Surgical Procedures and Clinical Results of Endoscopic Decompression for Lumbar Canal Stenosis

Munehito Yoshida, Akitaka Ueyoshi, Kazuhiro Maio, Masaki Kawai, and Yukihiro Nakagawa

Summary. The purpose of this study was to evaluate the surgical indication and clinical outcomes of endoscopic decompression for lumbar spinal canal stenosis. From September 1998 to March 2002, 250 consecutive patients underwent posterior endoscopic surgery for lumbar radiculopathy. Among these patients, 27 were treated by posterior endoscopic decompression for lumbar canal stenosis. There were 19 men and 8 women, and their average age was 60 ± 12.8 years. The major preoperative symptom was neurologic claudication, sometimes accompanied by sciatica. Clinical outcomes were evaluated by the Japanese Orthopedic Association (JOA) scoring system for lumbar disease (maximum score, 29). Among the 27 patients, the average JOA score was 13.7 ± 3.8 preoperatively, which improved to 26.4 ± 2.8 postoperatively. The average operation time was 56 min for one level, and the average blood loss was 46 ml for one level. There were no interoperative complications. The microendoscopic decompression technique is characterized by a small skin incision, less invasion of paraspinal muscle, and a small dead space. The ipisilateral approach and contralateral endoscopic decompression can be performed under the midline posterior structures the same as microsurgical decompression. This endoscopical decompression minimizes resection of the pathologic compression tissues and affords a safe procedure. The clinical outcome was excellent and patient satisfaction was good in most cases.

Key words. Lumbar canal stenosis, Endoscopic surgery, Microendoscopic discectomy, Surgical procedure, Clinical outcome

Department of Orthopedic Surgery, Wakayama Medical University, 811-1 Kimiidera, Wakayama 641-8510, Japan

Introduction

For the treatment of lumbar canal stenosis, laminectomy and wide fenestration have mainly been performed [1–4]. These two methods rely on detaching the paraspinal muscle tissue attached to the lamina on both sides of the spine. Accordingly, patients suffer atrophy and denervation [5, 6], which contribute to lower back pain postoperatively. Moreover, the resection of the interspinous and supraspinous ligamentum complex causes a decrease in the postoperative stability of the lumbar spine [7, 8] because of the destruction of a large amount of the posterior supporting tissues. Therefore, since 1998 we have aimed to develop a less invasive form of surgery based on the methods of posterior endoscopic surgery, microendoscopic discectomy (MED), as developed by Foley and Smith in 1996 [9]. This method does not involve the removal of paraspinal muscle, and it is possible to operate within only a 16-mm skin incision. MED was usually applied in cases of lumbar disc herniation and had not been applied in cases of lumbar canal stenosis. Based on our experience in performing MED [10, 11], we thought that endoscopic decompression could be applied to lumbar canal stenosis. Using this method, it is possible to address problems on the contralateral side in addition to those on the ipsilateral side. In this study, we describe the techniques for addressing lumbar canal stenosis and the evaluation of the clinical results.

Materials and Methods

From September 1998 to March 2002, 250 consecutive patients underwent posterior endoscopic surgery for lumbar radiculopathy. Among these patients, 27 were treated by posterior endoscopic decompression for lumbar canal stenosis. There were 19 men and 8 women, and their average age was 60 ± 12.8 years. The major preoperative symptoms were neurologic claudication, sometimes accompanied by sciatica. Clinical outcomes were evaluated by the Japanese Orthopedic Association (JOA) scoring system for lumbar disease (maximum score, 29).

Surgical Technique

At first, we used a curved chisel to cut the inferior part of the lamina and the medial side of the inferior facet, because the interlaminar space is very narrow in cases of lumbar canal stenosis. Then we removed the remnants of lamina with Kerrison rongeurs. In the next stage, we cut the ligamentum flavum by use of the sheathed knife blade, transversely, and divided the shallow and deeper layers. Using a ball probe, we dissected the underlying ligamentum flavum and removed the ligamentum flavum piece by piece with the Kerrison rongeur.

