Chemonucleation and Changes Observed on Lumbar MR Scan: Preliminary Report

This study examines the relation between the postchemonucleation clinical outcome and changes observed on the lumbar MR scan. Eight of 12 chemonucleated disks showed clinical improvement at the last follow-up, while the other four showed no improvement. In the cases that showed improvement there was a decrease in one or both dimensions of the defect in the thecal sac. Seven of eight showed an increase in the peridisk signal. Where there was no clinical improvement there were fewer decreases in the size of the defect, and three of four showed no increase in the peridisk signal.

Chemonucleation of the lumbar intervertebral disk was introduced by Smith [1] as an alternative to laminectomy for the treatment of herniated lumbar nucleus pulposus. As more recent studies have attested to the efficacy of this technique [2–8], its use has increased dramatically. With the development of sophisticated CT scanning equipment have come several studies that correlated the clinical outcome of this procedure with the radiographic changes it produces [9–11]. A description of the MR changes caused by chemonucleation has also been reported [12]. Our current study was undertaken to determine the correlation between changes in the lumbar MR examination before and after chemonucleation, and the clinical outcome.

Subjects and Methods

Eleven patients with signs and symptoms of herniated lumbar nucleus pulposus at L4–L5 or L5–S1 were entered into the study after confirmation of the diagnosis by both lumbar CT and metrizamide myelography. In one patient, two disks were chemonucleated, making a total of 12 intervertebral disk spaces to be included in the study. The patients were selected for the procedure according to the inclusion-exclusion criteria of the randomized double-blind study that determined the safety and efficacy of chymopapain [6].

MR studies were performed on a Technicare 0.5 T MR scanner using the standard body coil. Single-slice or multislice sagittal acquisitions were obtained to include the area from the bottom of S1 to the midthoracic area. T2-weighted images were obtained with several different repetition-time (TR) and echo-time (TE) values (expressed in milliseconds): TR 500, TE 30, TR 500, TE 60, TR 1000, TE 60, and TR 3000, TE 120. Sections were 1.0 cm thick. Preoperative scans were obtained 2–3 days before chemonucleation. Postoperative scans were obtained between 20–50 days (early postchemonucleation scan) and between 80–285 days (late postchemonucleation scan).

Because this study was begun during our initial months of MR operation, there was considerable variation in the quality of scans as the study progressed. It was our initial intent to calculate T1 and T2 values for regions of interest in areas such as the intervertebral disk spaces and vertebral bodies. However, surface coils were not available at the time the study was performed. Therefore, the number of picture elements in the selected regions of interest was too small to yield reliable data for calculating T1 and T2 values. The fact that values varied in the same tissue depending on the tissue's position in the z axis of the magnet also contributed to our decision to abandon an attempt to quantitatively evaluate relaxation times.
in different tissues. For each patient the last postoperative scan obtained with the TR 3000/TE 120 pulse sequence was compared with the preoperative study. These data are listed in Table 1. We subjectively compared whether the signal intensity of the injected intervertebral disk, its height, the anteroposterior width of the defect in the ventral aspect of the thecal sac, the height of the defect, and the signal intensity in the vertebral bodies surrounding the disk space were increased, decreased, or unchanged when compared with the initial study.

Two patients had only the early postoperative scan, three patients had only the late postoperative scan, and six patients had both the early and late scans. The patients who had only the early scans had good clinical outcomes and did not wish to undergo the late scan, even though they had agreed to do so at the outset of the study. One patient did not return for the late scan until the 285th postoperative day.

Chemonucleation was performed under general anesthesia, with 3000 units of chymopapain (Chymodiactin) injected into each disk. Clinical evaluations were obtained at the time of the follow-up MR examinations. Clinicians were asked to evaluate whether the patients were clinically improved or not improved compared with the prechemonucleation examination. These results are given in Table 1.

Results

Of the 11 patients (12 disk injections), there were three males and eight females aged 16–54 years. Eight of the disk injections resulted in clinical improvement at the time of the last follow-up examination. From the data in Table 1 it can be seen that all the cases that showed improvement showed a decrease in each either one or both dimensions of the defect in the thecal sac (Fig. 1), and five of the eight showed a decrease in both the height and width of the defect.

