Results of Microendoscopic Discectomy Performed in the 26 Cases with a Minimum 3 Years Follow-up

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Background: Microendoscopic discectomy (MED) is less invasive than conventional open discectomy, but the long-term benefits of this technique are still debated. Controversy also remains regarding the surgical indications, patient selection, effectiveness, learning curve and complications.

Methods: From Dec 2001 to Dec 2003, 26 patients with lumbar herniated disc disease received MED. The surgical indications included the following: (1) unilateral, single level lumbar disc herniation; (2) signs and symptoms compatible with the involved nerve root; (3) failure of conservative treatment. These cases were the initial MEDs performed by one of our senior authors (TS FU). Clinical symptoms and outcomes were assessed using the Japanese Orthopaedic Association Back Scores.

Results: Treatment in two cases was changed to open discectomy because of irreparable dural tears during surgery. For the remaining 24 cases, the average intraoperative blood loss was 55.8 mL. The average operation length was 136.8 minutes and the average post-surgical hospital stay was 2.4 days. At 12 weeks after the operation, 22 achieved excellent or good results. The satisfactory rate was 91.7%. On final follow-up, 21 patients had excellent or good results. The satisfactory rate was 87.5%. Complications included two irreparable dural tears, two superficial wound infections and one pseudomenigocele.

Conclusions: Our data indicate that MED is an effective procedure for lumbar disc herniation. The result is satisfactory under adequate surgical indications and patient selection. Despite the low complication rate, dural tears still remain a concern during the learning stage.

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Key words: disc herniation, minimally invasive spine surgery, microendoscopic discectomy

Minimally invasive spinal surgery has been practiced since 1964.[1,2] During the past 40 years, many kinds of spinal disc surgeries have been developed as minimally invasive procedures, such as per-

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cutaneous chymopapain injection, microscopic discectomy, and percutaneous discectomy. The microendoscopic discectomy (MED) technique was devised by Smith and Foley in 1997.[3] This procedure permits surgeons to perform not only a discectomy but also bone decompression procedures using a minimally invasive endoscopic approach.[3-7] In the MED technique, a series of tubular retractors with consecutively increasing diameters are used. This concept can cause minor muscular trauma characterized by "splitting" instead of "cutting".[5,8-10] Theoretically, with this technique, patients sustain less soft tissue injury and recover sooner than with conventional open discectomy.[9,10]

Although the MED technique has considerable advantages, the literature still documents difficulties and complications.[4,9,11-13] The limited exposure and two-dimensional video display predispose the nerve and other structures to potential injury.[9] Despite improvements in the endoscopic system and surgical technique, controversy remains regarding the effectiveness, learning curve, complications, and benefits to patients of MED.[14]

This study investigated the intraoperative findings and postoperative results in the first 26 MED procedures in our hospital. All patients were followed up for more than three years. The results, intraoperative findings, operative technique, and complications are reviewed.

METHODS

Patient population

Twenty-six consecutive patients who received MED for lumbar disc herniation between December, 2001 and December 2003 were included in this study. None of these patients had undergone any spinal surgery previously. All surgeries were performed by a single surgeon (TS Fu) and these 26 cases were the initial MED surgery experience of Dr Fu. All patients received prophylactic antibiotics perioperatively, and were encouraged to ambulate the day after surgery. The use of a corset for six weeks after surgery was advised.

The indications for surgery were as follows: (1) unilateral, single level lumbar disc herniation visualized on computed tomography and/or magnetic resonance imaging; (2) signs and symptoms consistent with symptomatic involvement of the nerve root exiting the adjacent neural foramen, including radicular leg pain; and (3) failure of a minimum of six weeks of appropriate conservative therapy. Patients with spondylodiscitis, segmental instability, severe neurological deficit, and psychogenic disorders were excluded from this investigation. Various types of herniated disc, including the protrusive, extrusive and sequestered types, were all included.

Operative technique

MED was performed using the METRx system (Medtronic Sofamor Danek, Memphis, TN, U.S.A.) under general anesthesia. The patient was placed prone on a radiolucent frame suitable for fluoroscopy. Placement of the initial K-wire and sequential dilators was confirmed with a lateral fluoroscope. The tip of the dilator was used to sweep the paraspinal musculature off the lamina edge, and the working channel was placed over the final dilator and fixed to the flexible arm. The endoscope was then inserted and adjusted such that the image on the video monitor shared the same orientation as the anatomy. A laminotomy was performed using a curette with an upwards angle and a Kerrison punch. The dura and traversing nerve root were then identified. Subsequently, the nerve root was retracted medially to expose the herniated disc. The herniated disc was then removed with a pituitary rongeur. Following nerve root decompression, the tubular retractor was removed and the fascia and 2-cm incision wound were closed.

