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Ligament-sparing Lumbar Microdiscectomy: Technical Note

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Song J-H, Park Y-K. Ligament-sparing lumbar microdiscectomy: Technical note. Surg Neurol 2000;53:592–7.

BACKGROUND
The prevention or inhibition of postoperative adhesions is a significant goal for successful lumbar discectomy, not only to reduce the probable risk of recurrent radiculopathy, but also to improve the likelihood of success of re-operation.

METHODS
We describe a new technique for sparing the ligamentum flavum in lumbar microdiscectomy. The superficial layer of the ligament is removed by horizontal splitting. Additional horizontal splitting of the ligament yields a paper-thin deep layer. Lateral vertical splitting and retraction is then carried out to provide a sufficient operative window. The split ligament returns to its original position after releasing the retraction, thereby closing the operative window.

RESULTS
This method could preserve a layer of the ligamentum flavum to act as a physical barrier, which in turn greatly restricts the peridural fibrosis.

CONCLUSIONS
This ligament-sparing technique enables surgeons to preserve the original anatomic plane and to reduce the extent of postoperative adhesion.

KEY WORDS
Ligament-sparing, microdiscectomy, postoperative adhesion

Numerous authors have refined the technique of lumbar discectomy [1,3,5–7,12,14]. The aim of these refinements has been to obtain maximal surgical benefit with minimal injury to the patient and to reduce the incidence of postoperative complications. We have developed a new technique to preserve the natural anatomic plane of the ligamentum flavum, which then acts as a barrier to limit the extent of postoperative peridural fibrosis.

Operative Technique

Our technique is actually the same as that of others, except for the handling of the ligamentum flavum. After induction of anesthesia, the patient is positioned prone on a Wilson frame. Care is taken to ensure that the abdomen is not compressed. After sterile preparation, a 2–2.5 cm vertical incision is made over the appropriate vertebral level. The placement of the incision is guided by fluoroscopy. Unipolar cautery is used to perform the subperiosteal dissection unilaterally adjacent to the appropriate spinous processes and onto the lamina. The dissection is confined to the interlaminar space being exposed. A microdiscectomy retractor is then inserted and the operating microscope with a 300 mm lens is brought into position. A high-speed drill or Kerrison rongeurs are used to resect a small portion of the superior lamina (Figure 1**A**). The midline recess of the ligament is not exposed. The laminectomy should extend laterally until the lateral slope of the ligament is encountered. A curette is used to detach the upper layer of the ligamentum flavum from the inferior lamina. Sweeping the curette around the edge of the inferior lamina facilitates the detachment. The thick upper layer is then rolled up and removed (Figure 1**B**). Superior facetectomy of the adjacent caudal vertebra is often needed. A microdissector and/or a No.11 scalpel is used to split the thin lower layer (Figure 1**C**). Because the lower layer is like an onion skin, it is easy to remove it stepwise until a paper-thin layer is left. A vertical split is then made at the lateral margin of the paper-thin ligament. A retractor is positioned to retract the ligament, nerve root sleeve, and epidural fat (Figure 1**D**). Any epidural bleeding should be controlled to maintain a bloodless field. Any loose disc material is then removed. A linear incision to the annulus may be required when disc herniation is subligamentous. Releasing the retractor after the discectomy may leave a tiny, 1–2 mm slit. The mus-

