# Chymopapain Chemonucleolysis: CT Changes after Treatment

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# Chymopapain Chemonucleolysis:
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**Chymopapain chemonucleolysis is now used extensively in this country to treat lumbar disk herniation. Despite increasing experience in patient selection, there continue to be patients who do not respond to treatment and require diagnostic reevaluation. Interpretation of postchemonucleolysis computed tomographic (CT) scans in these patients requires a knowledge of the CT changes that normally occur after treatment with chemonucleolysis. To define these temporal changes, a prospective CT evaluation was performed of 29 treated interspaces in 26 patients who returned for routine postchemonucleolysis follow-up. Despite a successful clinical response in 17 of 21 patients, changes in the size, location, shape, homogeneity, and density of the disk herniation were uncommon at the 6 week follow-up. In 24 treated interspaces, the most common changes at 6 week CT follow-up were the development of vacuum phenomenon in three (12.5%) and a slight decrease in the size of two (8.3%) disk herniations. A successful response was noted in 17 of 21 patients scanned at 6 month follow-up, with five (22.7%) of 22 injected interspaces exhibiting vacuum phenomenon and 13 (59.1%) interspaces showing an observable decrease in the size of the disk herniation. Early improvement of sciatica after chemonucleolysis often occurs without a change in the size of the disk herniation and may be mediated by chymopapain-induced disk-space narrowing. Continued improvement may be accompanied by both a decrease in the disk height and a reduction in the size of the disk protrusion.**

Chymopapain chemonucleolysis was introduced by Smith [1] in 1964 as a percutaneous method of treatment of lumbar disk herniation. Chymopapain exerts its effects by means of an enzymatic hydrolysis of the chondromucoprotein part of the nucleus pulposus, resulting in a loss of its water-binding capacity. This appears to reduce the pressure exerted by the herniated disk material on adjacent spinal nerves [2–4]. Although chymopapain chemonucleolysis has been used to treat lumbar-disk herniation for nearly two decades, it was not until recently that it gained widespread acceptance as a viable alternative to surgical diskectomy. The results of two recent independent double-blind studies [5, 6], as well as those of many open studies [7–21], leave little doubt that, in the properly selected patient, the effectiveness of chymopapain chemonucleolysis is similar to that of surgery. A number of issues, however, are unresolved. The exact mechanism of pain relief and the temporal radiographic changes that occur in the human disk space after chymopapain chemonucleolysis have not been defined clearly.

As many as 20%–30% of patients treated with chemonucleolysis do not have adequate pain relief after treatment [7–21] and require diagnostic reevaluation to determine the origin of their pain. Interpretation of the significance of abnormalities on posttreatment computed tomographic (CT) scans of these patients requires a knowledge of the changes that normally occur in the interspace after treatment. Little information is available, thus far, concerning the changes that occur in the successfully treated patient. Since most of the experience with chymopapain chemonucleolysis occurred before the advent of CT, it was not possible to evaluate the change in size of the disk herniation without repeat myelography. Our knowl-

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edge of these changes has been limited to animal studies, which may or may not reflect the changes that occur in symptomatic postchemonucleolysis patients. In the few asymptomatic patients studied with myelography [17, 21, 22] or CT [8, 10, 16, 22, 23] after successful chemonucleolysis, findings have been variable. Some investigators have shown a dramatic reduction in the size of the disk protrusion while others have not found a significant change. A few authors suggest that there may be some changes that are reversible with time [8, 24]. In order to define the temporal radiographic changes that occur after successful chemonucleolysis and to provide possible insights into the mechanisms of pain relief, we obtained sequential CT scans in a group of patients treated with chemonucleolysis.

## Subjects and Methods

After approval of the protocol by our hospital's institutional review board, a prospective CT evaluation was performed of the changes that occurred in the intervertebral space after chemonucleolysis. Patients injected with chymopapain between December 30, 1982, and April 21, 1983, were considered for inclusion, providing a CT scan had been obtained as part of their pretreatment diagnostic evaluation. Of the 34 eligible patients, only 26 patients chose to participate in the study.

Our methods for the clinical and radiographic selection of patients for chymopapain chemonucleolysis have been defined extensively in previous reports [5, 7, 21]. This selection is based on the same criteria used by one of us to choose patients for surgical diskectomy. All patients had intractable sciatica of equal or greater severity than any associated low-back pain. In each instance, sciatica had failed to respond to at least 3 weeks of conservative therapy. All had objective abnormalities on neurologic examination and limitation of straight-leg raising. Lumbar metrizamide myelography was performed in all patients and was diagnostic of a herniated nucleus pulposus in each instance. The CT scans, with few exceptions, were obtained on either a General Electric 8800 or Siemens Somatom DR-3 scanner. Ten of the pretreatment CT scans were performed within 6 hr after metrizamide myelography. All CT scans were obtained parallel to the interspace using a slice thickness of 4 or 5 mm and slice overlap of 1 mm. A digital lateral pilot scan was used in each patient to select the degree of gantry angulation and to visually assess the degree of interspace narrowing. The CT and myelographic diagnostic criteria used to define a disk herniation are extensively described elsewhere in this issue [21].

In all instances, chymopapain chemonucleolysis was performed under local anesthesia supplemented by intravenous sedation. Using fluoroscopic guidance, an 18 gauge spinal needle was placed within the appropriate interspace by way of the lateral extradural approach. Before chymopapain injection, the needle placement was confirmed by diskography. An anesthesiologist monitored the patient during and for 30 min after injection of 4000 U of chymopapain into the nucleus pulposus.

