AJNR

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AJNR Am J Neuroradiol 1988, 9 (4) 769-774
http://www.ajnr.org/content/9/4/769

Recurrent Postdiskectomy Low Back Pain: MR-Surgical Correlation

Leo Hochhauser[1]
Stephen A. Kieffer[1]
Edwin D. Cacayorin[1]
George R. Petro[1]
William F. Teller[2]

The preoperative MR findings in 11 patients, all of whom had developed recurrent low back pain after surgery for herniated lumbar intervertebral disk, were correlated with the surgical findings to determine possible criteria for distinguishing recurrent disk herniation from postoperative scar (extradural fibrosis). The preoperative MR findings agreed with the surgical findings in seven of eight patients with recurrent disk herniation and in six of nine individuals with extradural fibrosis. The most important parameters in differentiating recurrent herniated disk from extradural scar were the configuration and margination of the extradural mass rather than its signal characteristics. The most reliable MR sign for recurrent herniated disk was the presence of a sharply marginated focal polypoid disk protrusion beyond the posterior margins of the adjacent vertebral bodies shown to best advantage on sagittal T1- and T2-weighted and axial T1-weighted spin-echo MR images. Disk herniations usually maintained isointensity with the intervertebral disk of origin, while extradural fibrosis exhibited variable signal intensity. The preoperative diagnosis of extradural fibrosis on MR was based primarily on its irregular configuration and extension.

This study suggests that preoperative differentiation between scar and recurrent herniated disk is possible with MR when morphology and topography are considered in addition to signal intensity.

Recurrence of low back pain and sciatica after surgery for herniated lumbar intervertebral disk is a recognized clinical problem with a reported incidence of 5–10% [1]. Among the more common causes of this problem are recurrent disk herniation and postoperative scarring (extradural fibrosis) [1–3].

Although myelography has not permitted reliable differentiation of recurrent disk herniation from extradural scar [4, 5], CT of the lumbosacral spine with IV administration of iodinated contrast material (rapid bolus injection followed by drip infusion) has been reported to be effective in achieving this distinction [6–10]. Preliminary reports have suggested that MR imaging may also be an effective technique for distinguishing recurrent disk herniation from postoperative extradural fibrosis in postdiskectomy patients with recurrent low back pain [11–13]. This report correlates the MR findings in 11 such patients, all of whom were subsequently reexplored, with the surgical and pathologic findings to determine possible criteria for preoperative differentiation between recurrent herniated disk and scar with MR.

Subjects and Methods

Eleven patients who presented with postdiskectomy low back pain and sciatica were examined with MR imaging as part of their diagnostic workup and subsequently underwent reoperation. There were eight men and three women, ranging in age from 26 to 57 years (mean, 44 years). The interval between first diskectomy and surgical reexploration varied from 6 weeks to 11½ years (mean, 4 years).

MR imaging was performed on either a 1.0-T superconducting unit operating at a field

This article appears in the July/August 1988 issue of *AJNR* and the October 1988 issue of *AJR*.

Received November 18, 1987; accepted after revision February 26, 1988.

Presented at the annual meeting of the American Society of Neuroradiology, New York, May 1987.

[1] Department of Radiology, SUNY Health Science Center at Syracuse, 750 E. Adams St., Syracuse, NY 13210. Address reprint requests to L. Hochhauser.

[2] Department of Neurosurgery, SUNY Health Science Center at Syracuse, NY 13210.