It was extended from cephalad until the insertion of the ligamentum flavum was reached. We proceeded in the same fashion on the ipsilateral caudal lamina. On reaching the dural tube and nerve root, we retracted the nerve with the Penfield retractor and the nerve root medially. By using a curved chisel, we removed an additional medial facet. We continued to use the pituitary rongeur to remove a small chip of shaved lamina. Also, to stop unexpected bleeding, we used a bipolar coagulator. In executing the surgical procedure in this fashion, we successfully completed the ipsilateral decompression (Figs. 1, 2).

Next, we addressed contralateral decompression. We moved the tubular retractor to the medial side through and beneath the interspinous ligament (Fig. 3). Then, we removed the ligamentum flavum and medial facet by using the Kerrison rongeur from the contralateral side and exposed the dural tube and contralateral nerve root (Fig. 4).

It should be noted that this technique does not damage the contralateral paraspinal muscle tissue. As an added safety advantage, the Kerrison rongeur was always oriented away from the nerve root during the decompression procedure on the contralateral side (Fig. 3).

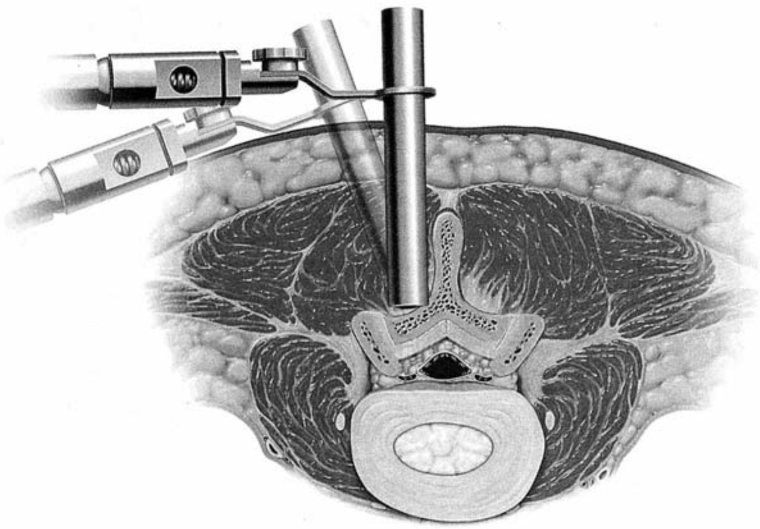

Fig. 1. Initial approach phase of unilateral endoscopic hemilaminotomy and medial facetectomy for bilateral decompression of lumbar canal stenosis

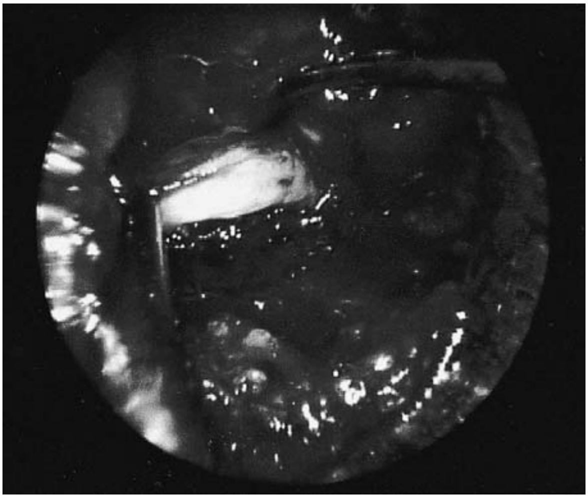

Fig. 2. Intraoperative endoscopic photograph shows satisfactory decompression of ipsilateral nerve root

