CLINICAL ARTICLE

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Posterior Microscopic Lesionectomy for Lumbar Disc Herniation with Tubular Retraction Using METRx™ System

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Objective : The authors have developed a procedure, termed posterior microscopic lesionectomy, that creates a minimal laminotomy site according to the location of the shifted disc using the METRx™ system in the lumbar spine. This study compared the usefulness and surgical outcomes of this procedure with those of traditional standard lumbar discectomy.

Methods : From June 2003 to June 2004, Twenty-two patients with one-level radiculopathy due to lumbar disc herniation underwent posterior microscopic lesionectomy with the assistance of an operating microscope and the METRx™ tubular retractor. Surgical results of the new procedure were compared to those of 39 patients who underwent traditional lumbar discectomy from April 2003 to September 2004. All patients were evaluated for pain score, clinical assessment according to the VAS, and Roland-Morris scores pre-operatively and at 1, 3, 6, and 12 months post-operatively.

Results : Mean blood loss, operation time, and admission date showed significant improvements for microscopic lesionectomy compared to traditional lumbar discectomy ($P < 0.001$). Also, both measures of short-term functional improvement, the Visual Analogue Scale(VAS) and Roland-Morris(RM) scores, were statistically better for microscopic lesionectomy than for traditional discectomy ($P < 0.001$).

Conclusion : Posterior microscopic lesionectomy can be performed more safely and provide greater benefit than traditional discectomy. The procedure is associated with less post-operative pain, shorter hospital stays, and quicker rehabilitation.

KEY WORDS : Microscopic lesionectomy · Lumbar disc herniation · Traditional discectomy.

Introduction

Since Mixter and Barr[11] first described herniation of disc material as a cause of neural compression in the lumbar spine, various surgical approaches have been developed to alleviate the condition. Recently, a minimally invasive approach to lumbar disc surgery has become popular as surgeons attempt to decrease perioperative morbidity and secondary segmental instability[3,6-8,20]. The authors of the present study have begun performing microscopic lesionectomy as a form of minimally invasive surgery in place of traditional surgery of the lumbar spine, as the former requires a much smaller incision than the latter, generally just one inch in length. The operation creates a small tunnel, using specially-designed tubular retractors, through the muscles in the back and to the region of the herniated disc. In comparison, a traditional lumbar discectomy involves a much larger incision and the stripping away of the muscles from the spinal column so as to facilitate visualization of the area of the herniated disc. The component of the procedure wherein fragments of the herniated disc are removed is quite similar in both techniques. We developed the minimally invasive microscopic lesionectomy to treat patients with lumbar disc herniations and compare here their clinical outcomes with those of traditional lumbar discectomy.

Materials and Methods

Twenty-two patients with one-level radiculopathy secondary to lumbar disc herniation underwent microscopic lesionectomy with tubular retractors between June 2003 and

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Table 1. Clinical and demographic data of patients with disc herniations

Parameter	Microscopic lesionectomy	Traditional discectomy	p-value
No. of patients	22	39	
Mean age (years)	44.1	37.5	NS*
Male/female ratio	11:11	32:7	NS
Level (no. of patients)			NS
L3-4	2	3	
L4-5	11	23	
L5-S1	9	13	
Symptoms			
mean duration (months)	3.6	4.5	NS
sensory change : yes/no	22/0	39/0	NS
motor deficit : yes/no	4/18	15/24	NS

*NS : not significant

June 2004. The 11 men and 11 women ranged in age from 20 to 81 years (mean age, 44.1 years). Between April 2003 and September 2004, 38 patients with lumbar disc herniations underwent traditional discectomy. These 32 men and 7 women ranged in age from 21 to 82 years (mean age, 37.5 years). Table 1 presents the demographic characteristics of the patient population. Pre-operative evaluations included detailed neurological examinations, radiological studies including lumbar magnetic resonance imaging(MRI), and subjective ratings of back and radicular pain(Table 1).

The inclusion criteria for this study were : (1) no symptomatic improvement after conservative management for at least 6 months; (2) no previous lumbar spine surgery; (3) presence of unilateral sensory pain and clinical evidence of radiculopathy (motor or sensory neurological deficit); (4) no indication for emergency surgery; (5) MRI documenting intraspinal disc fragments regardless of presence or absence of spinal stenosis; and (6) no evidence of any other spondylolisthesis.