Clinical evaluation was performed at 6 weeks and 6 months after treatment. The nature of clinical response to treatment was determined by the same neurosurgeon (M. J. J.) who had performed the pretreatment clinical evaluation. At the time of the assessment, each patient was assigned to either a *marked improvement* (satisfactory outcome) or *slight/no improvement* (unsatisfactory outcome) group. The marked improvement group was subdivided into those who were symptom-free, those with excellent response (at least 85% pain relief), and those with a good response (50%–85% pain relief). The slight or no improvement group was further divided into those who had a fair response (25%–50% pain relief) and those with no improvement (less than 25% pain relief).

Posttreatment CT scans of 26 patients at 29 treated interspaces were obtained at the time of routine 6 week or 6 month follow-up. To maximize the diagnostic information while minimizing the radiation exposure to the individual patient, the follow-up CT scans were obtained in the following manner. About 80% of treated interspaces were scanned at 6 weeks and 80% were scanned at 6 months. About 60% of treated interspaces were scanned at both intervals, allowing a more accurate determination of the progression of CT changes. All studies were performed without regard to clinical symptomatology. At 6 week follow-up, CT scans were obtained of 24 treated interspaces in 21 patients; at 6 month follow-up, scans were obtained of 22 treated interspaces in 21 patients. Seventeen interspaces in 16 patients were examined with CT at both 6 weeks and 6 months. Without knowledge of clinical response, a direct comparison was made between the baseline and follow-up CT scans to evaluate interval changes. All scans were reviewed by three neuroradiologists, and a consensus of opinion was reached concerning the observed findings. The size, shape, location, density, and homogeneity of the disk space and disk herniation were evaluated, as were the adjacent osseous structures, epidural fat, thecal sac, and paraspinous soft tissues to detect possible remote effects of chymopapain. Interval development of interspace narrowing was assessed by direct comparison of the baseline and follow-up lateral pilot scans. Accurate measurement of the degree of disk height loss was not possible from these scans; however, in many cases it was clearly evident that disk-space narrowing did occur. Interval development of disk narrowing was recorded only if the narrowing was clearly evident on direct comparison of baseline and follow-up scans. CT changes were then correlated with clinical responses.

## Results

### *Clinical Responses*

Satisfactory outcome to chymopapain chemonucleolysis (at least 50% relief of sciatica) was noted in 22 (84.6%) of 26 patients at both the 6 week and 6 month follow-up evaluation. There was a notable difference, however, in the degree of pain relief at these time periods. Although only nine (40.9%) of the 22 successfully treated patients had achieved marked (85%) pain relief at 6 weeks, 20 (90.9%) had this degree of improvement at 6 months. The overall results and the progressive improvement noted in these 26 patients are similar to those noted in the larger group of 200 patients reported previously [21]. Two of three patients who had two interspaces treated were clinical failures, while only two of 23 patients who had a single interspace treated failed to respond. Eight patients had CT findings [25–27] on their baseline examination that we believed to be strongly suggestive of "free" disk fragments that had migrated away from the interspace. Seven of these patients had successful outcomes to chemonucleolysis at both 6 week and 6 month follow-up. At 6 months, three of these patients were completely asymptomatic. One patient, with CT evidence of a free fragment, had no improvement in pain after chemonucleolysis. At surgery an extruded L5–S1 disk herniation was confirmed, with a large sequestered fragment compressing the S1 root sleeve.

*Temporal CT Changes*

The CT changes in the size and character of the posterior disk protrusions varied with the length of follow-up (table 1). At 6 weeks, only two (8.3%) of 24 disk herniations had diminished. Both of these patients were considered clinical successes. One disk herniation had enlarged slightly, even though a successful outcome was obtained. Although the disk herniation did not show an observable decrease in the extent of the protrusion in 22 (91.7%) of 24 instances, a successful outcome was noted in 76.2% of these patients (fig. 1). It is apparent, therefore, that in most patients a decrease in the size of the disk herniation at 6 weeks was not necessary to achieve pain relief. Direct comparison of baseline and 6 week follow-up lateral pilot scans revealed a significant degree of interspace narrowing in 50% of the 24 injected interspaces. The other interspaces showed only slight or no significant decrease in height.

TABLE 1: **CT Changes at Early and Late Postchemonucleolysis Follow-ups**

| Change | No. of Interspaces (%) | |
|---|---|---|
| | 6 Week Follow-up (*n* = 24) | 6 Month Follow-up (*n* = 22) |
| Size of herniation: | | |
| Increased | 1 (4.2) | 0 |
| No change | 21 (87.5) | 9 (40.9) |
| Decreased | 2 (8.3) | 13 (59.1) |
| New vacuum phenomenon: | | |
| Yes | 3 (12.5) | 5 (22.7) |
| No | 21 (87.5) | 17 (77.3) |
| Interspace narrowing | 12 (50.0) | 16 (72.7) |
| Extradiskal changes | 0 | 0 |

At 6 month follow-up, nine (40.9%) of 22 disk herniations were unchanged in size while 13 (59.1%) of 22 had diminished slightly (figs. 2–4). The response rate was slightly better in those with a diminution of the disk protrusion (92.3%) than in those with no significant decrease (77.8%). There was a slight flattening of the posterior contour of the disk protrusion at 6 months in two instances (9.1%). At 6 months, 16 (72.7%) of 22 treated interspaces showed definite disk-space narrowing on comparison of pre- and postinjection pilot scans (fig. 2).