***AJNR* 9:769–774, July/August 1988**
0195–6108/88/0904–0769

TABLE 1: CT, MR, and Surgical Findings

Patient No.	Age	Gender	Level	Interoperative Interval (months)	CT		MR[a]				Surgery	
					Type of Study	Finding	Scar[b]		Disk[c]		Scar	Disk
							T1	T2	T1	T2		
1	43	F	L5–S1	90	With contrast	Enhancing scar	Hyperintense	Isointense	—	—	+	—
2	26	M	L4–L5	97	CTM	Disk vs scar	Hypo/isointense	Hypointense	—	—	+	—
3	35	M	L4–L5	51	CTM	Disk vs scar	Hypointense	Hyperintense	—	—	+	—
4	30	F	L5–S1	16	Without and with contrast	Enhancing scar	Isointense	No study	Isointense	No study	+	+
5	57	M	L4–L5	104	Without contrast	Disk vs scar	Hypo/isointense	Isointense	Hypointense	Isointense	+	+
6	36	M	L5–S1	1½	With contrast	Disk + scar	Isointense	Hypointense	—	—	+	+
7	45	F	L4–L5	12	Without contrast	Disk vs scar	Isointense	Isointense	Isointense	Isointense	+	+
8	50	M	L5–S1	7	No study	—	Hypointense	Hyperintense	Isointense	Hyperintense	+	+
9	54	M	L5–S1	8½	No study	—	Hyperintense	Isointense	Isointense	Isointense	+	+
10	29	M	L5–S1	14	Without contrast	Disk vs scar	—	—	Isointense	Isointense	—	+
11	35	M	L3–L4	139	With contrast	Isodense with disk	—	—	Isointense	Hypointense	—	+

Note.—CTM = postmyelogram.

[a] MR study: Signal intensity relative to that of the adjacent intervertebral disk.

[b] Scar: Postoperative epidural fibrosis, all irregular or circumferential in configuration.

[c] Disk: Recurrent disk herniation, all polypoid in shape except for patient 6, who demonstrated only diffuse disk bulge.

strength of 0.5 T* (nine patients) or on a 0.6-T field strength unit† (two patients). In each case, the imaging protocol included both T1- and T2-weighted spin-echo images of the lumbosacral spine in the sagittal plane and also T1-weighted images in the axial plane through the lower two or three lumbar disk levels and adjacent vertebrae. All images were 0.5 cm thick with a 30-cm field of view and were obtained with rectangular surface coils (8 × 12 in. copper), appropriately tuned for the respective magnet and field strength, acting as receiver coils. The image matrix was 256 × 256. The T1-weighted sequences included pulse repetition times (TR) of 600–700 for the sagittal images and 600–950 for the axial images, echo delay times (TE) of 26–40, and four repetitions. The T2-weighted sagittal images were obtained with TRs of 2300–2500, a TE of 100, and two repetitions. Abnormalities on the MR images were defined by location, configuration, and signal intensity. Signal intensity of an abnormality was graded relative to the intensity of the adjacent intervertebral disk (hypo-, hyper-, or isointense).

After MR imaging, all 11 patients were surgically reexplored at the site of the abnormality noted on the MR images. The mean time interval between MR imaging and reoperation was 30 days (range, 1–97 days). In all cases, the surgeon was aware of the preoperative MR findings. The operative findings, including both the location and the nature of the abnormal tissue, were correlated with the preoperative MR interpretations.

Results

At reoperation, recurrent herniation of disk material was identified and resected in eight of the 11 patients (Table 1). Extradural fibrosis (scar) was found and resected in nine individuals; in six of these, accompanying disk herniation was identified beneath an overlying rim of scar tissue, while in three patients only scar tissue was found despite extensive exploration. Microscopic examination of resected tissue confirmed the surgeon's gross findings in all 11 cases.

Five recurrent disk herniations were identified at surgery at the L5–S1 level with associated extradural fibrosis in four. Two herniated disks were present at the L4–L5 level with associated scar formation in both. In one patient, recurrent disk herniation without associated scar was resected at the L3–L4 level.

In the six patients with extradural fibrosis and associated

* Vista 2055, Picker International, Highland Heights, OH.

† Teslacon I, Technicare Corp., Solon Springs, OH.

disk herniation proved at surgery, four of the scars were found to be focal, adherent to the posterior margin of the herniated disk and the lateral aspect of the thecal sac, while two scars more completely surrounded the dural tube with obliteration of both lateral recesses. In the three patients with extradural scar without disk herniation, the scars were found to be unilateral in two and bilateral in one.

The dominant feature on MR images of the recurrent herniated disks was their focal polypoid configuration (Figs. 1–3). Seven of eight surgically verified recurrent herniated disks presented on MR images as discrete, focal, polypoid, smoothly and sharply marginated posterior protrusions beyond the posterior margins of the adjacent vertebral bodies and usually continuous with the adjacent intervertebral disk (Table 1). Three of the eight disk herniations were found at surgery to lie free of and unconnected to the adjacent intervertebral disk, but none of these could be identified as "free fragments" on MR.

