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Microendoscopic Discectomy for Lumbar Disc Herniation

Surgical Technique and Outcome in 873 Consecutive Cases

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Study Design. A retrospective review involving 873 consecutive cases of lumbar disc herniation treated by microendoscopic discectomy (MED) was conducted and a mean 28-month follow-up was performed.

Objective. The purpose of this study was to describe the MED technique for lumbar disc herniation and report long-time outcome and complications.

Summary of Background Data. The conception of MED was introduced in 1997. Long-time outcome has not been described.

Method. A total of 873 consecutive patients with lumbar disc herniation were treated with the METRx system. Oswestry Disability Index (ODI) was used to quantify pain relief. The degree of pain and disability was also measured by visual analog scale (VAS) and modified MacNab criteria. A control group of 358 patients treated with standard open discectomy was used for comparison.

Results. There was significant improvement in the mean preoperative and postoperative VAS and ODI score for the MED and open groups, and there was no statistical difference of the pain improvement between the two groups. For the MED group, average length of hospital stay was 4.8 days; mean time to return to work or normal activities was 15 days; average operative blood loss per level was 44 mL. These were significantly less than open group.

Conclusions. MED is an effective microendoscopic system with fine long-term outcome in treating lumbar disc herniation. The endoscopic approach allows smaller incisions and less tissue trauma, compared with standard open microdiscectomy. Strict adherence to well-defined preoperative selection criteria could ensure optimal postoperative outcome.

Key words: discectomy, microendoscope, lumbar disc herniation, outcome. **Spine 2006;31:2689–2694**

Back and leg pain is mainly caused by a herniated lumbar disc. If such pain does not respond to conservative therapy, it may be treated surgically. In certain cases, surgical goals may be met by operating through a microendoscope. This paper discusses microendoscopic surgical treatment of lumbar disc herniation, known as microendoscopic discectomy (MED), with particular focus on the technique and the results of 873 cases.

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In 1934, Mixter and Barr,[1] first explained the traumatic or degenerative origin of disc herniation and its association with lumbago or sciatica. The initial complete laminectomy and transdural approach to herniated disc rapidly evolved into a hemilaminectomy, an extradural procedure.

Because of the greater trauma of open surgery, minimally invasive spine surgeries were introduced and some new instruments were developed. Forst and Hausmann[2] first reported the insertion of a modified arthroscope into the intervertebral disc space for direct visualization of the disc space in 1983. Kambin and other authors reported about 87% successful outcome rate with arthroscopic microdiscectomy.[3–6]

In 1997, Smith and Foley introduced the MED system, which allowed spinal surgeons to decompress a symptomatic lumbar nerve root reliably using an endoscopic, minimally invasive surgical approach.[7,8] In 1998, Smith and Foley presented results for their first 100 patients.[9] However, most surgeons are more familiar with microscopic approaches than with endoscopic approaches. The second-generation MED system was developed in 1999, called the METRx (Medtronic Sofamor Danek, Inc., Memphis, TN). A series of dilators were introduced to allow the use of not only endoscopic techniques, but also standard microscopic ones. Unlike percutaneous approaches, the METRx system allows surgeons to address not only contained lumbar disc herniations but also sequestered disc fragments and lateral recess stenosis. In Schick's intraoperative EMG study,[10] results showed that the endoscopic technique was superior to the open surgical technique and produced less irritation of the nerve root.

Materials and Methods

From February 2000 to December 2003, 873 consecutive patients with lumbar disc herniation were treated with METRx system, with a mean age of 41.5 years. Mean length of symptoms was 5.3 months; 43 patients with recurrent lumbar disc herniation, including 24 cases after chemonucleolysis and 19 after open discectomy, were also treated with MED. Levels operated on included L3–L4 (n = 15), L4–L5 (n = 417), and L5–S1 (n = 498). Among them, there were 57 patients with two-level herniated lumbar discs of both L4–L5 and L5–S1. Patient characteristics are listed in Table 1.

