Microendoscopic Discectomy (MED) For Surgical Management Of Lumbar Disc Disease: Technical Note
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Citation

Abstract
Many kinds of minimally invasive procedures for spine pathology have been developed over the years. Microendoscopic discectomy (MED) is one of the minimally invasive procedures for lumbar disc surgery. This method is characterized by using a tubular retractor system and unique visualization through the oblique lens of an endoscope. The tubular retractor system allows reduced tissue or muscle trauma, and the oblique endoscope can provide a clear and wide visualization of the operative field beyond the confines of the tubular retractor. However, there is a steep learning curve associated with using the endoscopic operation system efficiently and safety. In this technical note, we describe how to manage the MED system for lumbar disc surgery, and present the clinical results in 402 cases of MED. Furthermore, we discuss the indication for MED and its learning curve based on our experiences.

INTRODUCTION
Percutaneous lumbar nucleotomy as a minimally invasive procedure for lumbar disc herniation was firstly reported in 1975. Afterwards, percutaneous lumbar disc surgery evolved including percutaneous nucleotomy using automated disc removal devices, spinal endoscopy, and the laser. These procedures used posterolateral or paraforaminal approach, and the indications for these procedures have been limited to contained lumbar disc herniations. Furthermore, they have not proven to be as effective as standard open lumbar discectomy, because of longer operation times and some technical problems in addressing all the different aspects of lumbar disc disease.

On the other hand, microendoscopic discectomy (MED), one of the minimally invasive spine surgery systems for lumbar disc herniation, was introduced by Smith and Foley in 1997. This MED system is characterized by a tubular retractor system and oblique endoscope lens. A muscle dilating posterior approach reduces the approach site comorbidity and the angled endoscope may yield visualization beyond the confines of the tubular retractor. However, there is a steep learning curve to master this procedure. Actually, many surgeons prefer the METRx-MD system (Medtronic Sofamor Danek, Memphis TN) which allows the surgeons to operate under direct vision through the microscope. However, once this endoscopic technique is mastered, the modularity of the MED system also allows for the development of expanded applications beyond lumbar nerve root decompression.

From 1998, we introduced MED system and applied it not only in several types of lumbar disc surgery, but also decompression surgery of spinal stenosis, cervical radiculopathy and cervical myelopathy. In this article, based on our experiences we describe the surgical technique and clinical results in lumbar disc disease.

METHODS
PATIENTS
A retrospective chart view in patients who underwent posterior MED from September 1998 to December 2003 was conducted. A total of 402 consecutive patients (262 males and 140 females, mean age was 37.9±14.9 years) were included. There were 386 cases of lumbar disc herniations and 16 cases of posterior osseous endoplate lesions.

TECHNICAL NOTE
PATIENT POSITIONING
The patient is positioned prone and abdominal compression is avoided by properly positioning the patient on the frame or rolls to reduce intraoperative venous bleeding. The table should be compatible with fluoroscopy. We also use a knee-chest position with the hips and knees well flexed, which...
maximally reduces the lumbar lordosis and avoids abdominal compression.

**APPROACH SITE IDENTIFICATION**

The symptomatic side determined the surgical approach. In regard to operative equipment, we used METRx-MEDsystem (Medtronic Sofamor Danek, Memphis TN), which begins with a set of serial dilators that are used to sequentially dilate muscle. The operative surgeon generally stood on the side of approach with the video monitors placed opposite him. After fluoroscopic confirmation of a surgical level, marked on the skin by a skin marker, a small stab skin incision was made one finger breadth (10-15mm) lateral to the midline on the approach side, and fasciotomy of lumbosacral fascia was performed.

**DILATOR INSERTION AND TUBULAR RETRACTOR INSERTION**

To avoid inadvertent dural penetration, we routinely did not use a guide wire, but the smallest dilator (5.3mm) on the first step. After inserting a final dilator, we removed the dilators once, and then, put a finger into the aperture to palpate and confirm an anatomic manifestation of the posterior aspects of the surgical field. The dilators were then repositioned. This maneuver not only allows us to identify the bony landmarks of the operative field but also expedites tubular retractor replacement. After that, tubular retractor was docked on an interlaminar space. With respect to the tubular retractor, we preferred 16 mm in diameter because it was more easily placed on the interlaminar space and the wanding procedure was easier.