Surgical procedures

Patients underwent lumbar microscopic lesionectomy under general endotracheal anesthesia with the assistance of an operating microscope and the METRx^{TM} tubular retractor system (Medtronic Co, Memphis, TN, USA) while in the prone position. Surgery was performed by one surgeon. The tubular retractor was used to create a tunnel to the region of the spinal column containing the herniated disc. The desired tunnel size, 1.6cm in diameter or about 3/4 of an inch, was obtained through sequential tubular dilatation. The skin incision was somewhat shorter, generally 1.7 to 2.0cm. The surgery followed a "muscle-splitting" approach that passed the tubular retractor through a tunnel in the muscles of the back rather than stripping them away from the spine as in an open discectomy. We found that direct visualization of the ruptured disc material was possible, allowing us to remove the disc material and widen the foramen (Fig. 1.D).

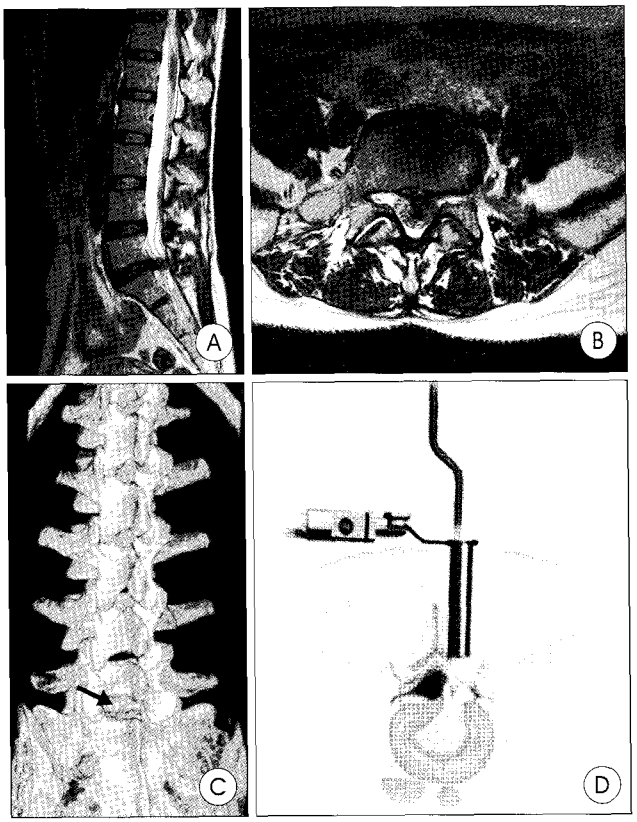

Fig. 1. A 40-year-old man suffered back and left leg pain and so underwent microscopic lesionectomy. There were no complications and he returned to work day after 5 days. A : Sagittal T2-weighted magnetic resonance images of representative cases. B : Axial T2-weighted images (lumbar disc herniation L5-S1 left side). C : Post-operative three-dimensional computerized tomography reconstruction demonstrating the area of fenestration (black arrow). D : Schematic view of a lumbar herniated disc removal viewed through the tubular retractor.(Paramedian muscle splitting approach).

Traditional discectomy is usually performed under general anesthesia (the patient is unconscious).

It is performed while the patient is lying face down or in a kneeling position. During the procedure, the surgeon makes an approximate one-inch or 1.5 inch incision in the skin over the affected area of the spine. Muscle tissue is removed from the bone above and below the affected disc and retractors hold the muscle and skin away from the surgical site so the surgeon has a clear view of the vertebrae and disc. In some cases bone and ligaments were removed for the surgeon to be able to visualize and then gain access to the bulging disc without damaging the nerve tissue.

In view of the surgical procedure, the point is that the posterior microscopic lesionectomy has removed only disc material by approaching and implementing only the part with the lesion. In other words, it has the advantage not only minimizing the muscle inury and laminetomy parts comparing with the traditional discectomy, but also directly approaching the part with the herniated disc material.