All patients were carefully selected and evaluated by several attendings. All the procedures were performed by or under the direct supervision of the senior author (X.W.). The inclusion criteria for patients in this study were: 1) clear clinical signs for nerve root irritation, with/without low back pain, 2) neurogenic claudication as defined by herniated disc limiting ambulation and/or standing tolerance, 3) a history of exercise intol-

Table 1. Clinical Characteristics of the Patients in the MED and Open Groups

	MED	Open	Statistics
No. of cases	873	358	
Sex (M/F)	535/338	230/128	NS
Mean age (yr)	41.5	43.8	NS
Length of symptoms (mo)	5.3	4.8	NS
Disc level			NS
L3–L4	15	8	
L4–L5	417	162	
L5–S1	498	215	
Location of herniation			NS
Central	162	73	
Paramedian	710	281	
Far lateral	58	31	
Mean follow-up (mo)	28	31	NS

NS = not significant.

erance, 4) a 6-week minimum of unsuccessful conservative treatment, and 5) initially acute attacking with severe symptom and prolapsed disc, supported by magnetic resonance imaging and computed tomography. The MED procedure was also performed on patients with poor outcomes after chemonucleolysis with collagenase. The exclusion criteria contained 1) disc protrusion without radiculopathy, chronic discogenic pain, 2) pyogenic discitis or other infections, 3) disc herniation associated with spondylolisthesis, and 4) widely lumbar stenosis.

The control group consisted of 358 patients with herniated lumbar disc disease treated *via* standard open posterior lumbar discectomy during the same period. These surgeries were performed at the same institution and by the same surgeon. The control group of open-surgery patients had a very similar clinical profile, with a mean age of 43.8 years (230 men and 128 women), and 27 with two-level herniated lumbar disc. The inclusion and exclusion criteria were similar with the MED group (Table 1).

Evaluation. Follow-up data were obtained from clinic follow-up visits, physical and occupational therapy records, and telephone interviews. Clinic records were reviewed to document their surgical results. Clinical outcomes were evaluated by several methods. The Oswestry Disability Index (ODI), version 2.0, was used both before surgery and after surgery to give surgeon information about how the patient's leg (or back) trouble has affected his/her ability to manage in everyday life. The sex question (Section 8) is unacceptable in our culture, and most patients are reluctant to answer this section; therefore, it was omitted in this study. So the total possible score is 45. The final score is calculated and presented as a percentage, which equals total score for all sections completed/total possible score: 0% represents no pain and disability and 100% represents the worst possible pain and disability.[11,12] The degree of pain and disability was also measured by visual analog scale (VAS) (range 0–100) and modified MacNab criteria.[13]

MED Technique. Second-generation METRx endoscopic instrumentation (Medtronic Sofamor Danek, Inc.) was used. It consists of a guidewire, a series of sequential dilators, a tubular retractor system (Figure 1), a rigid endoscope with other endoscopic assembly (Figure 2), and a standard video monitor system (Figure 3).

The common patient position was prone, with the abdomen free in order to reduce intraoperative venous bleeding. MED