**ENDOSCOPE INSERTION AND FOCUS AND IMAGE ORIENTATION**

The endoscope can be placed anywhere within the 360-degree periphery of the tubular retractor and retracted or extended for variable magnification. The endoscopic image is oriented to place the medial anatomy on the top of the video monitor (at the 12 o'clock position) and lateral anatomy on the bottom (at the 6 o'clock position). The V-shaped indicator is in the same position on the video screen as the endoscope is within the tubular retractor. Throughout the operation, the position of the endoscope should be moved to the appropriate position to obtain the optimal visualization. Objects of interest should be placed at the center of the screen. We usually placed an endoscope at around the 7-9 o'clock position, and in case for lateral decompression of the nerve root, the endoscope was placed at the 10-12 o'clock position, which allows us to operate from center to lateral trajectory preserving the facet. Right handed surgeon should handle the suction tube by left hand, and other operative instruments by right hand.

**INTERLAMINAR SPACE IDENTIFICATION**

All soft tissue should be removed to maximize the working space within the tubular retractor. Meticulous hemostasis was needed, and provided by the bipolar cautery. After detaching the ligamentum flavum from the lamina using up-going angled curette, the trailing edge of the upper lamina and the medial part of facet was removed by Kerrison punch to enlarge the interlaminar window to secure an adequate working space (Figure 1). To prevent an iatrogenic instability, medial facetectomy should be minimized as much as possible.

**Figure 1**

Figure 1: Enlargement of interlaminar window. To detach the ligamentum flavum from the lamina, an up-going angled curette is used. After that, the trailing edge of lamina and medial facet is removed by Kerrison punch. (Figure 1 to 5 are from Nakagawa Y, Yoshida M. Microendoscopic discectomy (MED) for lumbar disc herniation. In Takaoka K ed. New OS NOW No. 27, Medical View, Tokyo, 2005: 47-54, partially modified.)

**FLAVECTOMY**

The dorsal layers of ligamentum flavum were cut by a microknife perpendicularly to the fibers of the ligament, leaving some ventral layers (Figure 2).
**Figure 2**

Figure 2: Cutting the dorsal surface of ligamentum flavum. The cut edge is dissected back bilaterally by using the tip of sucker, knife and angled curette and removed.

If the dorsal surface of the ligamentum flavum was degenerated and thickened, degenerative tissue should be removed by pituitary ronguer until the elastic ligament tissue appears. The dorsal surface of the ligament was dissected from the cut edge by using a tip of microknife and suction tube, or a curette bilaterally and removed, and then, the ligament of the ventral layer is split gently by a Penfield dissector. The epidural fat tissue appeared after penetrating the ligamentum flavum (Figure 3).

**Figure 3**

Figure 3: Ventral layer of ligamentum flavum is split gently by Penfield dissector. The epidural fat tissue will emerge after penetrating the ligament. Ligamentum flavum is removed by a small Kerrison punch while protecting the neural tissue, and flavectomy should proceed to ensure an adequate exposure.

Ligamentum flavum was removed by small Kerrison punch while protecting the thecal sac, and flavectomy was performed to ensure an adequate exposure.

**NERVE ROOT EXPLORATION, DISCECTOMY AND CLOSURE**

Resection of the ligamentum flavum proceeded from medial to lateral until the nerve root was identified. The nerve root was retracted medially using a Penfield dissector or suction retractor (Figure 4).

**Figure 4**

Figure 4: Nerve root retraction. The nerve root is retracted medially using a Penfield dissector or suction retractor in a standard fashion.

If an annulotomy was necessary, it was accomplished with a microknife while protecting the nerve root with suction retractor. The herniated disc fragment was removed by pituitary ronguer (Figure 5).
This procedure was the same fashion of Love's style \textsuperscript{10}. We took care to avoid putting the pituitary rongeur too deeply into the intradiscal space. After removal of the herniated fragment and nerve root decompression, the disc space was thoroughly irrigated with saline to remove any free fragments. Any bleeding in the epidural space was controlled with bipolar cautery. A suction drain was placed if needed, and the fascia and skin was closed in the standard fashion. The suction drain was taken off after one or two days postoperatively. The techniques mentioned above are also available in a briefly summarized video (Video 1).