The mean density of the disk herniations and interspaces did not change significantly at 6 week or 6 month follow-up, although in two instances (6.9%) there was an interval development of areas of inhomogeneity (fig. 3). The most common change in the appearance of the intervertebral disk was the interval development of vacuum phenomenon (fig. 1). New vacuum phenomenon was noted in three (12.5%) of 24 treated interspaces at 6 weeks and in five (22.7%) of 22 interspaces at 6 months (table 1). Of the seven patients who developed vacuum phenomenon, all were considered clinical successes at 6 week follow-up and six of seven remained therapeutic successes at 6 month follow-up.

Eight patients had CT evidence of extruded disk fragments [25–27] that had migrated above or below the interspace. One patient, who had no change in the size of disk fragment, had no improvement in pain after chemonucleolysis and required surgical diskectomy. A free fragment below the L5–S1 interspace was confirmed at surgery. Six patients had successful outcomes at 6 week and 6 month follow-up, even though there had been no significant change in the size or location of the disk fragments (fig. 5). In one successfully treated patient, the size of the disk fragment had diminished slightly at 6 month follow-up.

No detectable changes in the appearance of the thecal sac, epidural fat, or paraspinous soft tissue were noted at 6 week

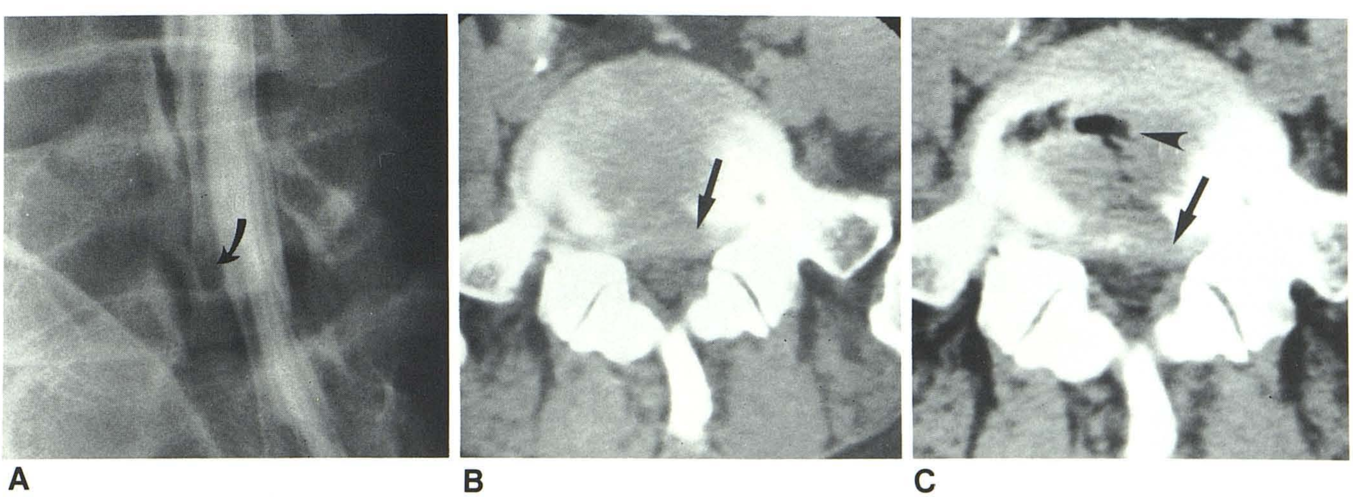


Fig. 1.—45-year-old man with left S1 radiculopathy. **A,** Metrizamide myelogram. Amputation of left S1 root sheath with distal nerve-root flattening and edema (*arrow*). **B,** Prechemonucleolysis CT scan confirms laterally located L5–S1 disk herniation (*arrow*). **C,** 6 week follow-up scan. No change in degree of posterior disk protrusion (*arrow*), but interval development of vacuum phenomenon (*arrowhead*). Clincal response: good.