Analysis of the MR signal intensities of the recurrent herniations revealed a common and often recognizable pattern. The recurrent herniation appeared isointense with the intervertebral disk of origin in six of eight patients on T1-weighted images and in four of seven patients on T2-weighted studies (Table 1). A hypointense rim consistently outlined the focal herniated disk on both T1- and T2-weighted images, most conspicuously on the latter.

The most frequent features of extradural fibrosis on MR images were the irregular configuration and unsharp margination of the extradural mass, findings demonstrated in six of nine surgically proved cases. The signal intensity of scar relative to that of the adjacent disk was more variable than that of disk herniation on both T1- and T2-weighted images (Table 1).

In four of the seven recurrent disk herniations correctly diagnosed preoperatively on MR, the MR examination additionally suggested the presence of extradural scar tissue that

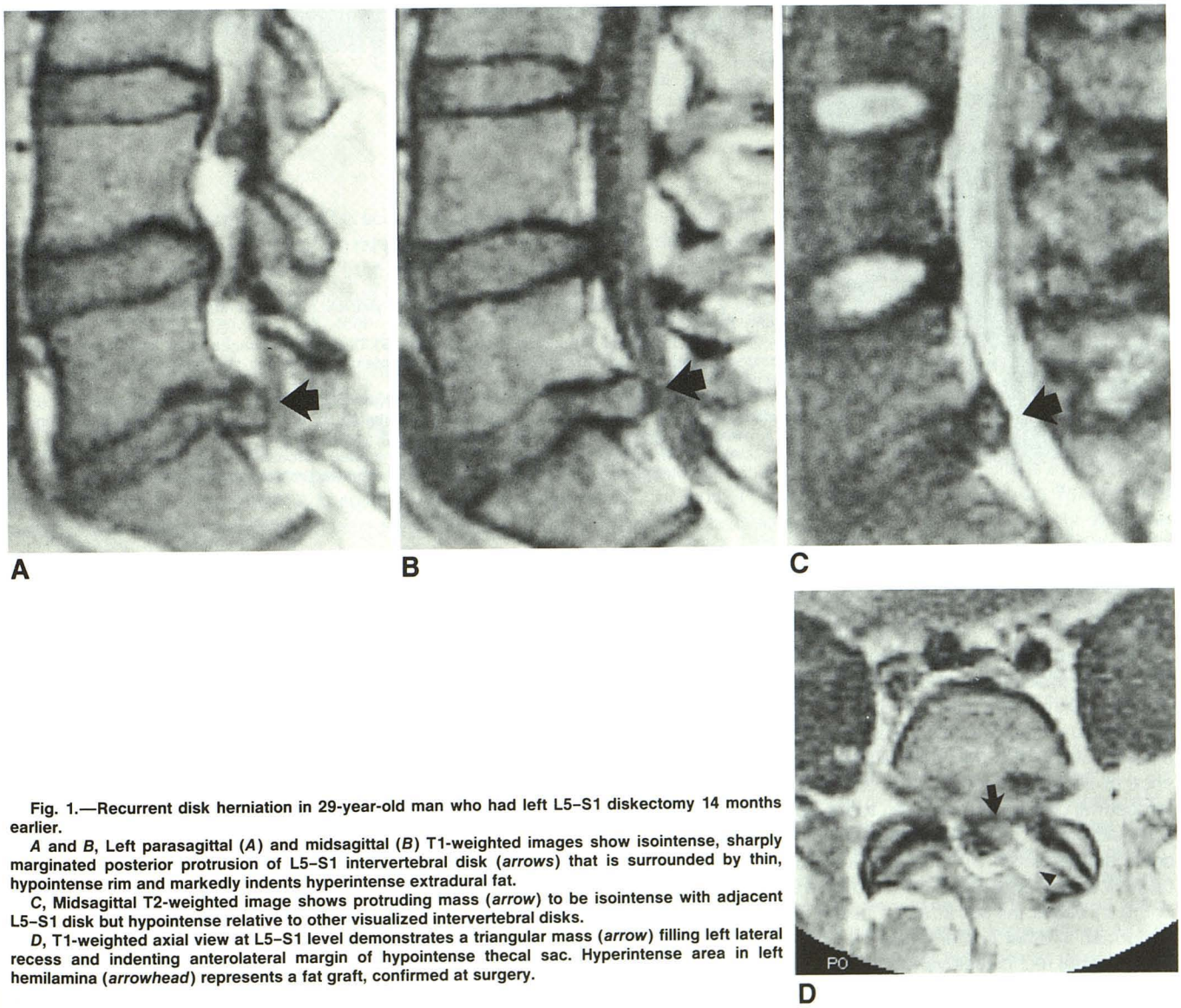

Fig. 1.—Recurrent disk herniation in 29-year-old man who had left L5–S1 diskectomy 14 months earlier.

***A* and *B*, Left parasagittal (*A*) and midsagittal (*B*) T1-weighted images show isointense, sharply marginated posterior protrusion of L5–S1 intervertebral disk (*arrows*) that is surrounded by thin, hypointense rim and markedly indents hyperintense extradural fat.**

***C*, Midsagittal T2-weighted image shows protruding mass (*arrow*) to be isointense with adjacent L5–S1 disk but hypointense relative to other visualized intervertebral disks.**

***D*, T1-weighted axial view at L5–S1 level demonstrates a triangular mass (*arrow*) filling left lateral recess and indenting anterolateral margin of hypointense thecal sac. Hyperintense area in left hemilamina (*arrowhead*) represents a fat graft, confirmed at surgery.**