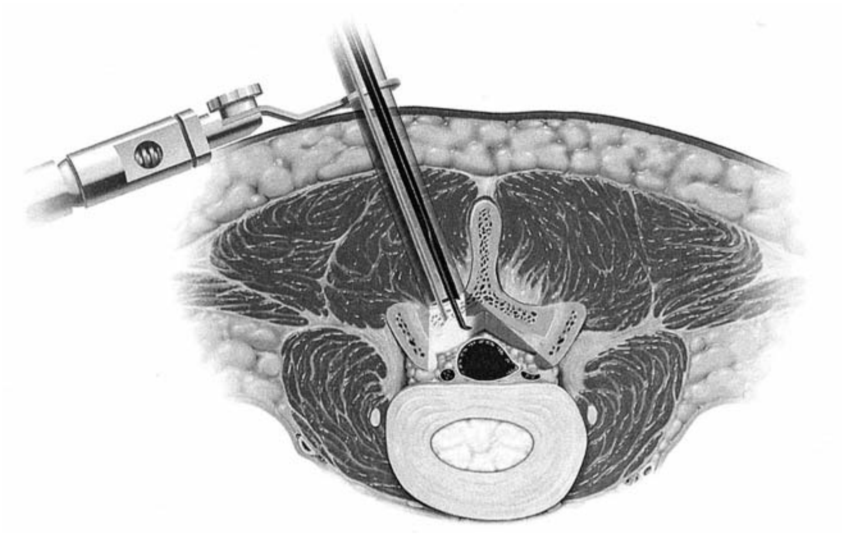

Fig. 3. Contralateral decompression under the midline posterior structures in unilateral laminotomy

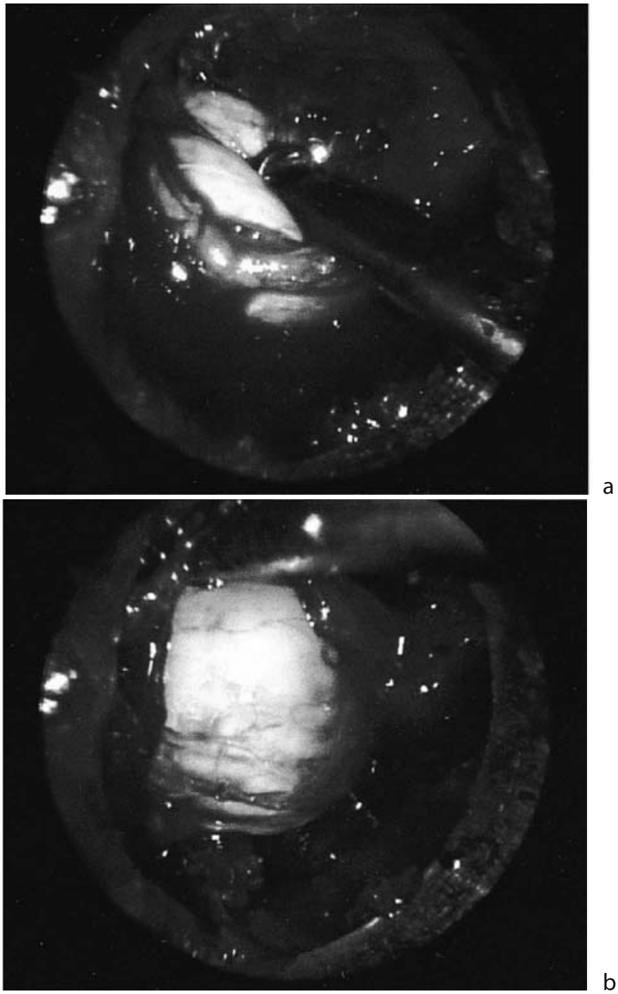

FIG. 4. **a** Intraoperative endoscopic photograph shows satisfactory decompression of contralateral nerve root from ipsilateral laminotomy. **b** Photograph shows that bilateral decompression was performed completely in this procedure

Results

Among the 27 patients, unilateral endoscopic laminotomy was performed in 3 patients and the ipsilateral endoscopic approach for bilateral decompression was performed in 24 patients (Figs. 5, 6). The average JOA score was 13.7 $\pm$ 3.8 preoperatively, which improved to 26.4 $\pm$ 2.8 postoperatively. The average operation time was 56 mins for one level, and the average blood loss was 46 ml for one level. Eighteen patients had one level decompressed, 7 had two levels, and 2 had three levels (Fig. 7). There were no interoperative complications.