Patient evaluation

The outcome analysis was based on direct questioning and examination using the criteria of the JOA evaluation system (the Japanese Orthopaedic Association evaluation system for lower back pain syndrome)[15] (Table 1) before surgery, at 12 weeks following surgery, and on the final follow-up. In this system 29 points represents a normal score. Post-surgery results were assessed based on the rate of improvement, and the recovery rates were calculated as described by Hirabayashi et al.[16]

$$\text{Recovery rate (\%)} = \frac{\text{(Postoperative score – Preoperative score)}}{\text{(29 – Preoperative score)}} \times 100$$

Table 1. The Japanese Orthopaedic Association Evaluation System for Lower Back Pain Syndrome (JOA Score)

Subjective symptoms	Evaluation and score		
Lower back pain	None	3	
	Occasional, mild	2	
	Occasional, severe	1	
	Continuous, severe	0	
Leg pain and/or tingling	None	3	
	Occasional, light	2	
	Occasional, severe	1	
	Continuous, severe	0	
Gait	Normal	3	
	Able to walk farther than 500 m although it results in symptoms*	2	
	Unable to walk farther than 100 m	0	
Clinical signs			
Straight-leg-raising test	Normal	2	
	30-70°	1	
	Less than 30°	0	
Sensory disturbance	None	2	
	Slight disturbance (not subjective)	1	
	Marked disturbance	0	
Motor disturbance	Normal	2	
	Slight weakness (MMT 4)	1	
	Marked weakness (MMT 3 to 0)	0	
Restriction of ADL	Impossible	Difficult	Easy
Turn over while lying	0	1	2
Standing up	0	1	2
Washing face	0	1	2
Leaning forward	0	1	2
Sitting (about 1 h)	0	1	2
Lifting or holding heavy objects	0	1	2
Running	0	1	2
Urinary bladder function	Normal	0	
	Mild dysuria	–3	
	Severe dysuria	–6	

Recovery rate (%) = (Postoperative score - Preoperative score)/(29 - Preoperative score) x 100.

Abbreviations: MMT: manual muscle testing; ADL: activities of daily living; *: Pain, tingling, and/or muscle weakness.

The recovery rates were classified according to a four-grade scale: excellent, more than 90%; good, 75-89%; fair, 50-74%; and poor, less than 49%. The results of patients with excellent or good scores were considered satisfactory and the satisfactory rate was calculated. All medical and surgical data on intraoperative blood loss, length of operation, postsurgical hospital stay, and complications were examined.

Statistical analysis

The data were assessed by SSPS for Windows version 10.0.7c. Because of the limited case numbers ($n < 30$), the comparison between the pre-operative, 12-week postoperative, and final follow–up JOA scores was performed using repeated measures analysis of variance (ANOVA). Statistical significance was set at p value < 0.05.

RESULTS

The treatment of two patients was changed to open discectomy because of irreparable dural tears during surgery. These two cases were excluded. Finally, 24 cases were included for final functional outcome analysis. (Table 2) There were 18 men

Table 2. Patients Who Received Complete MED Surgery from Dec 2001 to Dec 2003 (The patients are listed in chronological order according to date of surgery)