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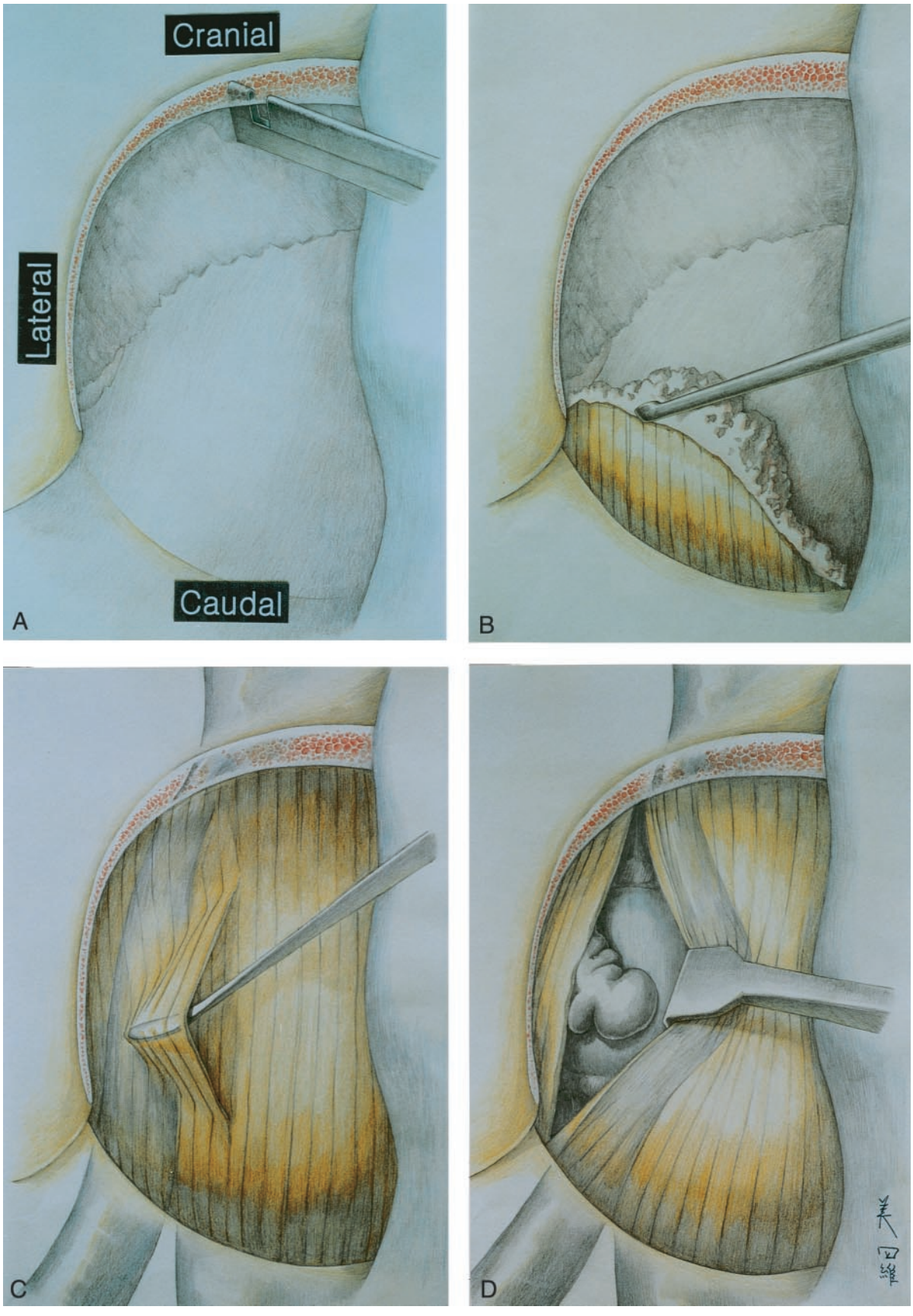