Table 2. Form used by interviewer for patient evaluation of pain and function before and after operation (Roland-Morris score)

Questionnaire	Score
I. Describe your level of lower back pain during the pre-operative period	No pain 1-2-3-4-5-6-7-8-9-10 Pain extremely severe; intolerable
II. Comparing your current pain with the pain you experienced pre-operatively, how much has the pain improved?	No pain 1-2-3-4-5-6-7-8-9-10 Pain extremely severe; disappearance aggravation
III. How disabled were you before your operation?	1. No disability at all, worked full time 2. Able to work full time, but at a less-than-normal level 3. Able to work only part time, but at usual level 4. Able to work only part time and at a lower level 5. Not able to work at all
IV. How disabled are you after your operation (according to scale shown above)?	1---2---3---4---5

Table 3. Modified Macnab criteria

Outcome	The degree of symptom improvement
Excellent	Minimal symptoms, no use of analgesics
Good	Marked improvement over preoperative status, occasional or rare use of analgesics
Fair	Some improvement over pre-operative status, continued need for analgesics, significant functional limitations
Poor	No improvement over pre-operative status, no improvement in functional capacity, regular analgesic use

Clinical assessment

Pain and functional status of each patient was scored pre-operatively and at 1, 3, 6, and 12 months post-operatively. Patient satisfaction with the new procedure was also evaluated. Scores of lower back and leg pain were documented separately by self-assessment 10-point VAS scores[17]. Perioperative Roland-Morris scores[16] were used to evaluate functional status, while modified Macnab classifications[9] were used to monitor satisfaction with the new procedure (Table 2, 3).

The Roland-Morris score (disability score) is calculated from answers to four questions and ranges from two points (no pain and no disability) to 15 (severe disability and extremely pain), after and before operation. A positive response scores points, so high scores indicate increased disability. Neurological examinations and telephone surveys were conducted of all patients at the four post-operative times to determine whether any new symptoms had developed since their previous clinic visits. Our analysis excludes all patients who were not followed for at least 12 months.

Radiological evaluation

Following microscopic lesionectomy, three-dimensional computerized tomography reconstructions and radiographs obtained of all patients demonstrated preservation of the lumbar facet joint and continuity of the surgically-treated lamina.

Statistical analyses

To evaluate undifferency of clinical and demographic data on both group and to test the differency of clinical outcome and postoperative results were applied statistical methods. We concluded as statistical meaning if the p-value was recorded less than 0.001.

Table 4. Summary of procedure-related data obtained from patients

Parameter	Microscopic lesionectomy	Traditional discectomy	p-value
Outcome (%)			
Excellent	20 (90.9%)	4 (10.3%)	
Good	0 (0%)	30 (76.9%)	
Fair	1 (4.5%)	1 (2.6%)	
Poor	1 (4.5%)	4 (10.3%)	
Mean Hospital days (return to work days)	4.5 (8.5)†	11.1 (18.7)†	p<0.001
Mean operation time (minutes)	95.0	114.8	p<0.001
Mean blood loss (cc)	69.5	290.5	p<0.001
Total Complications(patients number)	1* (4.5%)	8 (21.1%)	p=0.305
Discitis	1*	-	
Repeated operation	1*	2‡	
Foot drop	-	2	
Post-operative back pain	-	4	
Wound dehiscence	-	2‡	

* Patient suffered a discitis. Patient underwent surgical re-exploration and wound irrigation, †Number of days until patient returned to work, ‡Postoperative wound dehiscence occurred; wound (operation site incision) was resutured

Results

Clinical results and outcomes for all patients are summarized in Table 4. In cases of microscopic lesionectomy, blood loss ranged from 10 to 100ml (mean blood loss, 69.5ml). Operation time ranged from 30 minutes to 1 hour(mean operation time, 95 minutes). The mean hospital stay was 4.5 days, with one patient with discitis requiring a significantly longer stay of 47 days. Traditional lumbar open discectomy in 39 patients resulted in blood loss ranging from 200 to 450ml (mean blood loss, 290.5ml) and an

operation time of 1 hour to 3 hours (mean operation time, 114.87 minutes). The mean hospital stay was 11.12 days. All data on both group were statistically different and those referred us that new method proved out improvement on hospital stay, operation time and blood loss. Also, in case of microscopic lesionectomy, overall outcome according to the modified Macnab criteria was excellent in 20 patients (90.9%), fair in one patient (4.5%), and poor in one patient (4.5%). No evidence of post-operative spinal instability was found upon radiological evaluation until the final follow-up check. The patient with a poor outcome suffered discitis after surgery and underwent surgical re-exploration and intravenous antibiotic treatment during the hospital stay. In comparion group, the overall outcome was excellent in 4 patients (10.3%), good in 30 patients (76.9%), fair in one patient (2.6%), and poor in four patients (10.3%). Final outcome on both group was also different, and complications associated with traditional lumbar discectomy occurred in 21.1% of patients and included motor weakness (foot drop), postoperative back pain, and wound dehiscence (Table. 4).