Video 1: The patient was 41-year old female, with L5-S1 disc herniation on the right sided. Video starts from the procedure of flavectomy. Top of the screen indicates medial, bottom is lateral (right side), right is cephalad, and left is caudal.

**POSTOPERATIVE CARE**

We routinely permitted patients to ambulate after 5 hours postoperatively. We recommend wearing a commercially available soft corset for 3 weeks after surgery.

**OUTCOME MEASURES**

Clinical outcome was assessed using Japanese Orthopaedic Association scoring system for lumbar disease (JOA score) \textsuperscript{7}, with an average 2-years follow-up after surgery. Perioperative complications, frequency of revision surgery, operation time and blood loss were also investigated.

**RESULTS**

JOA score in lumbar disc herniation patients improved from $13.4 \pm 5.1$ preoperatively to $26.3 \pm 3.1$ postoperatively, and $27.6 \pm 2.2$ at the final follow-up (mean 2 years). With regard to posterior osseous endplate lesion patients, JOA score also recuperated from $16.9 \pm 3.6$ preoperatively to $27.1 \pm 2.3$ postoperatively, and $28.2 \pm 1.6$ at the final follow-up (Figure 6). Mean operation time was 95.3 minutes and mean blood loss was 67.5 ml. There was no case of permanent neural injury, but perioperative complications occurred in 16 cases (4.0%), including 6 dural tears, 3 misjudgements of operative site (wrong level), 4 epidural hematomas, 1 pyogenic spondylitis and 2 transient muscle weaknesses. Revision surgeries were performed in 12 cases (3%) and consisted of 9 recurrence of disc herniations, 2 epidural hematomas and 1 inadequate decompression.

According to the development of operation time of senior author, it seems that the surgical skill had been established after completing 30 cases (Figure 7). Furthermore, operation time and blood loss in the latest 30 cases were significantly less than those of the first 30 cases (Figure 8). These data were previously reported \textsuperscript{10}.

Figure 6: Clinical outcome of posterior microendoscopic discectomy (MED) of lumbar disc herniation and posterior osseous endplate lesion.
Figure 7
Figure 7: Relationship between the number of cases and the operation time

Figure 8
Figure 8: Comparison of operation time and blood loss between first 30 cases and latest 30 cases.

DISCUSSION
MED is an excellent technique which could replace a conventional open procedure if the learning curve could be overcome. Minimally invasive surgery including MED provides manifold benefits such as a small skin incision, reduced postoperative pain, shorter hospital stay, faster mobilization, shorter rehabilitation, reducing pain medication usage and antibiotics, quick recovery to daily life or work, and so on. Moreover, the endoscope allows the surgeon to obtain more wide visualization through the oblique lens, so it can be possible to operate in the field beyond the confines of the tubular retractor. Additionally, the ability to get the endoscope close to the neural tissue pathology provides the surgeon with a clearer view. The 3CCD camera head also contributes to the improvement of image quality, which allows surgeons to facilitate the MED technique to more difficult pathologies. The first generation of the MED system could not provide such a clear image due to its disposable, one-tip camera head. This fact is one of the reasons that many surgeons gave up the MED system, and the MED system has not been widely used. However, the progress of the image quality changed the situation. The versatility of this technique was seen in its ability to treat various lumbar disc pathologies including far lateral disc herniations, concomitant lateral recess stenosis, and noncontained disc herniation. With regard to clinical outcomes, our mid-term results are equivalent to open procedures.

On the other hand, it has been pointed out that the endoscopic procedure has a steep learning curve. Actually, most complications in this series were encountered in the early learning curve period. According to our experiences, surgical skill had been established after 30 cases of MED. MED procedure can be applied to other spine pathology and decompression surgery such as far lateral disc herniation, spinal stenosis, cervical radiculopathy or cervical myelopathy. To achieve safe and effective operation, it is crucial to master the MED technique in the first place and then apply to other pathologies.

CONCLUSIONS
The MED system is a safe and effective method for surgical management of lumbar disc diseases. However, because there is a learning curve, it is advisable to start with herniated free fragments in younger patients, and only later treat older patients with bony and ligamentous pathology associated with disc herniation. The MED procedure will be able to become the new gold standard for lumbar disc surgery in near future.

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