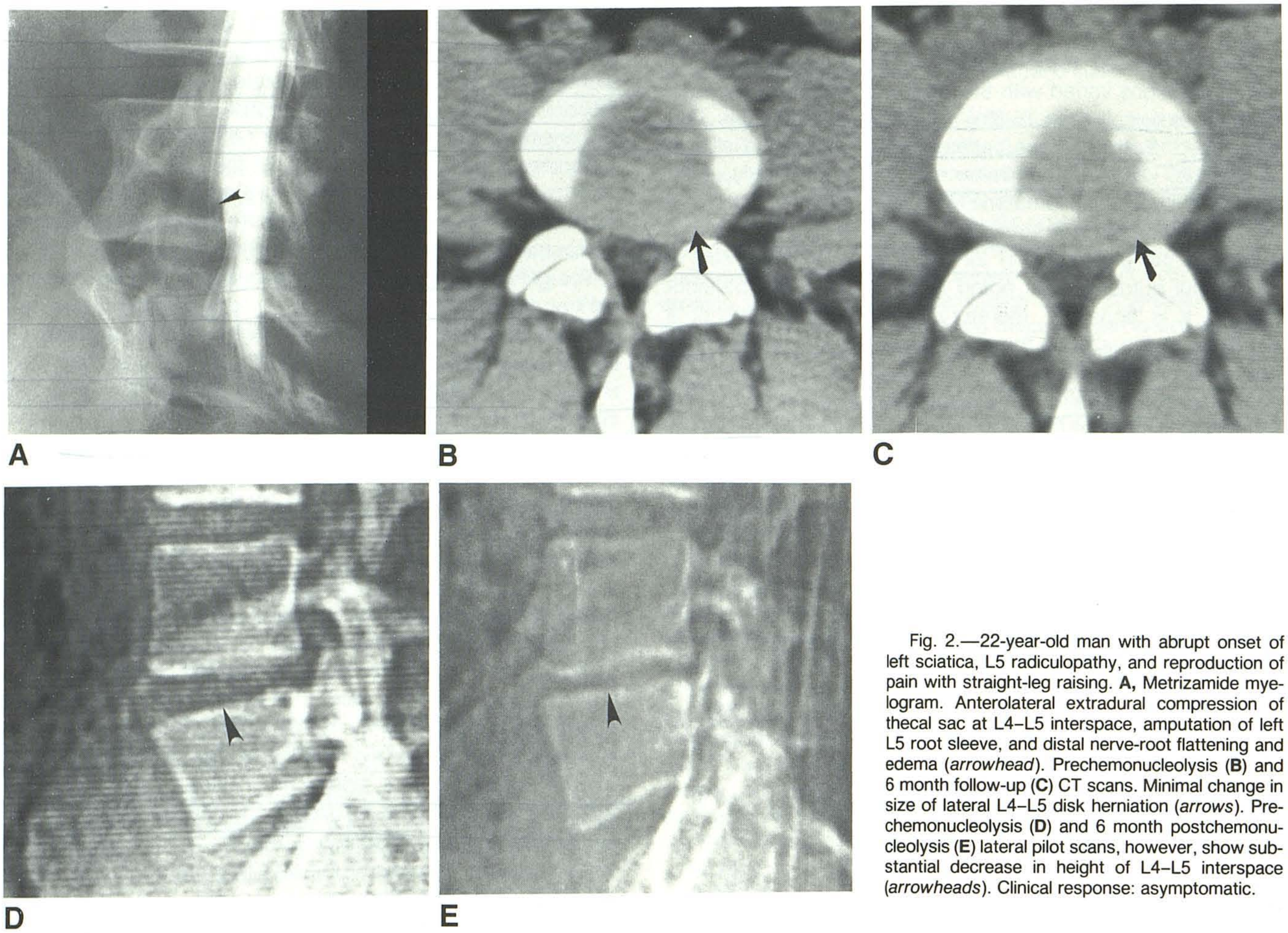


Fig. 2.—22-year-old man with abrupt onset of left sciatica, L5 radiculopathy, and reproduction of pain with straight-leg raising. **A,** Metrizamide myelogram. Anterolateral extradural compression of thecal sac at L4–L5 interspace, amputation of left L5 root sleeve, and distal nerve-root flattening and edema (*arrowhead*). Prechemonucleolysis (**B**) and 6 month follow-up (**C**) CT scans. Minimal change in size of lateral L4–L5 disk herniation (*arrows*). Prechemonucleolysis (**D**) and 6 month postchemonucleolysis (**E**) lateral pilot scans, however, show substantial decrease in height of L4–L5 interspace (*arrowheads*). Clinical response: asymptomatic.

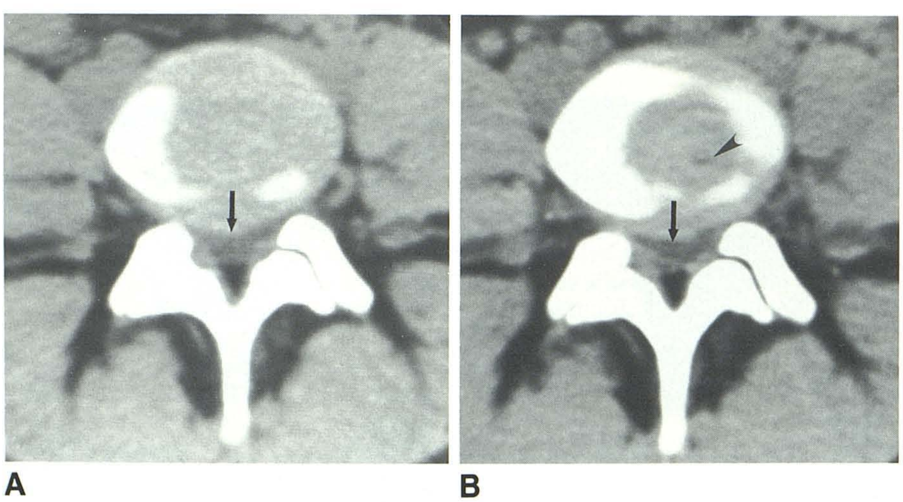
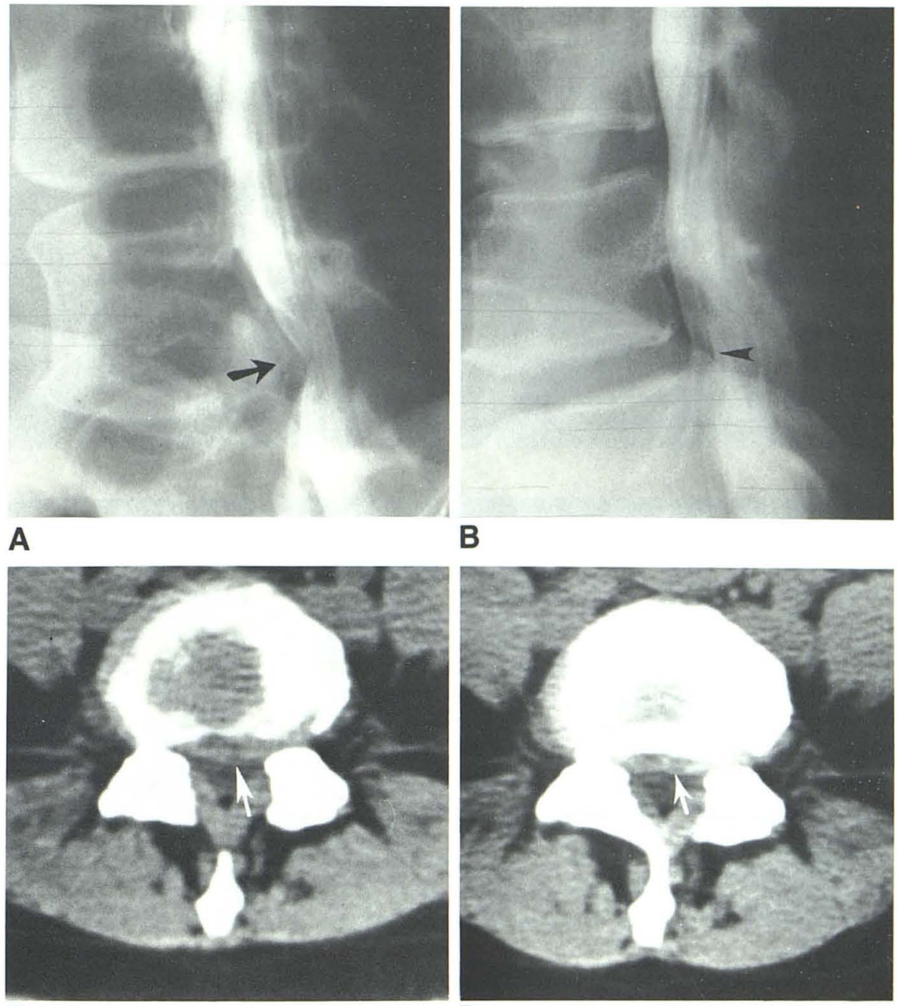