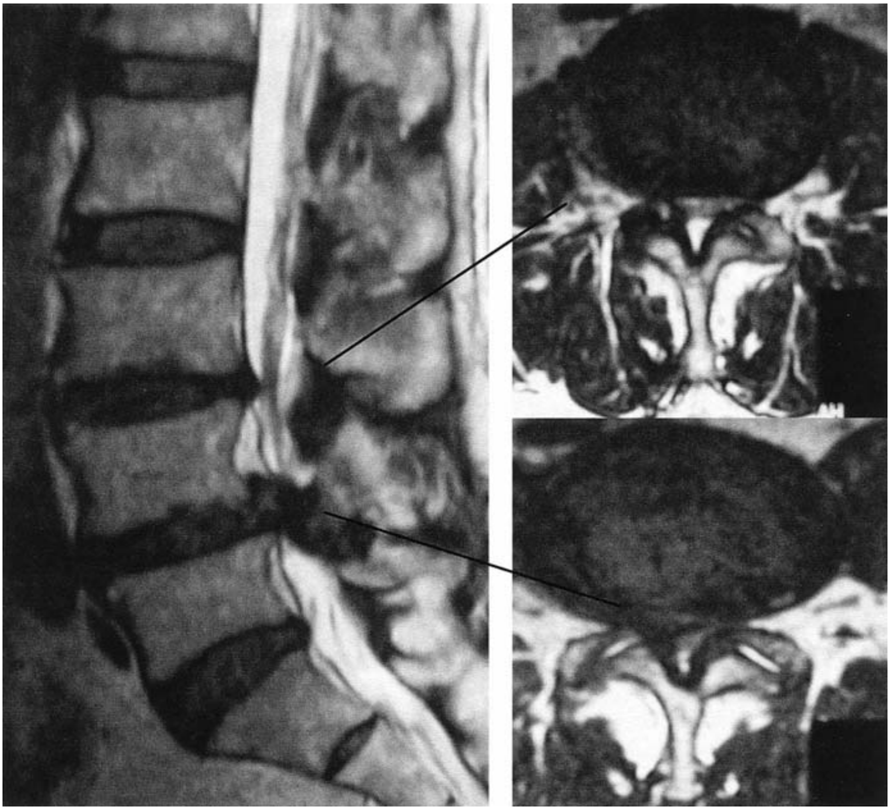

FIG. 5. Magnetic resonance imaging (MRI) of 74-year-old man shows severe lumbar canal stenosis at L3-4, L4-5

Discussion

In cases of degenerative stenosis, the major site of neurological compression is at the level of the interlaminar space. Accordingly, for the treatment of lumbar canal stenosis, wide laminectomy has been used to bring about adequate decompression of the dural tube and nerve roots beneath the lateral recess [1]. However, it was noted that the hypertrophied ligamentum flavum [12] and the medial parts of the superior facet compressed the nerve roots and dural tube at the lateral recess. As a result, wide fenestration has become a standard method of treatment [2]. However, these traditional treatments of lumbar stenosis cause extensive damage to the posterior spinal supporting tissues, such as the paraspinal muscle, the interspinous ligaments, the spinous

