Outcome analysis of patients after ligament-sparing microdiscectomy for lumbar disc herniation

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Object. The authors describe a microsurgical technique for the preservation of the ligamentum flavum and the long-term surgery-related results, including an independent assessment of outcome.

Methods. Three hundred seventy-seven patients underwent ligament-sparing microsurgical discectomy for a previously untreated single-level lumbar disc herniation and were followed for more than 2 years. A successful outcome at 6 months was demonstrated in 93.9% of the patients. At a median follow-up period of 30 months, successful patient-assessed outcome was 84.1%. During the mean follow-up period of 4.2 years (range 2–6.5 years), recurrent disc herniation was detected in 18 patients (4.8%). These patients all underwent repeated surgery. The overall surgery-related rate of complications was 1.3%.

Conclusions. The authors conclude that ligament-sparing microdiscectomy is a safe procedure, with a favorable success rate and minimal morbidity. Reoperation is safer and easier when using this technique compared with traditional ones.

KEY WORDS • disc herniation • ligament preservation • discectomy • lumbar spine • outcome

The microsurgical management of lumbar disc herniation has evolved considerably since the technique of microdiscectomy was reported by Caspar in 1977⁴ and by Williams in 1978.²¹ Since those reports, many authors reported favorable outcomes after microdiscectomy,^{5,8,10,11} and the technique became the gold standard for lumbar disc herniation. Microdiscectomy, in which the incision is small and the dissection limited, results in rapid healing of the wound, little scarring, and permits the preservation of the ligamentum flavum as well as epidural adipose and vascular tissue. Several authors, including ourselves,¹⁹ have reported various techniques for the preservation of the ligamentum flavum.^{1,6} Whether ligament sparing reduces peridural fibrosis and whether the reduction of peridural fibrosis improves outcomes, however, have not been resolved. Thus, to determine the effects of preserving the ligamentum flavum on the amount of epidural fibrosis formed and on patient outcome, we evaluated the clinical outcomes in 377 consecutively treated patients who underwent ligament-sparing microdiscectomy for a previously untreated single-level lumbar disc herniation. We also examined the operative findings in 18 patients in whom recurrent disc herniation had developed at the same level.

CLINICAL MATERIAL AND METHODS

Patient Population

Between September 1995 and January 2000, 430 patients underwent a unilateral single-level lumbar microdiscectomy procedure in which we performed a ligament-sparing technique at Guro Hospital, South Korea. Three hundred seventy-seven patients (234 men and 143 women) were followed for at least 2 years and form the basis of this study. Indications for surgery included the following: 1) severe radiculopathy for at least 6 weeks and the failure, for at least 1 month, of conservative treatment; 2) positive tension sign; and 3) disc herniation with compression of the nerve root confirmed by MR imaging.

Patients were excluded if they were covered under Workers' Compensation or were receiving a disability pension.

Surgical Technique

All operations were performed by the same surgeon (Y.P.) who followed a previously described protocol.¹⁹ Briefly, the spine is exposed through a 2 to 2.5-cm posterior midline incision, and subperiosteal muscle dissection is performed laterally to the posterior aspect of the facet joint. After insertion of a Caspar microdiscectomy retrac-

Abbreviations used in this paper: LOS = length of hospital stay.

tor and the introduction of an operating microscope, a small portion of the cephalad lamina is resected using a high-speed drill or Kerrison rongeurs until the midline recess of the ligamentum flavum is exposed (Video Clip 1). The laminectomy should extend a few millimeters superiorly into the lateral portion of the interlaminar space. Sweeping the Penfield dissector at the edge of the inferior lamina facilitates the detachment of the upper layer of the ligament. The thick upper layer of the ligament is then rolled off. Again, the dissector is used to make a longitudinal slit on the lateral margin of the paper-thin ligament. A nerve root retractor is positioned to retract the ligament medially at first. After the identification of the lateral margin of the nerve root, the root is retracted while being covered with the ligament. A linear incision to the posterior longitudinal ligament and the anulus is preferred, and the disc is removed using pituitary rongeurs in the usual manner. Releasing the retractor after the discectomy leaves a 1 to 2-mm slit on the ligament. The muscle fascia, subcutaneous layer, and skin are closed in layers.

Click here to view Video Clip 1: Intraoperative video clip showing two representative cases of ligament-sparing microdiscectomy. The first patient is a 25-year-old man with a wide interlaminar space in L5–S1, and the second is a 60-year-old woman with a narrow L4–5 interlaminar space.