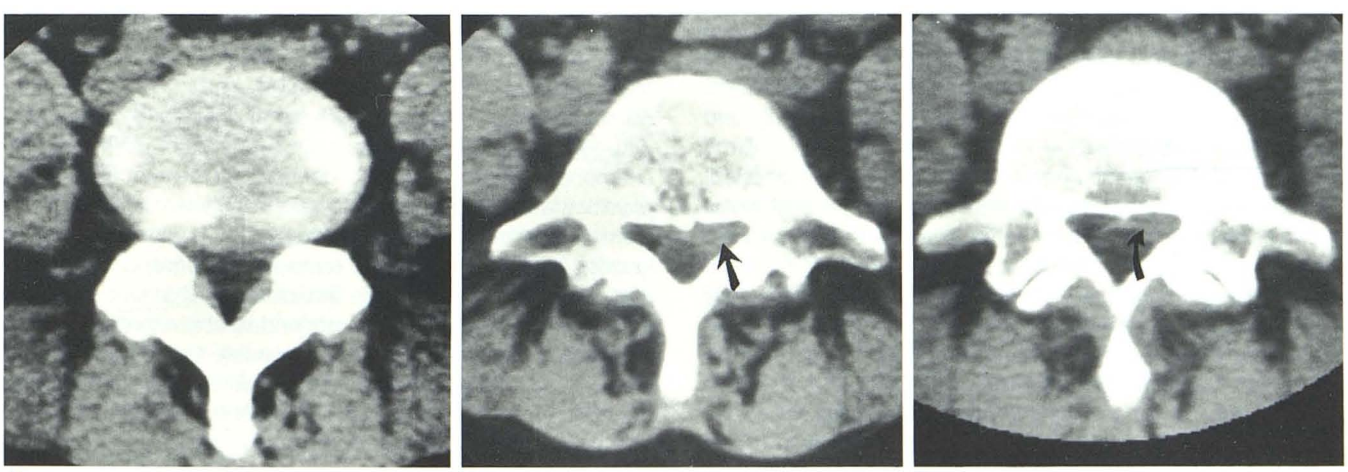
Fig. 3.—27-year-old woman with abrupt onset of bilateral sciatica. **A,** Prechemonucleolysis CT scan. Large, focal, central L4–L5 disk herniation (*arrow*) causing moderate compression of thecal sac. **B,** 6 week follow-up. Slight decrease in size of disk herniation (*arrow*) and development of area of inhomogeneity in nucleus pulposus (*arrowhead*). Clinical response: excellent.

or 6 month follow-up. One patient developed multiple, well circumscribed, focal, erosive changes of the superior and inferior end-plates of the adjacent vertebral bodies (fig. 6). These changes were minimal on the initial (6 week) follow-up scan but became pronounced at later (6 month) evaluation. This patient, however, had a good therapeutic response at 6 week follow-up and became totally asymptomatic at 6 month evaluation.



A B C D

Fig. 4.—39-year-old woman with left leg pain. **A** and **B**, Metrizamide myelogram. Angular ventral and left lateral extradural defect consistent with L4–L5 disk herniation. Amputation of L5 root sleeve (*arrow*) and "double density" on lateral radiograph (*arrowhead*). **C**, Prechemonucleolysis CT scan confirms ventral and left lateral L4–L5 disk herniation (*arrow*). **D**, 6 month follow-up scan. Significant decrease in size of posterior protrusion (*arrow*). Marked interval interspace narrowing has occurred. Clinical response: asymptomatic.