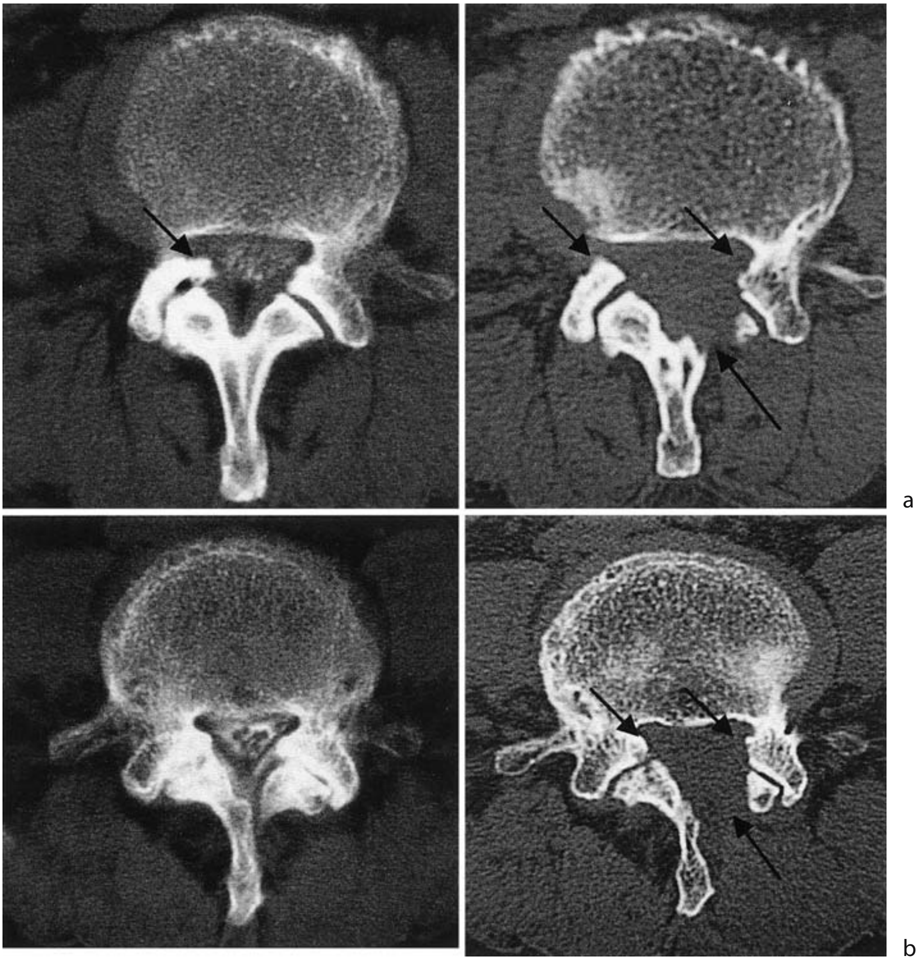

FIG. 6. **a** Preoperative CTM shows severe encroachment of superior facet joint at L3-4, L4-5. **b** Postoperative computed tomography (CT) shows bilateral decompression from ipisilateral laminotomy at L3-4, L4-5

processes, and portions of the facet joints, capsule, and ligamentum flavum. As a result, it is associated with significant postoperative pain, considerable hospitalization, prolonged recovery periods, and undesirable postoperative consequences. See and Kraft [5] described these concerns in their observation of chronic denervation and electromyographic abnormalities of the paraspinal muscles after open surgery. Sihvonen et al. [6] reported that this iatrogenic injury of the paraspinal muscle is correlated with an increased in-