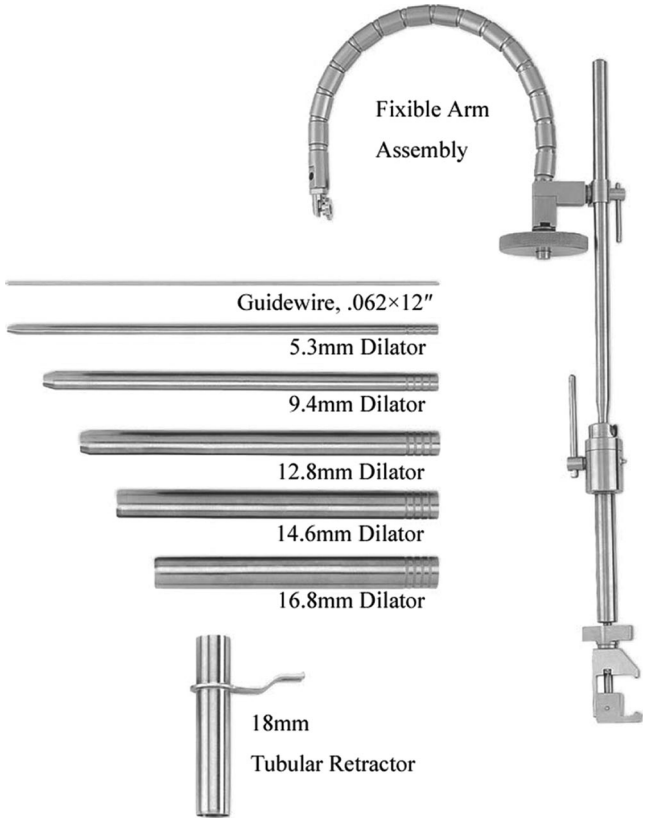

Figure 1. MED system of guidewire, series of sequential dilators, tubular retractor, and flexible assembly.

could be performed under relatively light epidural anesthesia. It could avoid the side effect of general anesthesia, and the patient was able to respond to the nerve root irritation as well. General anesthesia was merely used in some anxious patients. Intravenous injection of 1g cefazolin or ceftriaxone was used as a precautionary antibiotic after epidural anesthesia had performed.

The operative surgeon generally stood to the left of the patient and the assistant to the right. The video tower was placed to the top of the operating table, assuring that not only the operative surgeon, but also the assistant could view the MED procedure comfortably (Figure 4).

A guidewire was inserted and directed toward inferior aspect of the superior lamina and facet junction under lateral C-arm fluoroscopic guidance. After the set of serial dilators were inserted through a 16-mm longitudinal incision, the tu-

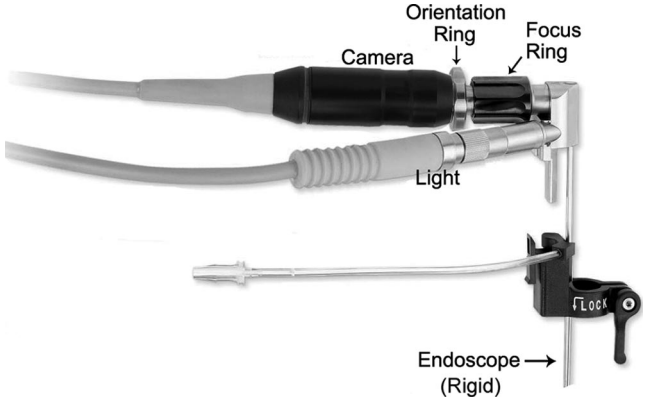

Figure 2. MED system of endoscopic assembly.

Figure 3. Standard video monitor system used for MED procedure.

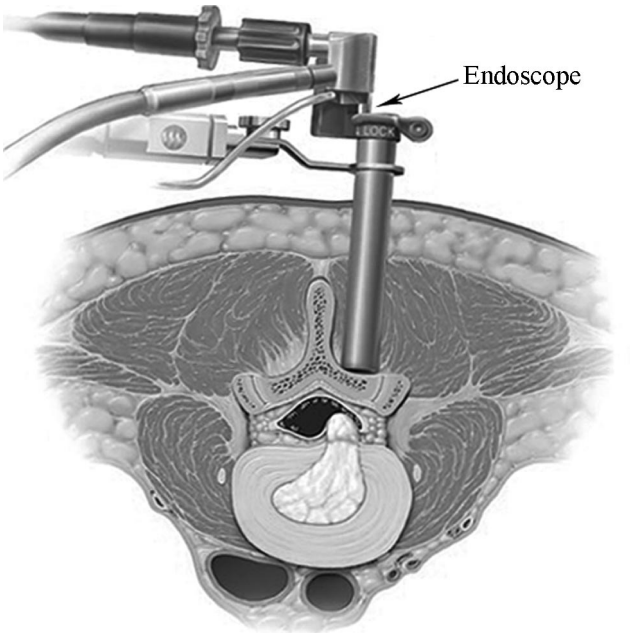

Figure 5. The tubular retractor in place, held by the flexible arm. The rigid endoscope was then inserted into the tubular retractor.

bular retractor was passed over the final dilator. The rigid endoscope was then inserted into the tubular retractor (Figure 5).