Patient no.	Sex	Age	F/U period	OP time (min)	Blood loss (ml)	HIVD level	Disc type	pre-OP JOA	post-OP 12 wks JOA	Final F/U JOA	Hospital stay (days)	Recovery rate (post-OP 12 wks)	Recovery rate (Final F/U)	Outcome (post-OP)	Outcome (F/U)	Annotation
1	M	41	61	180	100	L5-S1	protrusion	11	29	29	2	100	100	E	E	–
2	M	22	60	160	25	L5-S1	protrusion	15	29	29	2	100	100	E	E	–
3	Fe	42	60	180	30	L4-L5	extrusion	13	28	28	2	93.8	93.8	E	E	
4	M	48	58	187	150	L5-S1	protrusion	13	28	28	3	93.8	93.8	E	E	–
5	Fe	45	57	181	50	L5-S1	extrusion	10	27	27	3	89.5	89.5	G	G	*
6	M	39	55	140	25	L4-L5	sequestered	7	28	28	2	95.4	95.4	E	E	
7	M	25	55	156	25	L5-S1	extrusion	12	29	29	2	100	100	E	E	–
8	M	34	53	145	40	L4-L5	protrusion	13	29	29	3	100	100	E	E	–
9	Fe	41	51	165	100	L5-S1	extrusion	10	21	27	3	57.9	89.5	F	G	–
10	Fe	46	50	145	30	L4-L5	extrusion	7	28	7	2	95.4	0	E	P	†
11	M	31	49	150	25	L5-S1	extrusion	20	22	20	2	22.2	0	P	P	‡
12	M	25	48	134	30	L5-S1	extrusion	19	28	28	2	90	90	E	E	–
13	Fe	51	45	127	30	L4-L5	extrusion	21	28	28	2	87.5	87.5	G	G	
14	M	18	43	120	200	L4-L5	extrusion	20	28	28	2	88.9	88.9	G	G	–
15	Fe	41	42	151	50	L5-S1	extrusion	11	25	24	3	77.8	72.2	G	F	*
16	M	50	42	151	100	L4-L5	protrusion	14	27	27	2	86.7	86. 7	G	G	–
17	M	36	40	153	50	L4-L5	extrusion	11	27	27	3	88.9	88. 9	G	G	–
18	M	25	31	100	25	L4-L5	protrusion	8	28	29	2	95.2	100	E	E	§
19	M	55	38	82	50	L4-L5	protrusion	13	28	28	2	93.8	93.8	E	E	–
20	M	33	37	115	40	L4-L5	extrusion	8	28	29	3	95.2	100	E	E	
21	M	45	37	95	50	L4-L5	sequestered	13	28	27	3	93.8	87.5	E	G	II
22	M	37	37	85	50	L4-L5	extrusion	13	28	28	2	93.8	93.8	E	E	
23	M	29	36	94	40	L4-5	protrusion	13	29	29	3	100	100	E	E	
24	M	36	36	88	25	L4-5	Extrusion	7	28	28	3	95.4	95.4	E	E	
Average		37.3	46.70	136.8	55.8			12.6	27.4	26.7	2.4	89.0	85.1			

Abbreviations: M: male; Fe: female; E: excellent; G: good; F: fair; P: poor; F/U: follow-up. *: superficial infection, treated with oral antibiotics for 1 week; †: recurrent disc herniation about 1 year after MED, treated with open discectomy; ‡: residual pain, treated with selective nerve block which failed, then treated with laminotomy; §: pseudomeningocele formation about 2 months after MED, treated with debridement; II: residual pain, treated with selective nerve block.

(75%) and 6 women (25%), with a mean age of 37.3 years (range, 18 to 55 years). The average follow-up period was 46.7 months (range, 36 to 61 months). The disc herniations were at the L4-5 level in 15 patients and L5-S1 level in 9 patients. There were eight protrusive, 14 extrusive, and two sequestered disc herniations.

The average time of surgery was 136.8 minutes (range, 82 to 187 minutes). The average blood loss during the surgery was 55.8 mL (range, 25 to 200 mL). The average post-surgical hospital day was 2.4 days (range, 2 to 4 days). In the functional outcome analysis, the average preoperative JOA score was 11.0 (range, 7 to 15). Following MED surgery, the average JOA score significantly improved to 27.4 (range, 10 to 29) at 12 weeks after surgery (p = 0.001). The average score decreased to 26.7 (range, 7 to 29) on the final follow up visit, but was still significantly improved when compared to the preoperative score (p = 0.001). There was no significant difference between scores at 12 weeks and at the final-up visit (p = 0.452). The average recovery rates were 89.0% at 12 weeks and 85.1% at the final follow up. According to the JOA score, 16 patients displayed 'excellent' results and 6 had 'good' results at 12 weeks after surgery (Fig. 1). The 12 week satisfactory rate was 91.7%. On final follow-up, 14 patients had 'excellent' results and seven patients had 'good' results. The final follow-up satisfactory rate was 87.5%.

One patient experienced residual leg pain following surgery. The symptom persisted even after a selective nerve block. The result was poor and revision surgery for open discectomy was undertaken. Another patient suffered recurrent radicular pain after a fall four months after receiving MED. Selective nerve block was performed and the result was good on the final follow-up. One patient had recurrent disc herniation one year after MED surgery and thus was classified as having a poor outcome. Revision open discectomy was performed for this patient.