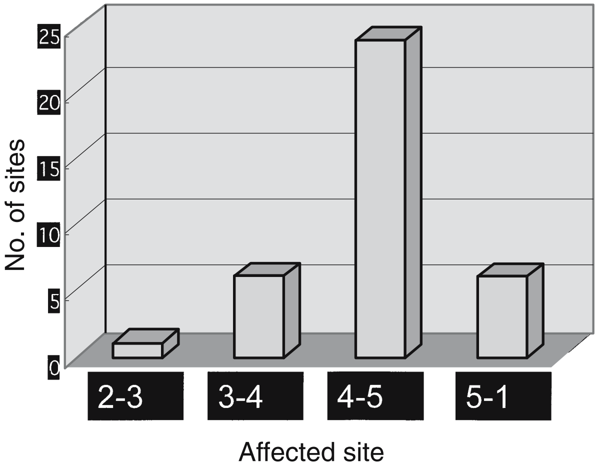

FIG. 7. Distribution of affected sites

cidence of postoperative unstable back syndrome. The loss of the midline supraspinous and infraspinous ligament complex can also lead to an increased risk of delayed spinal instability [7, 8]. In light of these factors, it was reported that microscopic contralateral flavectomy and sublaminoplasty should be applied from an ipsilateral approach, and this method became the favored operative method for bilateral decompression. The clinical results of this unilateral method, as described by McCulloch [13] and by Weiner et al., [14] were shown to be similar to those of the traditional methods, despite the less extensive resection of the posterior bony elements. Recently, endoscopic assisted procedures have been applied for the treatment of pathologic conditions of the spine. In the lumbar posterior approach, the MED system has advantages that conventional methods do not. A small skin incision causes less invasion of paraspinal muscle, and a small dead space characterizes the microendoscopic decompression technique. An ipsilateral approach and contralateral endoscopic decompression can be performed under the midline posterior structures in a similar manner as microsurgical decompression. The first advantage is that this method is less invasive, because the paraspinal muscle is not detached from the lamina. Second, it is possible to gain easier access to the contralateral side from the ipisilateral side than by current microscopic methods. In the endoscopic procedure, approaches can more readily be made by tilting the tubular retractor about 20° to 30° medially. Also, we can address damaged areas that we cannot access by direct vision. By using an endoscope angled at 25°, we can reach previously inaccessible areas. Accordingly, it is possible to resect the hypertrophied ligamentum flavum and the superior facet of the contralateral side. Moreover, we can confirm the compressed nerve root directly under the hypertrophied superior facet, which is not possible by direct vision. In carrying out the maneuver of decompression, we can keep track of the anatomical position and perform the decompression procedure while observing the compressed nerve root on the video monitor during endoscopic surgery. Third, the method has the added advantage that a two-segment approach can be carried out within one skin incision for neighboring segments. Fourth, endoscopic surgery permits a quick return to work, and not as much bed rest is needed compared with the traditional method, which requires 3 to 7 days at a minimum. However, endoscopic surgery for the spine is not without its drawbacks. It is a demanding technique and has a steep learning curve. The field of view through the endoscope is limited, which makes it difficult to appreciate the amount of bony resection that has been performed. However, it is necessary to become accustomed to the two-dimensional view and to acquire eye-hand coordination for endoscopic surgery. Applying this technique for lumbar canal stenosis is not recommended for those in the initial stages of the curve, and it should be applied only after mastering the endoscopic procedure for lumbar disc herniation. Furthermore, it is necessary to make a new, specialized instrument for lumbar canal stenosis. This technique should be indicated initially for lateral recess stenosis, because the interlaminar space is relatively wide. It can also be applied to cases of moderate central canal stenosis. Cases of severe stenosis with multilevel involvement and severely hypertrophied facet joints with congenital stenosis often regime complete laminectomy. Obviously, this technique cannot be applied in this patient population.

Conclusions

This form of endoscopic decompression minimizes resection of the pathologic compression tissues and affords a safe procedure. The clinical outcome was excellent and patient satisfaction was good in most cases.

References

1. Iguchi T, Kurihara A, Nakayama J, et al (2000) Minimum 10-year outcome of decompressive laminectomy for degenerative lumbar spinal stenosis. Spine 25:1754–1759
2. Nakai O, Ookawa A, Yamamura IF (1991) Long-term roentgenographic and functional changes in patients who were treated with wide fenestration for central lumbar stenosis. J Bone Joint Surg 73A:1184–1191
3. Postacchini F (1999) Surgical management of lumbar spinal stenosis. Spine 24:1043–1047
4. Aryanpur J, Ducker T (1990) Multilevel lumbar laminotomies: an alternative to laminectomy in the treatment of lumbar stenosis. Neurosurgery 26:429–433

5. See DH, Kraft GH (1975) Electromyography in paraspinal muscles following surgery for root compression. Arch Phys Med Rehabil 56:80–83
6. Sihvonen T, Herno A, Paljarva L, et al (1993) Local denervation atrophy of paraspinal muscles in postoperative failed back syndrome. Spine 18:575–581
7. Tuite GF, Stern JD, Doran SE, et al (1994) Outcome after laminectomy for lumbar spinal stenosis. Part I. Clinical correlations. J Neurosurg 81:699–706
8. Johnsson KE, Redlund-Johnell I, Uden A (1989) Preoperative and postoperative instability in lumbar spinal stenosis. Spine 14:591–593
9. Foley KT, Smith MM (1997) Microendoscopic discectomy. Techniques Neurosurg 3:301–307
10. Yoshida M, Katoh K, Sumiya H, et al (2001) Clinical evaluation of microendoscopic discectomy for lumbar disc herniation: comparison of MED and Love (in Japanese). Clin Orthop Surg 36:497–502
11. Yoshida M, Sumiya H, Iwasaki K, et al (2001) Initial clinical outcomes of microendoscopic discectomy for lumbar disc herniation. Spine Spinal Cord 14:381–388
12. Yoshida M, Shima K, Taniguchi Y, et al (1992) Hypertrophied ligamentum flavum in lumbar spinal canal stenosis. Pathogenesis and morphologic and immunohistochemical observation. Spine 17:1353–1360
13. McCulloch JA (1998) Microsurgery for lumbar spinal canal stenosis. Essentials of spinal microsurgery. Lippincott-Raven, New York, pp. 475–480
14. Weiner BK, Walker M, Brower R, et al (1999) Microsurgery for lumbar spinal canal stenosis. Spine 24:2268–2272