High-quality image could be achieved by adjusting the black ring on the endoscope. Since the video tower was placed to the top of the operating table, the endoscopic orientation was adjusted by turning the gold ring on the endoscope so that the superior lamina was at 12 o'clock and the medial anatomy is at 3 o'clock or 9 o'clock according to the herniated disc (Figure 6A). Then, flavectomy, laminotomy, nerve root retraction (Figure 6B), and discectomy were performed as in the open technique.[7,8,14]

Finally, the intervertebral space was irrigated with saline solution with higher pressure in order to swill out the remaining fragments. The wound was also irrigated to clear away cotton fiber, bone chips, blood clots, and so on. Any bleeding was controlled with bipolar forceps. Sodium hyaluronate was laid on the exposed dura, epidural fat, and nerve root to prevent scar formation. The lumbodorsal fascia was closed with one or two interrupted, absorbable sutures. The subcutaneous tissue was closed with an inverted suture.

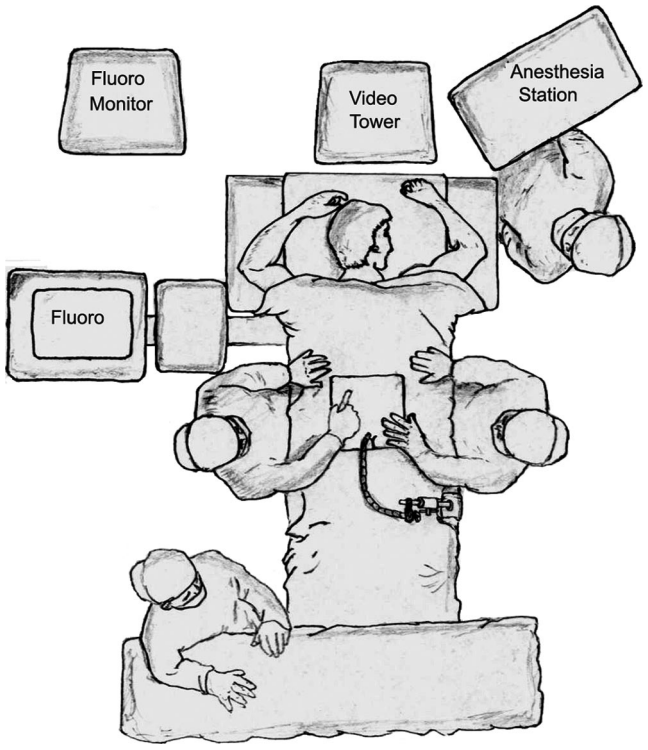

Figure 4. Operating room setup for MED procedure.

■ Results

The average length of hospital stay for the MED group and control group was 4.8 and 7.3 days, including the time of short-term postoperative rehabilitation. The mean time to return to work or normal activities was 15 days for the MED group and 21 days for the control group ($P < 0.05$), except for those who still had leg or low back pain. The mean operative time for every level of MED procedure was 56 minutes, which was slightly shorter than the 66-minute mean operative time for the open control group ($P > 0.1$). The average operative blood loss per level operated on was 44 mL for the MED group and 135 mL for the control group ($P < 0.001$). No patients in the MED group required intraoperative or postoperative blood transfusions; however, 4 patients in the control group received 1 U packed red blood cells each. A total of 157 (18%) MED patients and 132 (37%) control patients used analgesic medications mainly because of incision pain during the first one or two postoperative hospital stays (Table 2).

