Postoperative Lumbar CT: Technique, Results, and Indications

Othmar Schubiger[1] and Anton Valavanis[2]

Seventy-seven patients with recurrent radicular symptoms after operation for lumbar disk herniation were examined by plain computed tomography (CT) and by intravenously enhanced CT. With the latter technique, scar tissue and recurrent disk herniation can be distinguished: scar tissue shows definite contrast enhancement whereas recurrent disk herniation remains unenhanced. Nerve roots surrounded by scar tissue are often visualized on the postcontrast scan as rounded lucencies. Symmetrical undisplaced nerve roots were identified in 88% of cases of hypertrophic scar formation; this finding excludes recurrent disk herniation. Dural calcifications were found in five patients with hypertrophic scar formation. The authors conclude that CT with contrast enhancement should be the method of choice for evaluating patients with recurrent radicular symptoms after operation for disk herniation.

Recurrence or persistence of radicular symptoms after operation for lumbar disk herniation is a common problem [1]. Almost 10% of spinal computed tomographic (CT) examinations at our institution are performed in patients who have had surgery for disk herniation. About 5% of lumbar spine operations are reoperations, mostly for recurrent disk herniation but rarely for neurolysis in hypertrophic scar formation.

The diagnostic modalities capable of distinguishing the two main causes of recurrent radicular symptoms are scant [2, 3]. The clinical picture is often more conclusive than the radiodiagnostic information. Recurrent disk herniation usually presents with acute onset after a symptom-free interval, whereas the symptoms of hypertrophic scar formation often begin shortly after surgery and progress slowly.

Myelography with oily contrast media is seldom useful for distinguishing hypertrophic scar formation from recurrent disk herniation [4]. Myelography with water-soluble contrast media may better demonstrate irregularities of the dural sac, but precise differentiation of the two conditions cannot be made [5]. We analyzed the value of intravenously enhanced CT for the differentiation of recurrent disk herniation and hypertrophic scar formation in an earlier communication [6]. This report details our further experience in a larger series of patients.

Materials and Methods

Over a 2 year period, patients with recurrent radicular symptoms after operation for disk herniation were studied both by unenhanced CT and by intravenously enhanced CT at the operated level. The examinations were performed on a GE 8800 CT/T scanner. Five to seven contiguous slices 5 mm thick were obtained parallel to the intervertebral disk space. Contrast-enhanced scans were obtained immediately after bolus injection of a water-soluble contrast medium in the concentration of 600 mg iodine/kg body weight.

Of 146 patients examined, 77 had operative or myelographic confirmation of the diagnosed condition and are evaluated here. The patients with recurrent disk herniations all had surgical confirmation, whereas only 11 (23%) of the patients with hypertrophic scar formation had reoperation. In the group of 77 patients, 89 levels had been previously operated (66 patients at one level, 10 patients at two levels, one patient at three levels). The prior surgery was performed 6 weeks to 17 years (mean, 3.9 years) before the CT study.

Results

At 47 levels scar formation was identified on contrast-enhanced CT scans by one of four patterns [6]: (1) scar formation confined to the lateral border of the dural sac and extending anteriorly to the intervertebral disk: nine cases (19%) (fig. 1A); (2) more extensive scar formation involving the lateral margin of the dural sac at the level of the intervertebral disk space and extending into the lateral recess and/or the intervertebral foramen: 19 cases (40%) (fig. 1B); (3) nodular scar: seven cases (15%) (fig. 1C); (4) circular scar, encircling and often constricting the dural sac: 12 cases (26%) (fig. 1D).

In all cases of hypertrophic scar formation, the scar tissue was iso- or slightly hyperdense compared with the dural sac on unenhanced CT images and showed a homogeneous or somewhat mottled contrast enhancement. This enhancement was usually more intense in cases with recent operation but was also identified many years after surgery in some patients.

Eleven patients had recurrent disk herniation without additional scar formation (fig. 2A), whereas 21 patients had evidence of both hypertrophic scar formation and recurrent disk herniation (fig. 2B). The herniated disk material showed no enhancement, whereas scar formation presented as an enhancing band surrounding the disk herniation in 15 cases and was more nodular in six cases.

In 16 patients osseous hypertrophy was found. In nine of these, osseous hypertrophy was restricted to or more pronounced on the level and side previously operated (figs. 2A and 3). In three cases the hypertrophy was bilateral and in four cases there was a diffuse hypertrophy also at other levels not previously operated. In four cases the osseous hypertrophy was accompanied by hypertrophic scar formation, while in two cases an additional recurrent disk herniation was found.