Revision surgery was performed in 18 patients in whom disc herniation recurred at the same level; the same ligament-sparing principle was followed in this surgery. Indications for revision surgery were the same as those for the primary operation. The assessment of the character and location of the scar tissue was conducted by examining the tenacity of the epidural scar, expressed as type of surgical dissection required in four anatomical regions: posterior, lateral, anterior, and periradicular.

The duration of symptoms, side and level of herniation, LOS, and clinical improvement rate were recorded. Follow-up examinations were performed by the treating physician at 1 and 6 months to determine procedure complications and early clinical outcomes. The patients were contacted by letter or telephone at least 2 years after surgery by an interviewer blinded to the study. A standardized questionnaire developed by Quigley, et al.,¹⁸ was translated and used (Table 1). Success was defined as all of the following: 1) no or minimal remaining pain; 2) work not adversely affected; 3) no use of narcotic medications; and 4) patient satisfaction with the procedure.

RESULTS

Surgery-Related Outcome

The mean preoperative duration of radicular pain was 7.8 months. The affected levels were L2–3 in four patients, L3–4 in 19, L4–5 in 207, and L5–S1 in 147. The mean LOS was 8.8 days, and the total complication rate was 1.3%. One patient (0.27%) suffered dural injuries. In three patients (0.8%) wound infections and in one (0.27%) discitis developed.

The mean follow-up period was 4.2 years (range 2–6.5 years). Early clinical outcome, which was assessed by the treating physician 6 months after the operation, indicated a success rate of 93.9%. Nine patients underwent

TABLE 1
*Standardized patient questionnaire**

1) describe current pain compared w/ preop
a) none
b) improved and does not limit activity (work & leisure)
c) improved but does limit activity (work & leisure)
d) same as preop
e) worse than preop
2) current working situation
a) same job as before back problem
b) same job but light duty compared w/ before back problem
c) different job because of back problem
d) not working because unemployed or always at home
e) not working because of back problems
3) how do you feel about the operation?
a) pleased, would undergo again
b) pleased, but would not undergo again
c) displeased
4) describe your analgesic medication use
a) narcotic, daily
b) narcotic, nondaily
c) antiinflammatory only
d) none

reoperation before the follow up, and results were classified as unsatisfactory. In the patients' self-assessment, determined at a median of 30 months (range 24–52 months) after surgery, a satisfactory result was demonstrated in 84.1%.

Reoperation Data

The overall reoperation rate during the follow-up period was 5.6% (21 patients). Eighteen of these patients (4.8%) required reoperation for treatment of a recurrence at the same level, two for a lumbar disc at another level, and one for postoperative spinal instability. Half of all same-level recurrences (nine cases) occurred within 6 months of the primary operation. The frequency of a same-level recurrence was 2.4% at 6-month follow-up examination. Of all same-level recurrences, 72% (13 cases) developed during the first 2 years after the primary operation, and the frequency of recurrence was 3.5%. Although there was no statistical difference regarding the overall recurrence rate between men and women (5.2 and 4.1%, respectively), the recurrence rate after 6 months was higher in men than women (3 compared with 1.4% [$p = 0.09$, Fisher exact test]). The mean pain-free interval in the patients with recurrent disc herniation was 15.4 months (range 0.5–42 months).

During the reoperation, dissection was remarkably simplified by the absence of scar tissue adjacent to the dural sac and nerve root (Video Clip 2). The scar tissue on the surface of the laminotomy defect was easily rolled off from the thin layer of spared ligamentum flavum. In no case was scarring found in the posterior and anterior regions, nor around the nerve root. Minimal scar adhesions were noted in the lateral portion of dural sac, which was always very easily dissected using a blunt nerve hook, even in the case in which there was a late recurrence.

Click here to view Video Clip 2: Intraoperative video clip showing a representative patient in whom a disc herniation recurred after undergoing surgery in which the current technique was used. The interval between the two operations was 42 months.

Ligament-sparing lumbar microdiscectomy

The mean LOS after reoperation was 9.2 days. As of the time of preparing this report, no surgery-related complication had been noted in the patients in whom disc herniation recurred. During the follow-up period (mean 2 years, range 0.5–5.6 years) in patients requiring reoperation, no recurrence became apparent. Evaluation of clinical outcome determined 6 months after the operation revealed a success rate of 89% (16 of 18 cases). Self-assessment determined at 2 years showed a similar result (89% [eight of nine cases]).