With a mean follow-up of 28 months for the MED group and 31 months for the control group, 821 MED patients (94%) and 350 control patients (98%) were inter-

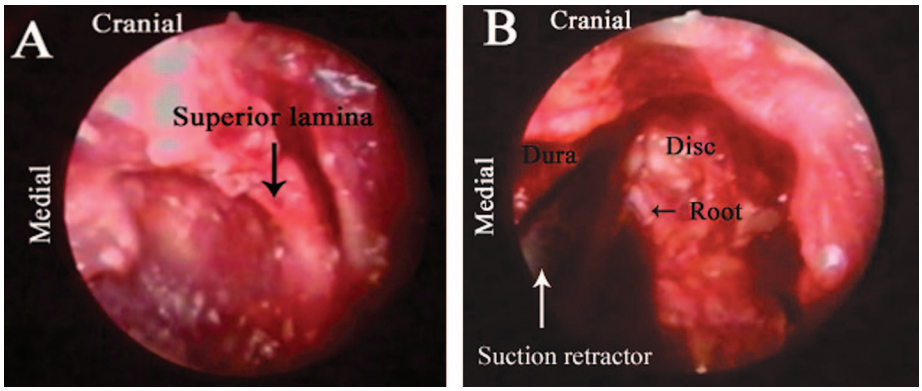

Figure 6. (**A**) Superior lamina was at 12 o'clock. (**B**) Nerve root was retracted medially by suction retractor to expose herniated disc.

viewed at that time. For the MED patients, sciatica had totally disappeared or markedly diminished in 649 (79%) patients. In 16 (2%) patients, sciatica had remained unchanged and become worse in 25 (3%) patients. Concurrently, low back pain recovered completely in 624 (76%) patients and markedly diminished in 112 (14%) patients. However, 57 (7%) patients still had leg and low back pain. For the control patients, 72% reported complete or obvious resolution of sciatica, 4% remained unchanged, and 5% became worse. As to low back pain, 69% of the control patients recovered completely, 9% markedly diminished, and 8% remained unchanged.

Evaluated by the VAS, the pain relief during the follow-up was statistically significant. For the MED group, the mean values of the preoperative and postoperative VAS for all 821 patients was 78 ± 20 and 23 ± 19, respectively ($P < 0.005$). The postoperative VAS for patients having returned to work was 19 ± 12, and 74 ± 18 for patients having lost their ability to work. For the control group, the change of VAS was also statistically significant (Table 3).

There was significant improvement in the mean preoperative and postoperative Oswestry score for the MED and open groups of patients. The mean postoperative ODI of all 821 MED patients was 23% ± 16%, compared with 48% ± 23% before surgery (Table 3). The mean ODI for the patients having returned to work was 13% ± 12%, as compared with a significantly higher index 43% ± 25% for those having lost their ability to work. The mean postoperative ODI of open group was 21% ± 18%, compared with 52% ± 26% before surgery. The mean ODI for the patients having returned to work was 16% ± 12%, as compared with a significantly higher index 48% ± 24% for those having lost their ability to work. There was no statistical difference of the pain improvement measured with a visual analog scale, ODI between the two groups.

Table 2. Comparisons of Perioperative Parameters Between MED and Open Groups

	MED (N = 873)	Open (N = 358)	*P*
Hospital stay (days)	4.8	7.3	<0.05
Blood loss (mL)	44	135	<0.001
Mean time to return to work (days)	15	21	<0.05
Operative time (min)	56	66	>0.1
The use of analgesic	157	132	<0.005
Complications	35	19	>0.05

According to the modified MacNab criteria, 74% of the MED patients had excellent outcomes, 19% good, 3% fair, and 4% poor. For the control patients, 70% had excellent outcomes, 20% good, 5% fair, and 5% poor. If the excellent and good categories were regarded as "success" and fair and poor as "failures," the total success rate of the MED group and open group was 93% and 90%, respectively. There was no difference between the two groups ($P > 0.05$). Those with "successful" result had significant higher ODI and VAS than those with "failed" result (Table 4).