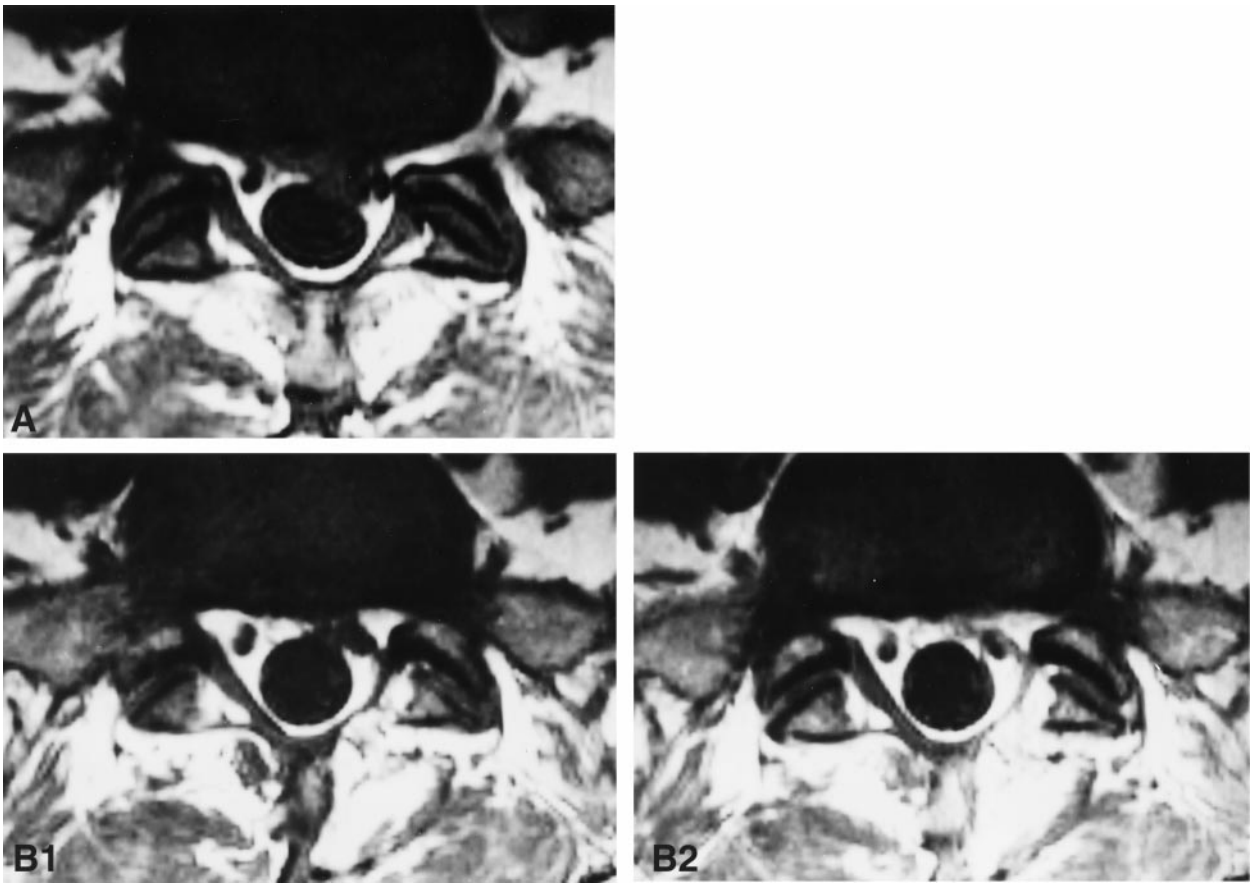
Received November 5, 1999; accepted April 7, 2000.