A B C

Fig. 5.—47-year-old woman with left L5 radiculopathy. **A** and **B**, Pretreatment CT scans. Relatively normal disk margin at L4–L5 interspace (**A**), but large fragment of disk material (*arrow*) below interspace (**B**) interposed between thecal sac and L5 root sheath. **C**, 6 month follow-up scan. No change in size of disk fragment (*arrow*), although margins are defined less clearly. Clinical response: excellent.

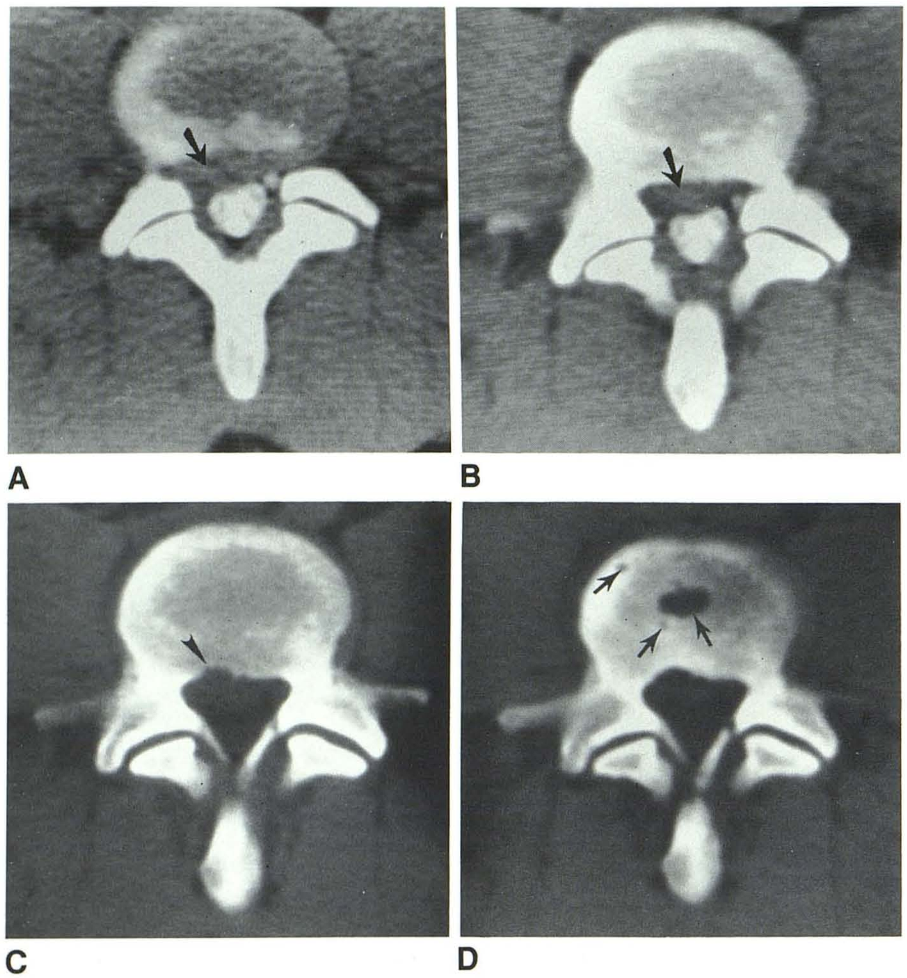


Fig. 6.—29-year-old man. **A** and **B**, Prechemonucleolysis CT scans. L4–L5 disk herniation (*arrows*). **C**, 6 week follow-up scan. Possible early erosive change of vertebral end-plate (*arrowhead*). **D**, 6 month follow-up. Multiple erosive changes (*arrows*). Slow progression and clinical course suggested nonpyogenic or chemical diskitis. Clinical response: 6 weeks—good; 6 months—asymptomatic.

*Treatment Failures*

Four (15.4%) of 26 patients were considered to be therapeutic failures at 6 week follow-up. Two of these, who had only slight relief of sciatica at 6 weeks, eventually became clinical successes at 6 month follow-up. One of the patients with a delayed success had a heavily calcified disk herniation.

At 6 month follow-up, four patients (15.4%) were judged to be therapeutic failures. Two of these had achieved a good response at 6 weeks, but improvement had not persisted. One of these two patients had significant foraminal stenosis due to osteophytic encroachment, in addition to a disk herniation. The other patient had a significant element of acquired central spinal stenosis at the level of the treated disk. The other two patients were considered to be therapeutic failures, both at 6 week and 6 month follow-up.

Three of four patients, who were judged to be therapeutic failures, required surgical intervention. A free disk fragment was found caudal to the treated interspace in one of these patients 3 weeks after chemonucleolysis. Lateral recess stenosis and central spinal stenosis were confirmed at surgery in the other two patients. One patient with osteophytic foraminal encroachment declined further therapeutic intervention.

**Discussion**

Sciatica is a very common disorder that affects many people at some time during their lives [28, 29]. Fortunately, in most patients, sciatica will respond to conservative measures within 2 months after onset [30]. In those patients who do not respond, however, more direct therapeutic measures may be necessary. The recent reemergence of chymopapain chemonucleolysis, after two decades of development, has provided a viable alternative to surgical diskectomy for treatment of sciatica due to a herniated nucleus pulposus. Little is known, however, about the temporal radiographic changes that occur after treatment. The changes that occur in the disks of those patients who respond to chymopapain chemonucleolysis must be defined to evaluate the significance of changes that occur in nonresponders. Evaluation of temporal radiographic changes may also help clarify the mechanism by which chemonucleolysis relieves sciatic pain caused by disk herniation.