There were 35 (4.0%) cases of significant medical complications in the MED group and 19 (5.3%) cases of such complications in the control group. There were 3 acute hematomas of the sacrospinalis in MED group and 3 in the open group. There were 14 cases of dural tears in MED group and 8 cases in the open group. Two MED patients had acute gastritis. There were 7 cases in the MED group and 3 in the open group with acute urinary retention. Four MED patients and 2 open patients had superficial wound infection. There were 5 cases in the MED group and 3 in the open group with discitis.

During the follow-up period, 20 (2.4%) MED patients required reoperation. 6 patients returned with recurrent herniated discs, which were treated with a repeat MED procedure. In addition, 2 patients were operated on for a disc herniation at another level. Ten patients were performed intervertebral fusion for segmental instability or displacement. Open surgery and intervertebral fusion were also required to 2 patients with lumbar stenosis involving several segments after MED procedure. The mean duration between the original operation and reoperation was 1.5 years (range, 5 months to 3 years).

In the initial 10 months after MED was introduced to our department, the operative time of early groups of 220 cases for every disc was 75 ± 26 minutes, whereas in late groups (653 cases) the operative time was 49 ± 21 minutes. The mean blood loss of early groups was 72 ±

Table 3. Preoperative and Follow-up Assessment

	MED			Open		
	Preoperative	Postoperative	*P*	Preoperative	Postoperative	*P*
VAS	78	23	<0.005	72	26	<0.005
ODI (%)	48	23	<0.005	52	21	<0.005

34 mL, compared with the mean blood loss of late groups of 35 ± 18 mL. There were 15 complications in early groups, including 8 dural tears, 2 acute hematomas of the sacrospinalis, 2 acute urinary retentions, 1 superficial wound infections and 2 discitis. Twenty complications were found in late groups, including 6 dural tears, 1 acute hematoma of the sacrospinalis muscle, 2 acute gastritis, 5 acute urinary retention, 3 superficial wound infection, and 3 discitis. Postoperative mean VAS was 25 ± 19 for early the groups and 22 ± 17 for the late groups ($P > 0.05$). Postoperative mean ODI was 26% ± 18% for the early groups and 22% ± 15% for the late groups ($P > 0.05$) (Table 5).

■ Discussion

MED combines standard lumbar microsurgical techniques with endoscope, enabling surgeons to successfully address free-fragment disc pathologic factors and lateral recess stenosis. The endoscopic approach allows smaller incisions and less tissue trauma, compared with standard open microdiscectomy. Because the MED procedure causes significantly less iatrogenic injury to the paraspinal musculature, it may potentially provide additional long-term benefits over more aggressive open procedures.

Open discectomy was once regarded as the "gold standard" treatment of herniation. However, it destroys the rear structure of spine, causing segmental instability and long-term distress. Discectomy performed *via* MED system is an endoscopic microdiscectomy, which produces less tissue trauma than a microdiscectomy and certainly much less than a standard open discectomy. In the Schick *et al* intraoperative EMG study,[10] 15 patients with lumbar disc herniations were treated *via* an endoscopic medial approach and 15 patients *via* the open microscopic surgical technique. Results indicated that the endoscopic technique was superior to the open surgical technique and produced less irritation of the nerve root. Significantly less mechanically elicited activity was recorded during both the approach and the root mobilization. The study showed that MED allows a smaller incision and less tissue trauma with comparable visualization of the nerve structures than does open surgery. The MED system causes less mechanically elicited EMG activity as a marker for nerve root irritation. Muramatsu *et al*[15] reported on their series of 70 patients who underwent MED and 15 patients for whom Love's method was used to treat lumbar disc disease. A significant difference in mean operative blood losses for the two groups was observed. There was a significant difference in the mean number of days before the patients became ambulatory. Meanwhile, patients in the MED group required less postoperative analgesia than the open group during their stay.[16]