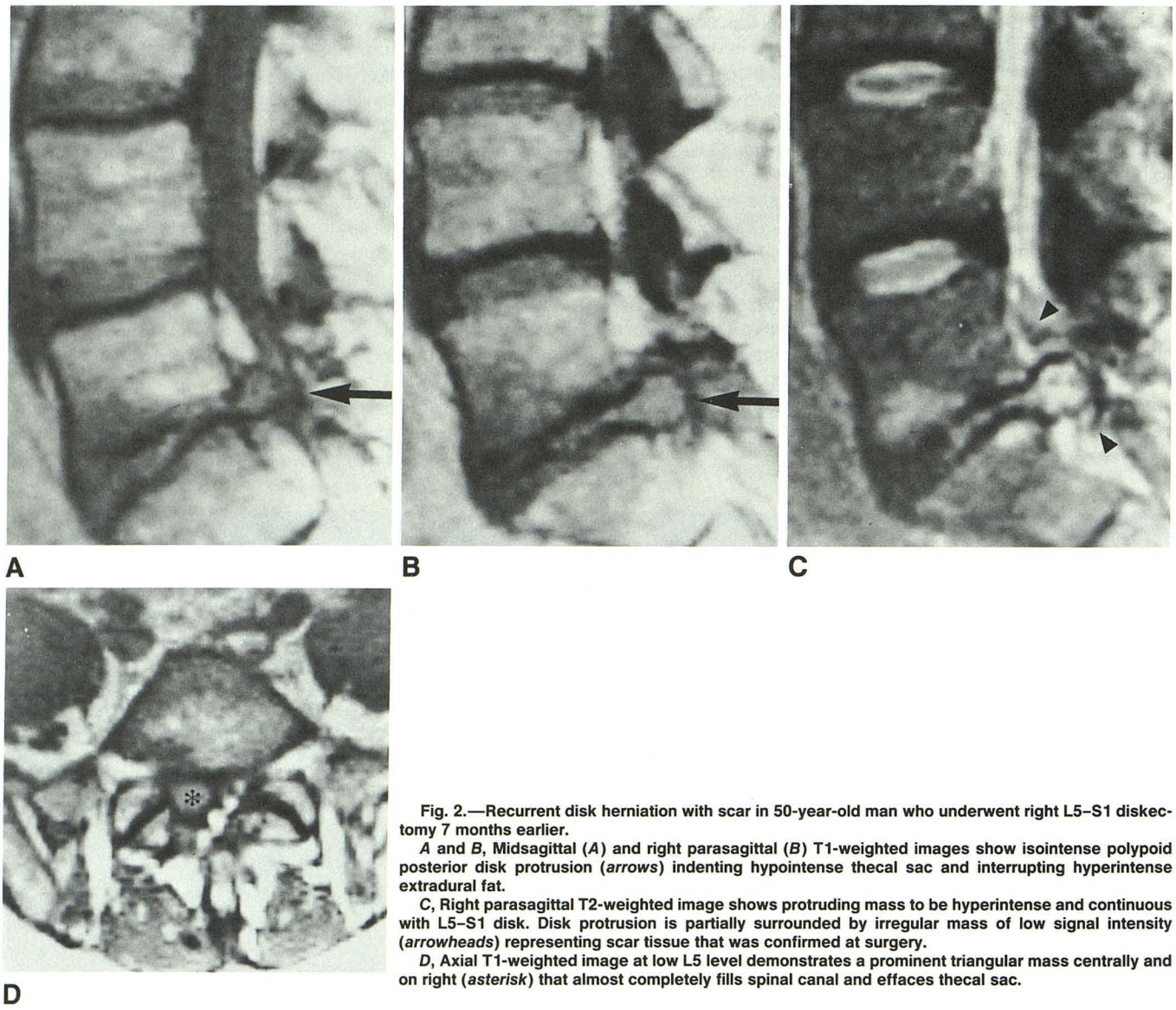

Fig. 2.—Recurrent disk herniation with scar in 50-year-old man who underwent right L5–S1 diskectomy 7 months earlier.

***A* and *B*, Midsagittal (*A*) and right parasagittal (*B*) T1-weighted images show isointense polypoid posterior disk protrusion (*arrows*) indenting hypointense thecal sac and interrupting hyperintense extradural fat.**

***C*, Right parasagittal T2-weighted image shows protruding mass to be hyperintense and continuous with L5–S1 disk. Disk protrusion is partially surrounded by irregular mass of low signal intensity (*arrowheads*) representing scar tissue that was confirmed at surgery.**

***D*, Axial T1-weighted image at low L5 level demonstrates a prominent triangular mass centrally and on right (*asterisk*) that almost completely fills spinal canal and effaces thecal sac.**

was confirmed at surgery. This diagnosis was suggested on the basis of an irregular hypointense extradural mass on T1-weighted axial images that extended beyond the sharply delineated margin of the disk herniation (Figs. 2D and 4).

Extradural scar without associated disk herniation was diagnosed preoperatively by MR in four patients and confirmed at surgery in three. In one patient, in whom the MR images were interpreted as extradural fibrosis with associated midline bulging disk (Fig. 4), the surgeon confirmed the presence of dense scar but additionally discovered a small posterocentral disk herniation deep to the scar.

No distinctive difference in signal intensity was noted that could be correlated with the time interval since the previous diskectomy. Preoperative CT studies were available in nine of the 11 cases. All but three of these CT examinations were performed in other centers, and the scanning (and likely also the injection) techniques varied widely. Five of the six outside CT studies were done without IV contrast enhancement, two of which were obtained after myelography with intrathecal water-soluble contrast. Only one outside study was done without and with IV contrast, while three studies at our institution were performed after a rapid bolus injection of IV contrast. Given the wide variance in CT techniques among these studies, it was not possible to make any conclusive interpretation of the findings.

Discussion

The formation of scar tissue in the lateral recess of the spinal canal after dissection of the extradural space is a common response to the trauma of surgery and has been identified in asymptomatic patients on routine postoperative CT examination [14]. Both plain CT and CT myelography will frequently demonstrate an extradural defect without enabling a distinction between extradural scar and recurrent disk herniation [4]. Preoperative differentiation of extradural fibrosis