[1]Department of Diagnostic Radiology, Section of Neuroradiology, Kantonsspital, CH-5001 Aarau, Switzerland. Address reprint requests to O. Schubiger.
[2]Department of Diagnostic Radiology, Section of Neuroradiology, University Hospital, CH-8091 Zürich, Switzerland.

AJNR 4:595–597, May/June 1983 0195-6108/83/0403-0595 $00.00

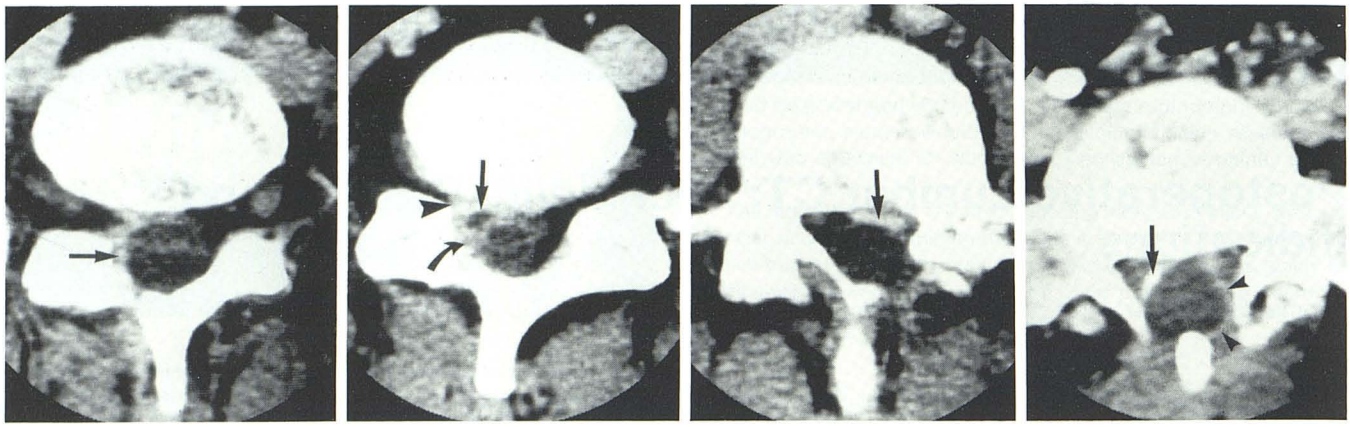

Fig. 1.—Contrast-enhanced CT. Four patterns of hypertrophic scar formation. **A**, Type 1. Small epidural scar (*arrow*). Small enhancing rim extends lateral to dural sac from fenestration of lamina to intervertebral disk space. No indentation of dural sac. **B**, Type 2. More extensive epidural scar. Thick enhancing band lateral to dural sac (*curved arrow*) extends clearly into intervertebral foramen (*arrowhead*). Normally positioned nerve root (*straight arrow*) is embedded in scar tissue. **C**, Type 3. Nodular scar (*arrow*). Nodular enhancing lesion in lateral recess. Exiting nerve root not seen. **D**, Type 4. Circular scar (*arrowheads*). Dural sac appears as enhancing ring, perhaps representing arachnoiditis. Irregular enhancement of epidural space probably corresponds to minor epidural scar formation. Symmetrical exiting nerve roots are poorly visualized. Small dural calcification on right (*arrow*).

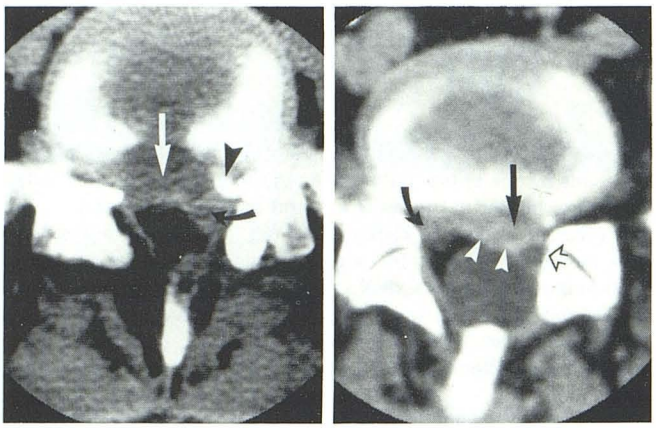

Fig. 2.—Contrast-enhanced CT. Recurrent disk herniation. **A**, Without additional scar formation. Area of recurrent herniation (*white arrow*) is hyperdense compared with dural sac and does not enhance after contrast administration. Small free disk fragment on left (*curved arrow*). Unilateral left-sided osseous hypertrophy of superior articular process with impingement on lateral recess (*arrowhead*). **B**, With small focus of hypertrophic scar formation. Site of recurrent herniation (*straight arrow*) is nonenhancing and surrounded by enhancing rim (*arrowheads*) which proved to be fibrous scar tissue. Displaced left nerve root (*open arrow*) appears as lucent area surrounded by small ring of enhancing scar tissue. Normally positioned right nerve root (*curved arrow*).