Four of the disk injections produced no clinical improvement at the time of the last follow-up examination, which occurred from 87–132 days after chemonucleation. All four showed a decreased disk height and a decreased signal intensity in the disk after chemonucleation (Fig. 2). Three of the four failures showed no change in the intensity of the "peridisk" signal and one showed an increase. None of the four showed a decrease in both the height and width of the defect.

The only complication of chemonucleation in our series occurred in a 48-year-old woman who had a brief episode of hypotension immediately after an injection of Chymodiactin. However, her blood pressure did not fall below 80 mm Hg systolic and she was stable when taken to the recovery room. The injection was at the L4–L5 level. The MR scan before injection showed high signal intensity in the vertebrae surrounding the L4–L5 intervertebral disk space that increased on the postchemonucleation scan (Fig. 3).

Discussion

The actual change produced in the intervertebral disk by chymopapain has been studied extensively, and several general conclusions emerge [4, 7]. Chymopapain seems to affect the water-binding capacity of the noncollagenous ground substance of the nucleus pulposus [4, 7]. This is believed to lead to "rapid hydrolysis and shrinkage of the displaced (and undisplaced) disk material, reduction of disk pressure on the nerve root, and alleviation of the sciatica that results from this pressure" [4].

An extensive study of CT in the evaluation of chemonucleation outcome examined patients 1 week before and 6 weeks after the procedure [11]. Postchemonucleation scans showed a reduction in the size of the herniated nucleus pulposus of 1–3 mm in nine of 10 levels injected and also showed a slight further decrease in one case scanned 12 weeks after chemonucleation. Some showed interspace narrowing and interval appearance of central interspace gas collections. One-half of the levels showed at least a 10 H increase in the density of the herniated nucleus pulposus after treatment. In nine of 10 levels, concordance was noted between improvement in the prechemonucleation findings on physical examination and a decrease in size of the herniated nucleus pulposus on the CT scan.

A similar study reported the results of postchemonucleation CT scans of 29 interspaces [10]. At 6 weeks, 13% showed an interspace gas collection, and 8% had a decreased size of the defect. Of those patients having clinical improvement at 6-month follow-up, 23% had an interspace gas collection and 59% had a decrease in the size of the defect in the thecal sac. Early improvement was often seen without a decrease in defect size but with a decrease in disk height [9]. It was thus postulated that the shortened disk lessened the tension

<table>
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<th>Clinical Outcome: Case No.</th>
<th>Age</th>
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* In case 10, two disks were chemonuclelated.
Fig. 1.—T2-weighted TR 3000/TE 120 images in 26-year-old man with left sciatica. Complete recovery was seen at last follow-up after chemonucleation at L4-L5.

A, Preoperative scan shows decreased signal in disk spaces at L3-L4 and L4-L5. Large defect in thecal sac is from herniated disk at L4-L5 (arrows).

B, 34 days after chemonucleation at L4-L5. Decrease in height of disk space and in size of defect in thecal sac at L4-L5 (black arrows). Peridisk signal is increased (two-tone arrows).

C, 131 days postchemonucleation. Further decrease in size of defect in thecal sac. Peridisk signal is still intense but less so than on day 34.

Fig. 2.—T2-weighted TR 3000/TE 120 images in 27-year-old woman with right sciatica. Her pain was still present 111 days after chemonucleation at L5-S1 for a herniated nucleus pulposus.

A, Preoperative scan shows decreased signal in disk space at L5-S1 and minimal defect in thecal sac at that level.

B, Postoperative day 111. Defect in thecal sac is slightly larger (arrows) than on preoperative scan. There is no increase in peridisk signal.

Fig. 3.—T2-weighted TR 3000/TE 120 images in 48-year-old woman who experienced sudden hypotension after injection of chymopapain at L4-L5. At last follow-up, her symptoms were relieved.

A, Increased peridisk signal was present on preoperative scan at L4-L5 (arrows).