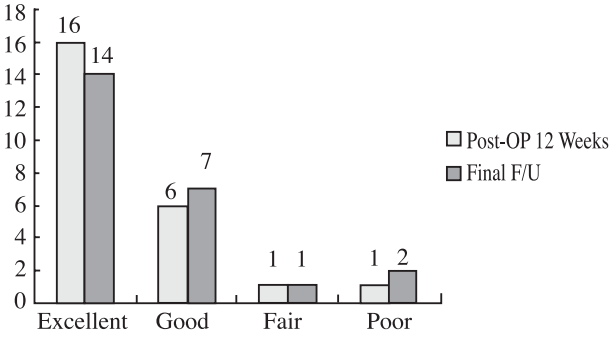

Fig. 1 Functional outcomes of 24 patients who received microendoscopic discectomy at 12 weeks post-surgery and on the final follow-up (F/U).

Complications were reported in five patients. Two irreparable dural tears occurred intra-operatively and the operations were shifted to open discectomy. Two superficial wound infections were found and treated with oral antibiotics for one week. The final functional results of these two patients were good in one case and fair in the other. One patient underwent a second operation for pseudomenigocele two months after MED. The result was excellent on the final follow-up visit. No deep wound infection was observed. No major vascular or neurological complications occurred.

DISCUSSION

This study found MED to be an effective procedure for treating lumbar disc herniation. In the current study, the post-op 12 week and final follow- up functional scores were significantly improved compared to the preoperative score. Furthermore, no major operative or postoperative complications occurred. Some minor complications, including superficial wound infection and intra-operative dural tears, were treated without any subsequent sequelae. Given the high recovery rate and satisfactory rate, MED surgery appears to be a suitable treatment option for lumbar disc herniation.

Conventional open discectomy is a standard procedure for treating lumbar disc herniation. The posterior approach permits direct visualization of neural elements and optimizes their decompression. Theoretically, direct excision of the herniated disc is the best method of nerve decompression.[17-19] However, direct excision means direct exposure and dissection, which results in more soft tissue trauma.

The earliest minimal spinal surgery for disc herniation was percutaneous chymopapain injection. Its

efficacy was proved but it is still not as good as conventional open discectomy.[20] Microscopic discectomy, as described by Casper,[21] is a less invasive procedure compared to open discectomy but still requires cutting and dissection of paraspinal muscles. Percutaneous discectomy is the least invasive technique but the indications are limited.[22]

MED uses a minimally invasive endoscopic posterior approach. Instead of cutting or dissecting, a series of tubular retractors can split the paraspinal muscle and reach the lamina area. With the assistance of endoscopic imaging, a laminecomy or laminontomy can be done and the herniated tissue can be directly resected to decompress the affected nerve root via a tubular retractor. This technique results in minor soft tissue trauma, a rapid recovery and a short hospital stay.[8-11]

Using the JOA scoring system, Nakagawa et al reported that recovery rates in the MED group at 12 weeks and on final follow up were 80.8% and 82.4%, and in the open group, 51.1% and 79.1%.[9] Our data were similar to Nakagawa's reports. Thus, compared to other minimally invasive procedures, the results of MED surgery are equal to open surgery and even better in the early period. The indications for MED surgery are wider than for other minimally invasive procedures such as percutaneous discectomy.

In this investigation, most patients who underwent MED achieved good or excellent outcomes. However, the duration of surgery from initial preparation to the completion of the whole procedure was long. Muramatsu et al and Nakagawa et al also reported long durations of surgery for MED.[8,9] Besides the time spent removing the soft tissue over the lamina and interlaminar space, considerable time is spent in preparing an acceptable surgical field for clear orientation of the anatomy. The lumbar level to be approached needs to be confirmed before and during surgery using fluoroscopy. To prevent the guide wire and sequential dilators from being pushed into the interlaminar space, the position of these instruments must be confirmed and guided using a fluoroscope several times during surgery. These are the most time-consuming procedures involved in MED. The surgery duration in later cases was shorter, which may have resulted from a decrease in the times required for preparation of the surgical field and repeated fluoroscope checks.

To achieve good results in MED surgery, surgical indications and adequate patient selection are very important. Because of the limited surgical field, MED surgery is most indicated for single level and unilateral disc herniation disease. Patients with spondylodiscitis, segmental instability or severe neurological deficits may also have local inflammation, anatomical changes and severe soft tissue adhesion, which increase the infection rate, technical challenge, and operation time. MED should be avoided in these patients, especially when beginning the use of this procedure.