Our data indicates that chymopapain chemonucleolysis was effective in 84.6% of patients at both early and late follow-up, even though only two (8.3%) of 24 and 13 (59.1%) of 22 disk herniations, respectively, had diminished by these

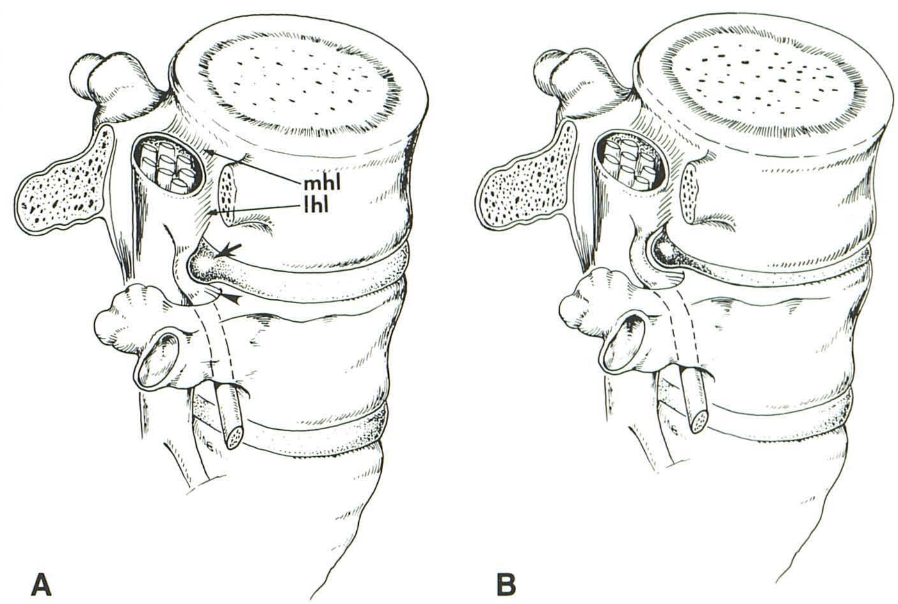



Fig. 7.—Possible mechanism by which interspace narrowing reduced nerve-root compression by disk herniation. **A,** Anterior fixation of proximal aspect of root sheath by Hofmann ligaments and distal fixation at intervertebral foramen by similar connective tissue bands (*arrowhead*) makes it possible for intervening disk herniation (*arrow*) to compress adjacent nerve root without actual entrapment against posterior elements. **B,** Approximation of two points of fixation, secondary to interspace narrowing, effectively lengthens intervening segment of spinal nerve, allowing it to more freely drape over disk herniation, which has remained unchanged in size. mhl = medial Hofmann ligament, lhl = lateral Hofmann ligament.

follow-up periods. It is apparent that an observable diminution in the herniation is not necessary to achieve pain relief at 6 weeks. Even though the size of the disk herniation did not change at follow-up, it was clearly evident that chymopapain did have an effect on the treated interspace. The development of vacuum phenomenon and significant interspace narrowing demonstrate the morphologic evidence of chymopapain's enzymatic action on the nucleus pulposus.

With longer follow-up the CT changes did become more pronounced with a greater number of patients exhibiting a diminution of the disk herniation, vacuum phenomenon, and significant interspace narrowing. The greater frequency of disk-space narrowing and reduction in the size of the disk herniation was accompanied by a progressive improvement in the degree of pain relief. At 6 month follow-up, 20 (90.9%) of 22 successfully treated patients had achieved at least 85% pain relief as compared with only nine (40.9%) of 22 patients at 6 weeks. Successful treatment at 6 months was associated with both a diminution of the disk herniation and a loss of disk height, while at 6 weeks only loss of disk height was usually evident.

In view of a lack of a change in the size of the disk herniation at 6 week follow-up in responders, one must ask how chemonucleolysis reduces sciatic pain. It is clear that chymopapain has a biochemical effect with enzymatic hydrolysis of the mucopolysaccharide part of the nucleus pulposus [1–4], but it is not well understood how this action reduces nerve-root compression and tension, which are responsible for the sciatic-type pain [17, 22, 31–33]. Some authors believe that it is accomplished primarily by a diminution of the nucleus pulposus and the herniated nuclear material, thereby reducing the hydraulic pressure exerted by the nucleus on the adjacent nerve root [1–4, 13]. Other investigators, however, report many dramatically successful responses occurring without apparent decreases in the size of the disk protrusions at follow-up CT or myelography [8, 10, 16, 17, 21–23]. MacNab et al. [17] observed no significant change in the size of the myelographic defect in 10 symptom-free patients studied with myelography at varying periods after chemonucleolysis. In our series, 76.2% of 21 patients who had no significant change in the size of the disk protrusion had a successful outcome to chemonucleolysis at 6 week follow-up. It would seem that a decrease in the size of the disk herniation cannot be the only, or even the primary, means by which pain relief occurs at 6 weeks.