Since 1997, introduced by Smith and Foley,[7,8] the MED system has been used in treating lumbar herniated discs successfully for the past 9 years. However, considerable experience is required to adequately decompress the neural structures. MED techniques involve a learning curve that must be diligently overcome. The field of view through the endoscope is limited, making it difficult to expose and decompress the nerve root. The two-dimensional view and hand-eye spatial separation of the endoscopic view can also be extremely disorienting, compared with the open surgery. Ensuring satisfactory excision of disc and canal decompression while keeping the integrity of the facet complex and neural elements will obviously require additional training and experience. First, the surgeon should have considerable experience of no less than 100 cases of open discectomy. Access to a training facility and/or laboratory that allows the use of cadaveric and animal microendoscopic surgery is important for the safe application of the MED technique.

Besides varying experience of the surgeons who perform this procedure, different selection criteria of patients to be treated *via* MED can severely influence the outcomes. Muramatsu *et al*[15] did not use MED to treat patients with herniation associated with segmental instability and low back pain, patients with combined lumbar canal stenosis and herniation, or patients who had previously undergone back surgery. Other surgeons do not use MED to treat recurrent disc herniation. The optimal

Table 4. Comparisons of Postoperative VAS and ODI Based on Patients' MacNab Classification

	MED			Open		
	Success (N = 764)	Failure (N = 57)	*P*	Success (N = 315)	Failure (N = 35)	*P*
VAS	20	69	<0.005	22	75	<0.005
ODI (%)	11	41	<0.005	15	49	<0.005

Table 5. Comparisons Data for Early and Late MED Groups

	Early Groups (N = 220)	Late Groups (N = 653)	*P*
Operative time (min)	75	49	<0.01
Blood loss (mL)	72	35	<0.01
VAS	25	22	>0.05
ODI (%)	26	22	>0.05
Total complications	15	20	<0.05

indication of MED is single-level radiculopathy secondary to lumbar disc herniation.[17] In our initial period, the inclusion criteria was so wide that 2 patients with lumbar stenosis involving several segments were treated with the MED procedure, which proved to be unsuitable. As a result, open surgeries were required after 5 months and 6 months, respectively. Aged patients complicating segmental instability are not the optimal indication for the MED procedure. Clinical signs and symptoms of segmental instability of the lumbar spine were detected in 10 patients before MED. Eight of them were reoperated and performed intervertebral fusion after a mean postoperative follow-up of 1 year (range, 7 months to 2 years). Consequently, strict adherence to well-defined preoperative selection criteria is so important that it could ensure optimal postoperative outcomes.

As the series progressed, the operative time and bleeding decreased. Complications of late groups were significantly less than that of early groups, especially as dural tears were concerned. There was clearly a full-scale improvement in knowledge and skill of not only the surgeon, but also the assistant. Other variables that influence the learning curve were familiarity with instruments, apprehension of the three-dimensional and mastery of anatomic structure. To master the MED procedure, the surgeon must be willing to spend a significant amount of time and effort in education and training.

Except for considerable experience, one of the reasons why some surgeons are unwilling to perform MED procedure is that they worry about the results of MED. They think it is difficult to perform decompression completely because the surgical field is restricted to a diameter of 18 mm and the working space is limited. Actually, in order to achieve thorough decompression, the working channel can be swung and repositioned. Since lumbodorsal fascia and lumbar skin are relatively less movable or stretchable, the bilateral microendoscopic approach should be performed when central herniation or lateral herniation associated with contralateral recess stenosis was involved. In our early stage, unilateral approach was performed to manage the contralateral recess stenosis with swinging the endoscope laterally. It proved to be difficult to achieve optimal location because of the restriction of lumbodorsal fascia and skin. Subsequently, bilateral approach was used.