B, Postoperative day 110. There is further increase in intensity of peridisk signal (arrows).

on the nerve root, accounting for the early relief, without a decrease in the size of the herniation [10].

Reported MR changes after chemonucleation have been sporadic. One patient showed reduced signal in the disk because of an extruded disk followed by rapid disappearance of signal after chemonucleation [12]. This patient also showed retraction of the mass indenting the thecal sac.

Like CT, the postchemonucleation MR scan shows a different constellation of findings in patients whose clinical symptoms improved compared with patients whose symptoms
remained unchanged or worsened (Table 1). Decrease in the MR signal and decrease in height of the disk seem to be present in all patients after chemonucleation, regardless of whether the patients improve. Decrease in the height and width of the defect in the thecal sac and the presence of an increased signal intensity on the T2-weighted image in the vertebral bodies surrounding the injected disk, singly or in combination, correlate well with clinical improvement.

In the improved group, 75% showed a decrease in defect height, 88% showed a decrease in defect width, and 88% had increased signal in the vertebral bodies surrounding the injected disk. In contrast, only 25% of the unimproved cases had a decrease in defect height, 50% had a decrease in defect width, and 25% had an increase in the signal around the disk.

Furthermore, seven (88%) of the eight improved cases had two of the three positive indicators (decreased defect height, decreased defect width, and increased signal around the disk) on the postchemonucleation scan, whereas only one (25%) of the four unimproved cases had two of the three present. Five (63%) of the eight improved cases had all three positive indicators present, but none of the four unimproved cases had all three present.

While our sample is small, it indicates that MR, like CT, reflects the changes that occur after chemonucleation and should be as valuable as CT in the objective evaluation of the outcome of this procedure. In addition, the absence of ionizing radiation in this procedure makes it more suitable than CT as a technique for postchemonucleation evaluation.

Because our latest postchemonucleation scan was obtained only 285 days after chemonucleation, we cannot comment on the late MR changes in these patients. However, it seems that up to 285 days, the signal in the disk space decreases on the T2-weighted image. If the changes noted in the chymopapain-injected disk [4, 7] reflect a change in the water-binding capacity of the nucleus pulposus, the decreased signal in the disk space would be the expected finding. It also appears from our data and from that of previous CT studies [9–11] that, as Chafetz et al. [12] reported, not only does chemonucleation cause decreased signal within the injected disk, it also causes partial retraction of the defect indenting the thecal sac in the patient with clinical improvement.

The finding of increased signal intensity surrounding the injected disk space after chemonucleation was first reported by Modic et al. [13]. The presence of this finding was an important correlate of clinical improvement in our series. This has been attributed to scarring or inflammation resulting from the procedure [13]. Disk-space infection is a known complication of chemonucleation, occurring in about 2.5% of cases [14]. The CT findings of disk-space infection have been described [14–16]. MR shows high signal in the vertebral bodies [17] in cases of disk infection. This finding in our series suggests that, at least in the early stages after chemonucleation, a successful procedure is probably accompanied by a mild inflammatory reaction in the adjacent end-plates and/or vertebral bodies.

It is interesting to note that in the one complication experienced in this series, a case of transient hypotension after chymopapain injection, the patient had high signal intensity surrounding the injected disk before the procedure, and this signal increased on the postchemonucleation MR scan. On the basis of one case it is impossible to say whether this preexisting condition predisposed the patient to the complication, but the presence of this finding on a prechemonucleation scan should be regarded with caution.

In conclusion, MR imaging of the lumbar spine after chemonucleation routinely will show diminished signal in the injected intervertebral disk. The postchemonucleation scans in cases with successful outcomes are more likely to show a decrease in one or both dimensions of the defect in the thecal sac and an increase in the intensity of the signal in the vertebral bodies surrounding the injected disk space than are the same scans in patients who show no clinical improvement. The changes shown on the MR scan apparently reflect changes in the water-binding properties of the intervertebral disk and would seem to indicate that successful chemonucleation is also accompanied by an inflammatory reaction.

Postchemonucleation MR provides information similar to that of CT but has the advantage of not using ionizing radiation.

REFERENCES