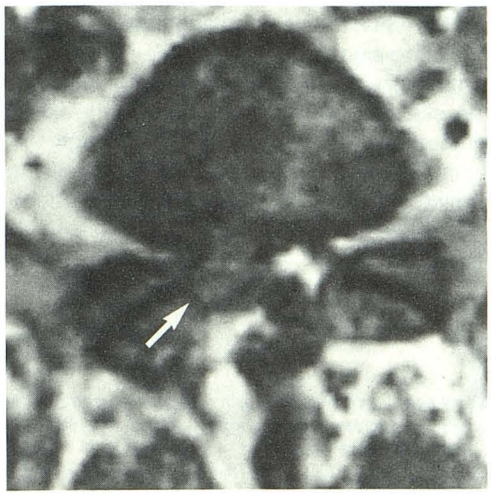

Fig. 3.—Recurrent disk herniation in 30-year-old woman 2 years after right L5–S1 diskectomy. Axial T1-weighted image at low L5 level shows large focal polypoid disk protrusion (*arrow*) beyond posterior margin of vertebral body to the right of midline. Mass fills right lateral recess and displaces and compresses hypointense thecal sac.

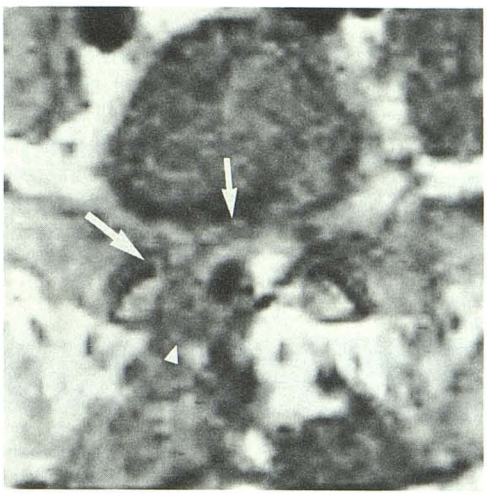

Fig. 4.—Scar with central disk herniation in 36-year-old man who had right L5–S1 diskectomy 6 weeks earlier. A mildly hypointense extradural mass (*arrows*) compresses thecal sac on right and extends posteriorly into laminectomy site (*arrowhead*) on this axial T1-weighted image at low L5 level. The portion of this mass anterior to thecal sac was thought to represent an associated midline bulging disk. At surgery, dense scar tissue was identified, but deep to the scar in the midline the surgeon found a free central disk fragment.

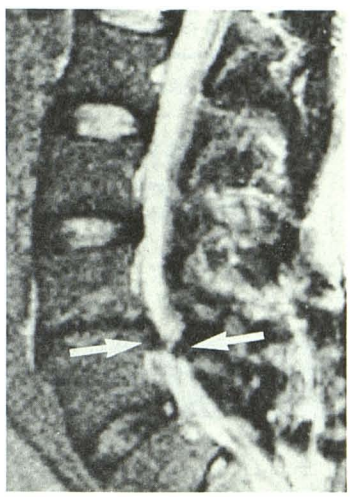

Fig. 5.—Postlaminectomy scar in 35-year-old man who underwent right L4–L5 diskectomy 5 years earlier. Sagittal T2-weighted image demonstrates irregular indentation of hyperintense thecal sac at L4–L5 level both anteriorly and posteriorly by a hypointense mass (*arrows*). At surgery, "considerable scar" was encountered surrounding the sac, but no recurrent disk herniation was identified.

from recurrent disk herniation can be accomplished with CT with IV contrast enhancement using a rapid bolus drip infusion technique. Accumulated experience from several centers has confirmed the efficacy of this technique that allows differentiation of enhancing hypertrophic scar from nonenhancing disk material [6–10].

The technical aspects of this examination are essential to its success [8], and our experience suggests that failure to achieve a rapid IV bolus injection of iodinated contrast medium and/or to obtain early thin-section axial CT scans in the area of interest can result in an inadequate study. This experience led to the consideration of MR imaging as a less invasive preoperative method for differentiating extradural scar from recurrent disk herniation.