It is relatively difficult to detect free fragments endoscopically, especially the smaller and sequestered ones. The bigger free fragments could be found out by reviewing MRI and CT before surgery. Generally, free fragments herniate downward and compress the inferior nerve root. In this study, there were 4 cases with free fragments herniating upward and compressing superior nerve root. Exploration underlying the posterior longitudinal ligament and dural sac was necessary to find out whether there were free fragments. Sometime small fragments herniate into lateral recess, which could be detected with a boll-tip probe.

Although the hospital stays were 1 to 2 days after the MED procedure as described in some articles,[7,13,18] the average length of hospital stays was 4.8 days in our medical system as presented above. There is hardly any special rehabilitation center in our community, and most domestic rehabilitation condition is poor. So patients are instructed to rehabilitate in the same department by one special physician after the MED procedure or open discectomy. This results in the increase of hospital stays.

■ Key Points

- MED is a safe and successful endoscopic system with fine outcome in treating lumbar disc herniation.
- Strict selection criteria could ensure optimal long-term outcome.
- This new technique require additional training and considerable experience.

References

1. Mixter WJ, Barr JS. Rupture of intervertebral disc with involvement of the spinal canal. *N Engl J Med* 1934;211:210–5.
2. Forst R, Hausmann G. Nucleoscopy: a new examination technique. *Arch Orthop Trauma Surg* 1983;101:219–21.
3. Kambin P. Arthroscopic microdiskectomy. *Mt Sinai J Med* 1991;58:159–64.
4. Kambin P. Arthroscopic microdiscectomy of the lumbar spine. *Clin Sports Med* 1993;12:143–50.
5. Savitz MH. Same-day microsurgical arthroscopic lateral-approach laser-assisted (SMALL) fluoroscopic discectomy. *J Neurosurg* 1994;80:1039–45.
6. Hermantin FU, Peters T, Quartararo L, et al. A prospective, randomized study comparing the results of open discectomy with those of video-assisted arthroscopic microdiscectomy. *J Bone Joint Surg Am* 1999;81:958–65.
7. Foley KT, Smith MM. Microendoscopic discectomy. *Tech Neurosurg* 1997; 3:301–7.
8. Perez-Cruet MJ, Smith M, Foley K. Microendoscopic lumbar discectomy. In: Perez-Cruet MJ, Fessler RG, eds. *Outpatient Spinal Surgery*. St. Louis: Quality Medical, 2002:171–83.
9. Smith MW, Foley KT. Microendoscopic discectomy: the first 100 cases. *Annual Meeting of the Congress of Neurological Surgeons*, Seattle, October 1998.
10. Schick U, Döhnert J, Richter A, et al. Microendoscopic lumbar discectomy versus open surgery: an intraoperative EMG study. *Eur Spine J* 2002;11: 20–6.
11. Fairbank J, Couper J, Davies J, et al. The Oswestry low back pain questionnaire. *Physiotherapy* 1980;66:271–3.
12. Fairbank J, Pynsent P. The Oswestry Disability Index. *Spine* 2000;25:2940–53.
13. MacNab I. Negative disc exploration. *J Bone Joint Surg Am* 1971;53:891–903.
14. Perez-Cruet MJ, Foley K, Isaacs R, et al. Microendoscopic lumbar discectomy [technical note]. *Neurosurgery* 2002;51(suppl. 2):129–36.
15. Muramatsu K, Hachiya Y, Morita C. Postoperative magnetic resonance imaging of lumbar disc herniation: comparison of microendoscopic discectomy and Love's method. *Spine* 2001;26:1599–1605.
16. Schizas C, Tsiridis E, Saksena J. Microendoscopic discectomy compared with standard microsurgical discectomy for treatment for uncontained or large contained disc herniations. *Neurosurgery* 2005;57(suppl 3):357–60.
17. Foley K, Smith M. Microendoscopic discectomy (MED): surgery technique and clinical results. *North American Spine Society 12th Annual Meeting*, New York, October 1997.
18. Brayda-Bruno M, Cinnella P. Posterior endoscopic discectomy (and other procedures). *Eur Spine J* 2000;9(suppl 1):24–9.