0090-3019/00/$–see front matter
PII S0090-3019(00)00231-7



1 Artist's illustrations of the ligament-sparing laminectomy. **A**. The hemipartial laminectomy is done in the usual fashion. **B** ~ **C**. Sweeping the curette around the edge of the inferior lamina facilitates detachment of the superficial layer of the ligamentum flavum. The thick upper layer is then rolled up and removed. Because the lower layer is like an onion skin, stepwise removal using a microinstrument results in a paper-thin layer. **D**. A retractor is positioned to retract the ligament, nerve root sleeve, and epidural fat.



2 **A**. Preoperative lumbar MRI showing left-sided disc herniation at the L5/S1 level. **B**. Lumbar MRI, 3 months postoperatively, showing a hemilaminotomy and a thinned ligamentum flavum. T1-weighted axial image (**left**) and gadolinium enhanced axial image (**right**). Note that the epidural fat layer was well preserved and the peridural fibrosis (enhancing portion medial to the exiting nerve root) was minimal.

cle fascia, subcutaneous layer, and skin are closed in layers.

Case Illustration

A 35-year-old man was referred in August 1996 with a 6-week history of low back pain and left-sided buttock and leg pain. He had been given medication that failed to improve his symptoms. Neurological examination revealed a positive straight leg raising test in the left leg at 50°; he felt pain radiating down the lateral calf. The Achilles tendon reflex was absent in the left leg. The patient had a sensory hypesthesia at the S1 dermatome. Lumbar MRI revealed a left-sided disc herniation at the L5-S1 level (Figure 2**A**). He underwent a ligament-sparing microdiscectomy. After the operation, he enjoyed an uneventful recovery. Follow-up lumbar MRI was carried out 3 months postoperatively. The epidural fat layer was well preserved (Figure 2**B**). At present, more than 2 years after the surgery, the patient is doing well, except for a decreased Achilles tendon reflex.

Discussion

Postoperative adhesion has been regarded as an unavoidable consequence of laminectomy or discectomy, and many authors believe that peridural fibrosis is associated with negative postoperative results [3,4,7–9]. Peridural fibrosis causes adhesions between normal anatomic structures, and these adhesions significantly increase the risk of neural injury and the duration of surgery at reoperation [4,10]. Many authors believe that peridural fibrosis is an important factor leading to clinically significant sequelae [3,10,12,13]. For example, Ross et al [11], in a randomized, double-blind, controlled multicenter clinical study of 197 patients, concluded that patients with severe peridural scarring have a 3.2-fold increased risk of experiencing recurrent radicular pain compared to those without

peridural scars. In contrast, Nygaard et al [8], in their prospective cohort study with a 1-year follow-up in 54 patients, found no significant association between postoperative scarring and clinical outcome. Therefore, the association between peridural fibrosis and postoperative outcome is still a cause for clinical debate. However, because the revision rate for low back surgery is more than 20% [13], and the recurrence rate of disc herniation is 3–9% [6], the extent of peridural fibrosis per se has its own clinical significance. Therefore, prevention or inhibition of postoperative adhesions is a significant goal for successful lumbar discectomy, not only to reduce the probable risk of recurrent radiculopathy, but also to improve the likelihood of success of reoperation.

Numerous authors have investigated techniques to reduce peridural fibrosis. Some studies have evaluated the use of free fat grafts, silastic, Dacron, methacrylate, bone grafts, synthetic membranes and foams, and methylprednisolone, all with inconclusive results [10,11]. Recently, a resorbable gel (Adcon-L®) was introduced onto the market, but the long-term benefits have yet to be defined [2]. Furthermore, the use of such substances may incur additional costs.

We consider it to be important to preserve the natural barrier, the ligamentum flavum, and that this is the safest and most effective way of reducing the extent of peridural fibrosis. The prevention or inhibition of the migration of fibroblasts is an important factor in reducing the extent of scar formation. We believe that the preserved ligamentum flavum not only reduces scar formation, but also helps the surgeon to locate the anatomic plane at re-operation.

The concept of ligament sparing is not new. Long and McAfee have described a flap technique in which the ligament is incised at the superior, inferior, and lateral margins, a technique which permits restoration of the ligament to its original position by suturing [7]. Delamarter and McCulloch described a method of microdiscectomy with ligament-sparing, in which the ligament was detached from its lateral margin [1]. However, they did not describe the thinning of the ligament, which is the essential component of our technique. If the ligament is thick, it is difficult to achieve a smooth retraction and to assess whether the nerve root sleeve is adequately decompressed or not. With their technique, one would not expect there to be less scar formation in the region lateral to the nerve root if the most lateral portion of the ligament were to be detached. Our technique preserves this part of the ligament, and in addition, no additional effort and time are required to suture the ligament back in a small working space.

It is necessary to have some anatomic knowledge to achieve adequate dissection of the ligamentum flavum. The ligamentum flavum consists of a superficial and a deep layer. There is an inferoventral slip of the ligament that attaches to the anterosuperior surface of the caudal lamina. This slip is the inferior portion of the deep layer and, as such, permits the selective removal of the superficial thick layer [9]. Because the layers of the facet capsule insert onto the superolateral part of the caudal lamina, a crude attempt to remove the superficial thick layer can result in injury to the capsule [15].