In this small and somewhat selected series, consisting only of surgically confirmed cases, the preoperative diagnosis on MR agreed with the findings at surgery in seven of eight surgically verified recurrent disk herniations and in six of nine operatively demonstrated extradural scars. The sagittal views, both T1- and T2-weighted, proved highly useful in demonstrating the continuity and isointensity of the polypoid disk herniation with the adjacent intervertebral disk to best advantage (Figs. 1 and 2). Although the contrast resolution of the axial T1-weighted images was limited, these images were required to establish the location and extent of the extradural mass and to evaluate the degree of impingement of the mass on the thecal sac and the contents of the lateral recess of the spinal canal and the intervertebral foramen (Figs. 1D, 2D, 3, 4). The sagittal T2-weighted images also may be of aid in assessing the extent of scar tissue partially surrounding the thecal sac (Fig. 5). A thin, irregular, hypointense rim, consistently seen to surround the posterior margin of the disk herniations on the sagittal T1- and T2-weighted images, was considered to represent a combination of the outer fibrous portion of the disk and the contiguous posterior longitudinal ligament in a pattern previously described on diskographic-anatomic correlation studies [15] (Fig. 2C).

On MR images, recurrent disk herniation typically appeared as a focal polypoid or angular posterocentral or posterolateral protrusion into the spinal canal beyond the posterior vertebral margin (Figs. 1–3). The protruding mass was usually smooth in contour and continuous with the adjacent intervertebral disk on both T1- and T2-weighted images. On T1-weighted images, the isointense mass contrasted sharply with the hyperintense extradural fat and hypointense thecal sac. On T2-weighted images, the mass contrasted sharply with the hyperintense thecal sac (Table 1). While the degree of posterior protrusion into the spinal extradural space was most impressively displayed on the sagittal images, axial T1-weighted images demonstrated the focal configuration and location of the mass and thus enabled differentiation of herniated disk from diffuse bulging disk.

Scar was identified on MR images as a less well defined and less well marginated extradural mass of inhomogeneous and variable signal intensity (Figs. 2, 4, 5). Areas subsequently confirmed surgically as fibrous tissue often exhibited lower signal intensity than the adjacent intervertebral disk (Table 2). However, the intensity pattern in these areas was less homogeneous than in disk herniations, and scattered interspersed regions of higher signal intensity were also frequently identified within the predominantly hypointense scar. In the six patients in whom surgery demonstrated both disk hernia-

TABLE 2: MR–Surgical Correlations

Surgical Finding	MR Findings	No. of Cases
I. Disk herniation (8 cases)	Configuration:	7/8
	Polypoid/triangular	1/8
	Diffuse bulge	
	T1 intensity:[a]	6/8
	Isointense	1/8
	Hypointense	
	T2 intensity:[a]	4/7
	Isointense	1/7
	Hypointense	1/7
	Hyperintense	
II. Extradural fibrosis (scar) (9 cases)	Configuration:	6/9
	Irregular	3/9
	Circumferential	
	T1 intensity:[b]	3/9
	Isointense	4/9
	Hypointense	2/9
	Hyperintense	
	T2 intensity:[b]	4/8
	Isointense	2/8
	Hypointense	2/8
	Hyperintense	

[a] The signal intensity is described relative to the signal intensity of the adjacent intervertebral disk. In one patient, the disk herniation could not be identified apart from surrounding hypointense scar tissue.

[b] The terminology refers to the predominant signal intensity relative to that of the adjacent intervertebral disk. In many instances, the scar tissue exhibited an inhomogeneous pattern with regions of varying intensity.

tion and overlying extradural scar, it was possible to differentiate disk from scar on MR in only the four patients in whom the surrounding scar was clearly of lower intensity than the herniated disk on both T1- and T2-weighted images. Where scar tissue surrounded the nerve root and obliterated the lateral recess, it was not possible on MR to differentiate nerve root from scar tissue because the signal intensity was similar in both.

The configuration of the extradural mass appears to be the single most important parameter in differentiating recurrent herniated disk from extradural scar by MR imaging. Surgically proved extradural scars did not exhibit the sharply defined polypoid configuration of most disk herniations in this series. While initial anecdotal reports suggested that these processes could be distinguished on MR by their differing signal characteristics [11–13], this study indicates that reliable differentiation is only possible when morphology and topography are considered in addition to signal intensity.

It should be emphasized that this retrospective study is small and may be skewed, since it does not include those cases that have been treated conservatively. Although this study indicates that MR may be of value in distinguishing recurrent disk herniation from postoperative extradural fibrosis, additional experience is needed in order to more firmly establish its reliability.

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