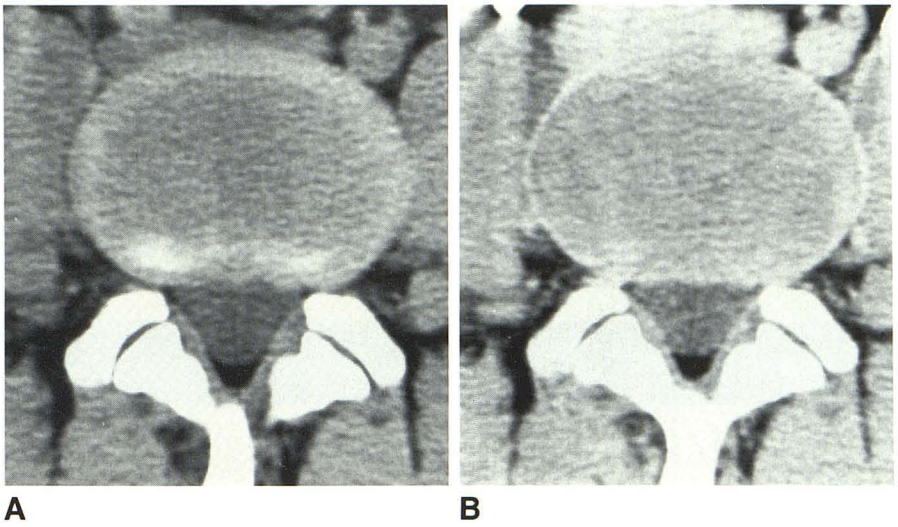

Fig. 6.—**A**, CT of normal L4–L5 disk. **B**, CT at same level. Note enhancement of anular margin after IV contrast.

results suggest that a "regular" dose of intravenous contrast can sometimes be nondiagnostic or even misleading. However, further studies are needed to adequately compare different techniques.

High-dose contrast-enhanced lumbar CT in the postsurgical patient is extremely helpful in differentiating postoperative scar from reherniated disk. Although most recurrent herniated disks will appear as nonenhancing masses with surrounding scar, some may exhibit homogeneous enhancement. One must evaluate the configuration of the extradural abnormality, as well as the enhancement characteristics. Epidural abscess can have a CT appearance very similar to reherniated disk material and should be considered in the proper clinical setting. In addition, contrast-enhancement of the anular margin with double-dose technique appears to be more common than originally expected, and does not indicate a pathologic condition.

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