We believe that our technique is an example of genuinely minimally invasive surgery, which preserves the original anatomic plane and diminishes the formation of postoperative adhesions. This report simply describes the technique of ligament-sparing laminectomy. We have been used this technique since 1994, and the outcome has been satisfactory for the more than 300 patients treated with this technique. The clinical and radiological data will be reported elsewhere.

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COMMENTARY

The authors have described a technique for sparing a portion of the ligamentum flavum in an attempt to limit peridural fibrosis. The technique is interesting. Its true utility is not particularly clear. There is no study that has demonstrated that there is a definite correlation between epidural fibrotic changes and pain. All wounds heal with some degree of fibrosis, and it remains unclear from a rigorous scientific standpoint whether epidural fibrosis plays any role in postoperative pain after lumbar discectomy. Certainly, peridural fibrosis is significant when one is doing a re-exploration type of surgery.

It is also unclear whether their technique truly prevents peridural fibrosis, as the ligamentum flavum is a combination of fibrous tissue and elastic tissue and a source of lumbar peridural fibrosis. In addition, it may be that the principal contributing course in the development of peridural fibrosis may be postoperative seepage of blood from epidural vessels with the development of small peridural blood and fluid collections. However, the technical note is interesting and may be of some value to neurosurgeons.

One additional cautionary comment is that one should never limit the exposure to the neurological structures, as this increases the possibility of retraction injury, and failure to do an adequate neurological decompression by removing all compressive disc fragments.

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This is an interesting technical note. The issue, which is not proven, is whether ligament sparing will in fact reduce peridural fibrosis and whether reduction of peridural fibrosis will improve outcome. There are two major problems that I see. The first is that the authors' contention that postoperative adhesions will be reduced by a ligament-sparing operation is not proven by the article or supported by factual data. The second presumption is that the reduction of peridural fibrosis will improve outcome. The evidence for this is marginal, and for an operation of which the outcome, both short- and long-term, is 90% good, huge numbers of patients would have to undergo the procedure. Their presumption that peridural fibrosis is related to poor outcome is simply not borne out by the literature in any quantitative way. It is intuitively correct to preserve and restore anatomical status, but the presumption that preserving the ligamentum flavum will reduce peridural fibrosis depends upon the unproven thesis that fibroblasts grow primarily through the laminotomy defect and the hole in the ligament, another fact that I think is unknown.

A third comment that is very important relates to what surgery is required for typical lumbar root compression syndromes. What the authors describe would be satisfactory for the simple free-fragment disc. In our recent study of some 600 prospectively studied patients undergoing lumbar discectomy, we found the simple free fragment to be a real minority among the reasons for such surgery. The majority of patients required a much more extensive procedure than would be allowed by simple lumbar microdiscectomy.

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This technical report describes a manner of preserving the thin inner ligamentum flavum during microdiscectomy, which potentially reduces the chances of postoperative epidural fibrosis. The basis for attempting to reduce postoperative epidural scarring is, in part, because of associations in the literature between such scarring and persistent complaints of back and lower extremity pain. In fact, epidural fibrosis has been implicated, in part at least, as the underlying pathology responsible for the so-called "failed back syndrome." The authors are correct in pointing out that this concept of epidural scar causing persistent pain is controversial. My own reported review of the literature on this topic did not uncover compelling evidence that there is any such association, and suggested that

the concept of "failed back syndrome" is flawed and should be re-evaluated [2].

Dr. Ralph Cloward, when carrying out the posterior lumbar interbody fusion, dissected the cranial, lateral, and caudal margins of the ligamentum flavum from the adjacent bone, after bony removal of the medial facet and adjacent lateral laminae. The lateral edge of the ligament was held medially by a guy suture during the procedure, and let back down in place at closure [personal demonstration]. A similar technique was described by Blume in 1985 [1]. The currently described technique, however, provides less dissection into the epidural space and a better chance of restoration of the anatomy to a normal configuration postoperatively.

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The goal of war is to win and to make the enemy pay a horrible price. Then they will think more carefully about waging war with you again.