Spencer et al. [31] suggested that the height of the interspace may have an important effect on the degree of nerve-root compression by a disk herniation. For a given degree of posterior disk protrusion, they showed experimentally that the height of the interspace significantly influences the degree of nerve-root compression and tension. This effect is readily understandable in view of the known ligamentous fixation of the lumbosacral nerve roots. The proximal root sleeve is firmly tethered by the medial and lateral Hofmann ligaments [34] (fig. 7) to the posterior longitudinal ligament above the interspace, whereas the distal root sleeve is attached by similar ligaments to the anterior and medial aspects of the pedicle of the next more caudal vertebral body. The nerve root, tethered proximally and distally, becomes tightly stretched by an intervening disk herniation. Approximation of the two points of fixation will allow the intervening segment of the nerve root and associated dural sleeve to become effectively longer. This can reduce nerve-root compression, since the relatively longer nerve root can more freely drape around the protruding disk herniation (fig. 7). The decrease in disk height may, therefore, reduce nerve-root tension and compression without any change in the size of disk protrusion. Since relief of sciatica typically occurred at 6 weeks without a decrease in the size of the disk herniation but usually was accompanied by at least some degree of interspace narrowing, our data would tend to support this as a possible mechanism of pain relief.

Several other investigators have also noted a significant correlation between clinical response and the development of and extent of interspace narrowing [8, 12, 19, 20, 22]. The loss in disk height has been noted to be less in those patients treated by chymopapain chemonucleolysis who have a narrow pretreatment disk space [21]. The lower response rates, also noted in these patients, suggest that the decrease in disk height that occurs with chemonucleolysis may be important in achieving a good response [21].

Interspace narrowing could possibly explain the improvement of sciatica that occurs in some patients with free disk fragments. Seven of eight patients in this series who had CT and myelographic evidence of extruded disk material that had migrated away from the level of the treated interspace had successful responses, even though there were no changes in the size or location of the disk fragments. Since it has been shown experimentally that chymopapain is immediately bound to the mucopolysaccharide matrix of the nucleus pulposus and that any enzyme escaping from the nucleus pulposus is rapidly inactivated [2], it is unlikely that these free disk fragments were exposed to a significant amount of active enzyme. It would seem that the effect of chymopapain in these successfully treated patients must be through a less direct action such as that of interspace narrowing.

An actual decrease in the size of the disk herniation did occur in 13 (59.1%) of 22 interspaces at later follow-up, suggesting that this may also play a significant role in relief of sciatica. It is noteworthy, as evidenced by our series and many others [5, 6, 11, 19], that there may be progressive improvement in sciatica for as long as 6 months. We found that, although the percentage of patients classified as therapeutic successes was similar at 6 weeks and 6 months, the level of pain relief was much greater at 6 months. It is possible that early improvement is accomplished primarily as a result of the reduction in nerve-root compression brought about by interspace narrowing, with a more complete response occurring as the actual size of the disk herniation diminishes with longer follow-up.

Although there is evidence that interspace narrowing may be an important mechanism by which chemonucleolysis effects the relief of sciatica, there is great concern [6, 11] that this may, in itself, lead to symptomatology by the production of foraminal stenosis. Despite this potential concern it has not seemed to be a significant problem even though some series have been followed for up to 7 years [7, 11, 13, 35]. It must be pointed out, however, that surgical diskectomy (usually accomplished by evacuation of as much disk material as possible) also leads to a similar degree of disk-space narrowing with the same potential complication. In this regard, chemonucleolysis may have an advantage, since there is some evidence that disk regeneration can occur after chemonucleolysis [24]. Rewidening of the disk space after chemonucleolysis has been observed to occur in humans [8, 35] and typically occurs in some animals [8, 24, 36]. There is experimental evidence that the nucleus pulposus can, in some cases, retain the ability to synthesize proteoglycans and that the biochemical composition of the nucleus pulposus may normalize within 3 months after treatment [24]. Because of the potential for development of foraminal stenosis, however, the practice of "prophylactic" treatment of a disk that might later give problems should be condemned.

A second area of potential concern has been the possibility of the development of extradiskal changes such as arachnoiditis and epidural scarring. Although our experience is small, those patients who had follow-up myelography, CT, or subsequent surgery in this and in our previous study [21] have not developed any evidence of arachnoiditis. Our observations would support the impression of others [8, 10, 13] that these changes, if they occur, are extremely uncommon. One of our patients, however, did develop unusual erosive changes of the end-plates of the adjacent vertebral bodies. The time course of development of these changes and the clinical course make it less likely that they can be attributed to a pyogenic diskitis. It is possible that these changes are a result of a chymopapain-mediated chemical diskitis. Previous authors have reported similar findings in several patients, thought to be secondary to aseptic, chemical, or nonpyogenic diskitis [10, 15, 35, 37].

Since successfully treated patients do not usually have a change in the size of the disk herniation at 6 weeks after chemonucleolysis, it is obvious that the persistence of the disk protrusion at follow-up cannot, in itself, be used as an indicator of chemonucleolysis failure. It is important to be certain that there are no other causes of chemonucleolysis failure that have been overlooked before attributing failure to a lack of change in the size of the protruding disk. The presence of free disk fragments or other concurrent causes of nerve-root compression (foraminal, lateral recess, or central spinal stenosis) should be excluded first.

In conclusion, our data would support the large body of evidence that, in the properly selected patient, chymopapain chemonucleolysis is an effective alternative to surgical diskectomy for the treatment of lumbar disk herniation. Follow-up evaluation with CT suggests that, in a substantial percentage of patients, this effectiveness is accomplished without a significant initial change in the size or appearance of the disk herniation. The mechanism of pain relief in these cases may be mediated by a number of different factors, the main one at early follow-up possibly being a loss of disk height. Continued improvement at 6 month follow-up is associated with a loss of disk height as well as a frequent decrease in the size of the disk herniation itself. Extradiskal effects of chymopapain appear to be uncommon.

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