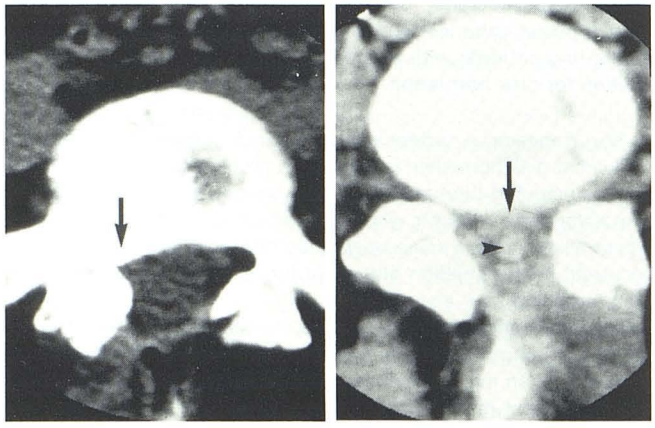

Fig. 3.—Contrast-enhanced CT. Unilateral osseous hypertrophy on previously operated side (*arrow*). No scar formation.

Fig. 4.—Contrast-enhanced CT. Severe arachnoiditis. Significantly enhancing mass (*arrowhead*) inside dural sac, which appears as enhancing ring (*arrow*). Myelography showed total block at this level.

In 24 cases the pathway of the exiting nerve root was completely obliterated by hypertrophic scar formation and was not discernible on the precontrast scan. In 18 of these, the exiting nerve root was visible on the postconstrast scan as a nonenhancing lucent round area. It was not significantly distorted in 15 cases (figs. 1B and 1D). Only two cases of hypertrophic scar formation showed dislocation of the nerve root, whereas in a patient with concomitant recurrent disk herniation the nerve root that was surrounded by scar tissue was clearly displaced by herniated disk material (fig. 2B).

Five patients with hypertrophic scar formation demonstrated small linear calcifications of the dura (fig. 1D). In three cases of severe arachnoiditis, one with a total block on myelography, there was diffuse enhancement of the dural sac (fig. 4).

Discussion

Therapy for recurrent radicular symptoms after operation for disk herniation depends largely on the etiology of the recurrence of the nerve root compression. Patients with recurrent disk herniation often become symptom-free after reoperation, whereas the condition of patients with hypertrophic scar formation usually remains unchanged [1]. There is no obvious explanation why some patients

react with the formation of abundant scar tissue whereas other patients tolerate surgery without such reaction. Patients with hypertrophic scar formation are likely to react in the same way after a second operation; medical therapy is therefore the treatment of choice in cases of hypertrophic scar formation [1].

The myelographic appearance of hypertrophic scar formation is shortening or obliteration of the exiting nerve root pouches as well as irregularity and deformity of the dural sac. These changes are better demonstrated with water-soluble contrast media than with oily contrast media and are specific in cases of arachnoiditis with involvement of the entire circumference of the dural sac [7]. However, in patients with focal changes confined only to parts of the dural sac or confined to the epidural space, myelographic differentiation of the condition from recurrent disk herniation may be difficult or impossible [4, 7].

CT of the lumbar spine not only demonstrates the outlines of the dural sac but also directly visualizes the intraspinal soft tissues surrounding the sac. Unfortunately, the tissue attenuation values as expressed in Hounsfield units are not specific for recurrent disk herniation and hypertrophic scar formation. The density of scar tissue usually is equal to or slightly greater than that of the dural sac. The CT density of herniated disk material varies from slightly to clearly hyperdense [8]. Precise differentiation of recurrent disk herniation and hypertrophic scar formation by plain CT is only possible in lesions with significant hyperdensity or even calcification (i.e., disk material). Our experience indicates that the use of intravenous contrast media is a good method for enhancing this differentiation. The vascularized fibrous scar tissue shows significant contrast enhancement, whereas the nonvascularized disk material remains unenhanced. Contrast enhancement occurs not only in the early stages of scar formation with hypervascular granulation tissue but also persists for years. Lesser degrees of enhancement are observed in older scar tissue.