Common complications of MED do not differ significantly from those of open discectomy. The most frequently encountered complications are dural tears, neurological damage, soft tissue injury and infection.[1,4,11-13] There were five cases with complications in this study. Treatment for two patients was changed to conventional open discectomy because of intra-operative irreparable dural tears. Pseudomeningocle was found in one patient two months later after MED surgery and this patient received further debridement surgery. The formation of a pseudomeningocele might result from a small dural tear which was undedectable during MED surgery. Perez-Cruet et al. also reported eight patients (5%) with dural tears and one patient with pseudomeningocele formation in their series.[11] Since assessment of the spatial relationship between the actual field and the image on the two-dimensional video display is unfamiliar to surgeons, the risk of technique-related dural tears and nerve root injury remains a matter of concern. The complication rates may be reduced with increasing surgeon experience. However, in the series of Nakagawa, dural tears still occurred even after the surgeon had experience with 20 MED cases. Furthermore, a rare complication after MED surgery was reported in 2006.[23] Three patients who received MED had newly developed, contralateral neurologic deficits. Although this did not occur in this series, surgeons should be aware of the possibility of ipsilateral and contralateral neurologic deficits. Therefore, a cautious and careful approach is essential even for experienced surgeons.[9]

No deep infections were found in the present series, but there were two cases of superficial infection located above the fascial layer. These two complications could result from over- stretching of the skin and soft tissue during initial placement of the tubular dilators. MED is a minimally invasive procedure but still requires a skin incision of adequate length. The maximal diameter of the tubular dilator is 16.8 mm, necessitating a skin incision of around 2 cm. A short skin incision (<2 cm) may cause over - stretching and ischemic changes in the tissue around the edge of the skin during long-term application of the final working sheath. Superficial infections can be treated initially with oral antibiotics. If no improvement is achieved, surgical debridement is necessary.

MED is undoubtedly technically challenging. There is a learning curve during initial practice.[3,7,9-11] The current series also displayed learning curve issues. Although the surgeon had experience in applying minimally invasive microendoscopic techniques in animal spinal surgery,[24] dural tears still occurred. We propose that surgeons should perform MED on human cadavers or animals before attempting the procedure on real patients.

In conclusion, the data from this study indicate that MED is a treatment option for lumbar disc herniation disease. The results in the initial cases presented here are good. MED can provide numerous benefits of minimally invasive spinal surgery, such as early mobilization and rapid recovery. Despite a low complication rate, dural tear remains a concern. MED training in cadavers or animals is necessary before performing the endoscopic surgery presented here.

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顯微內視鏡椎間盤切除術在早期 26 位病患施行之結果：三年以上之病例追蹤

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背 景： 顯微內視鏡椎間盤切除術在手術中對組織的傷害小於傳統椎間盤切除術。但是顯微內視鏡椎間盤切除術的長期預後仍有一些爭論。因此我們追蹤三年以上的病例，作預後的統計和評估。

方 法： 從 2001 年 12 月到 2003 年 12 月，總共有 26 位病患因爲腰部椎間盤突出症接受顯微內視鏡椎間盤切除術。病患的臨床表現症狀和治療後的結果使用 the Japanese Orthopaedic Association Back Scores 來評估。

結 果： 26 位病患中有兩位因爲術中發生脊膜破裂的併發症而改爲傳統手術。剩下 24 位病患中，平均術中失血量 55.8 ml；平均手術時間 136.8 分鐘；平均術後住院天數爲 2.4 天。在術後 12 週時，有 22 位病患得到良好或好的結果，短期追蹤的滿意度爲百分之 91.7。在最後追蹤時，仍有 21 位病患有良好或好的結果，長期追蹤的滿意度爲百分之 87.5。而其他的併發症包括有：難以顯微內視鏡修補的脊膜破裂、淺層的傷口感染和假性腦室膜膨出。

結 論： 我們的結果顯示顯微內視鏡椎間盤切除術是一種有效的手術方式，可以治療腰部椎間盤突出症。雖然發生併發症的機率並不高，但是脊膜破裂仍然是手術醫師在學習階段時需要特別留意的。

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關鍵詞：椎間盤突出症、微創脊椎手術、顯微內視鏡椎間盤切除術

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