DISCUSSION

A definite correlation between epidural fibrotic changes and pain has not been reported. Clinical outcome after primary lumbar disc surgery does not correlate with the application or type of interposition membrane used to prevent epidural fibrosis or the amount or enhancement of peridural scar formation in studies assessed at 1 year postoperatively.^{2,15,16} The affected nerve root entrapped within the peridural scar, however, is theoretically more susceptible to recurrent disc prolapse and its compression. The presence of epidural scar around the decompressed nerve root might also affect the diagnostic accuracy of neuroimaging studies.^{3,7} Furthermore, scar tissue makes repeated surgical intervention for recurrent ipsilateral herniation more demanding, increases the risk of dural tear,^{12,13} and may affect the clinical outcome of reoperation. Therefore, prevention or inhibition of postoperative adhesions is a significant goal for surgeons undertaking successful lumbar discectomy, both to reduce the risk of recurrent radiculopathy and to improve the likelihood of successful reoperation.

Preservation of the natural barrier is the safest and most effective way to reduce the extent of peridural fibrosis. The prevention or inhibition of the invasion of fibroblasts from the muscle layer is an important factor in reducing the extent of scar formation. We believe that preservation of the ligamentum flavum not only reduces scar formation but also helps the surgeon to locate the anatomical plane at reoperation.

The concept of ligament sparing is not new. A three-sided flap technique in which the ligament is incised at the superior, inferior, and lateral margins has been developed.^{1,14} Delamarter and McCulloch⁶ have described another method of ligament sparing in which the ligament was detached from its lateral and inferior margins (a two-sided technique). The highly elastic and contractile properties of the ligament, however, leave the epidural space open to the muscular layer along the detached portions. This is more evident in the superior and inferior margins because of the vertical orientation of the elastic fibers in the ligament. In practice, it is impossible to suture all the way around the detached portions. Thinning of the ligaments—the essential component in our technique—can facilitate an easy retraction of the ligament via a single longitudinal slit made in the lateral portion of the ligament (a one-sided procedure). Vertically oriented elastic fibers attached to the upper and lower osseous margins permit restoration of the ligament to its original position after the removal of disc fragments. Once the ligament covers the neural and epidural structures, the postsurgical scar tissue

formed over the ligament does not invade the ligament or epidural space. Because the scar tissue could be removed easily, we successfully performed reoperation in the same ligament-sparing manner, without further extension of laminotomy or excision of the ligament.

Because we performed no revision surgery in cases in which epidural fibrosis and scarring developed, the overall reoperation rate (5.4%) is relatively low in this study. A moderate rate of recurrence (4.8%), however, was noted in relation to the current technique. Recurrent herniation has been reported to occur in 3 to 9% of patients after microscopic disc excision, with varying follow-up periods.^{8,10,17,21} In all reoperations performed at the same level, a new herniation was found during surgery. This can be explained by the fact that all patients had undergone magnetic resonance imaging investigation, the diagnostic method of choice in cases in which surgery for a lumbar disc herniation has already been conducted. Another possible explanation is that clear identification of structures with the aid of an operating microscope and the well-preserved ligamentum flavum prevent even a small sequester from being embedded in the epidural scar formation. As reported in other studies,^{9,20} most recurrences in our study occurred within the 1st year after discectomy. The slightly higher incidence of recurrence early after surgery might simply reflect the possibility of missed disc fragments or inadequate decompression. Although the short-term recurrence rate may be balanced out by the low recurrence rate after 6 months, significant efforts should be made to reduce it. Therefore, surgeons should bear in mind that limited exposure to the neurological structures in the present technique can lead to inadequate decompression resulting from the failure to remove all compressive disc fragments.

Most of the potential causes of surgery-related failure are avoided in patients who undergo ligament-sparing microdiscectomy. Our relatively low overall complication rate (1.3%) compares favorably with rates (3–11%) reported in the literature.^{5,9,17,18} The low rate of dural injury and absence of nerve root injury may be related to the protection of these structures with the overlying ligamentum flavum. As a natural barrier, the preserved ligament is also presumed to help reduce the rate of postoperative discitis.

CONCLUSIONS

Ligamentum flavum-sparing microdiscectomy is a safe procedure, with minimal morbidity, a favorable success rate, and an acceptable recurrence rate. Because the procedure-induced peridural scar formation is reduced, reoperation becomes much easier and safer compared with that involving traditional techniques.

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