The shape of the lesion is another useful criterion for differentiation of recurrent disk herniation from hypertrophic scar formation. Recurrent disk herniation usually presents as a nodular lesion in continuity with the intervertebral disk space, whereas hypertrophic scar formation in most cases presents as a bandlike lesion. Nodular hypertrophic scar formation is the least common form (occurring in about 15% of cases) and can be distinguished from recurrent disk herniation by contrast enhancement. The bandlike type of hypertrophic scar formation should also be investigated with intravenous contrast injection in order to exclude or detect coexisting recurrent disk herniation. The ringlike enhancement encircling the dural sac corresponds to the myelographic picture of a concentrically stenosed dural sac as seen in cases of arachnoiditis, whereas the other CT patterns of hypertrophic scar formation are likely to represent epidural fibrosis or inflammation.

Of special interest is the course of the exiting nerve roots. In only two cases with hypertrophic scar formation was there asymmetry of the two exiting nerve roots. In one case in which recurrent disk herniation was combined with hypertrophic scar formation, the nerve root appeared as a hypodense area surrounded by enhancing scar tissue and was clearly displaced by the herniated disk material. Symmetry of the exiting nerve roots was also observed in cases with total amputation of the nerve root sheaths on myelography and is therefore extremely helpful: the demonstration on contrast-enhanced CT images of symmetric, normally positioned nerve roots embedded in enhancing scar tissue excludes the presence of additional recurrent disk herniation. Minor dislocations of the exiting nerve roots in cases of severe compression of the dural sac [9] are rare in our experience and do not indicate the presence of additional recurrent disk herniation. Only significantly displaced nerve roots are suspicious for the presence of additional recurrent disk herniation.

Dural calcification with hypertrophic scar formation has been reported in one case of arachnoiditis ossificans [10]. Our five cases with dural calcification were not examined with oily contrast media, which might have presented a similar picture on CT. These local calcifications may represent a very mild form of arachnoiditis ossificans.

One of the three cases with significant intradural contrast enhancement showed complete block on myelography. All three cases presented with the circular pattern of hypertrophic scar formation, suggesting the presence of arachnoiditis. Since the capillaries of the nerve roots have tight junctions and nerve roots normally do not enhance, intradural contrast enhancement may be due to granulation tissue surrounding the clumped nerve roots.

Hypertrophic osseous changes after surgery for disk herniation are frequently described [11]. Four of our cases also had evidence of diffuse osseous hypertrophy at other levels not previously operated. In three other cases, CT demonstrated bilateral osseous hypertrophy after unilateral surgery. But in nine patients the hypertrophic changes were restricted to the operated side and level (or were more pronounced there than at other levels not operated); four of these patients had significant hypertrophic scar formation adjacent to the osseous hypertrophy.

REFERENCES

1. Law JD, Lehman RAW, Kirsch WM. Reoperation after lumbar intervertebral disc surgery. *J. Neurosurg* **1978**;48:259–263
2. Sackett JF, Strother CM. *New techniques in myelography*. Hagerstown, MD: Harper & Row, **1979**:84
3. Haughton VM, Williams AL. Computed tomography of the spine. St. Louis: Mosby, **1982**:108
4. Shapiro R. *Myelography*. Chicago: Year Book Medical, **1976**:203
5. Langlotz M. *Lumbale Myelographie mit wasserlöslichen Kontrastmitteln*. Stuttgart: Thieme, **1981**:44–45
6. Schubiger O, Valavanis A. CT differentiation between recurrent disc herniation and postoperative scar formation: the value of contrast enhancement. *Neuroradiology* **1982**;22:251–254
7. Picard L, Roland J, Blanchot P, David R, Montaut J, Pourel J. Scarring of the theca and the nerve roots as seen at radiculography. *J Neuroradiol* **1977**;4:29–48
8. Nakagawa H, Malis LI, Young YP. Computed tomography of soft-tissue masses related to the spinal column. In: Post MJD, ed. Radiologic evaluation of the spine: current advances with emphasis on computed tomography. New York: Masson, **1980**:320–352
9. Meyer JD, Latchaw RE, Roppolo HM, Ghoshhajra K, Deeb ZL. Computed tomography and myelography of the postoperative lumbar spine. *AJNR* **1982**;3:223–228
10. Barthelemy CR. Arachnoiditis ossificans. *J Comput Assist Tomogr* **1982**;6:809–811
11. Quencer RM, Murtagh FR, Post MJD, Rosomoff HL, Stokes NA. Postoperative bony stenosis of the lumbar spinal canal: evaluation of 164 symptomatic patients with axial radiography. *AJR* **1978**;131:1059–1064