Like this, the reason why the difference of the complications is shown between the microscopic lesionectomy and the traditional discectomy, is as follows. To begin with, the latter has required much more time to perform the operation and much more loss even in the mean blood.

The section on which the operation is performed is larger in the latter one than in the former one. The improvement in the wound problem and pain is also considered to be more late. As stated below, the former type(microscopic lesionectomy) shows faster recovery speed by one month in the early recuperation month after the operation performed.

After being admitted with an average VAS lower back pain score of 9.0, microscopic lesionectomy patients reported a mean VAS score of 1.0 during follow-up. Relief of symptoms such as lower back pain, sciatica, sensory deficit, and motor deficit was observed in the majority of patients in the first postoperative day as against the traditional discectomy. That is, The mean Roland-Morris score for all cases was 6 (range, 4 to 14) after operation, indicating a very low level of disability. Traditional lumbar discectomy patients, in contrast, had a mean VAS score of 9.38 at admission and 2.07 at follow up (Fig. 2). The mean Roland-Morris score for traditional discectomy was 13.13 (range, 10 to 15) at the first month post-operation. In response to a direct question, all patients expressed that their surgery had been worthwhile and that they would undergo microscopic lesionectomy rather than traditional lumbar discectomy again if in a similar situation. The Roland-Morris scores indicate that patients were more satisfied following microscopic lesionectomy than traditional discectomy (Fig. 3).

After Microscopic lesionectomy, a clinical symptoms have

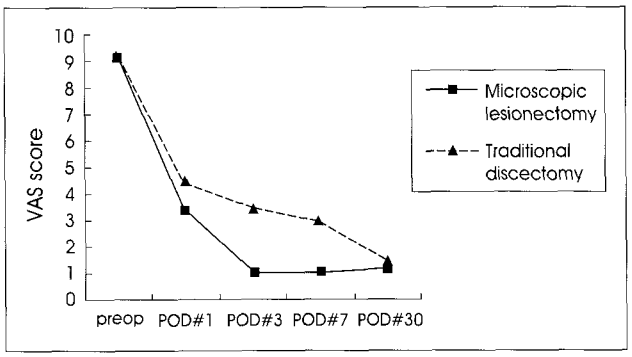

Fig. 2. Pre- and post-operative Visual Analogue Scale(VAS) scores This graph demonstrates the highly significant reduction of lower back pain and radiating pain based on the 10-point VAS score in microscopic lesionectomy versus traditional discectomy. (POD #: post-operative day number at follow up).

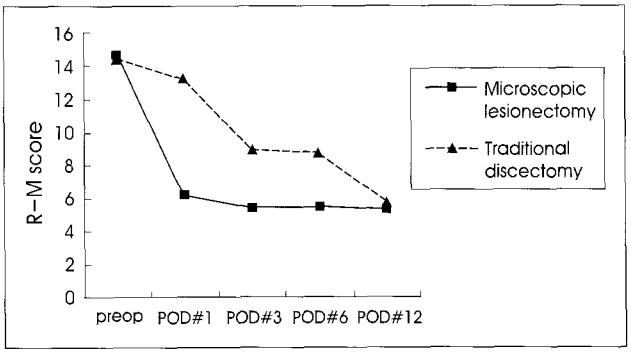

Fig. 3. Pre- and post-operative Roland-Morris scores. Monitoring the change in a patient's score from the Roland-Morris questionnaire for lower back pain allowed us to detect a clinically-significant clinical change during the follow-up period. Patients were more satisfied by microscopic lesionectomy than by traditional discectomy by the first post-operative month. (POD#mo: post-operative month number).

been improved much aspect than traditional discectomy at a postoperative first day in VAS score. VAS score is been similar aspect almost at a postoperative 1 months. Compared with R-M score during 1 month after surgical operation, Microscopic lesionectomy presents much take a favorable improvements at a clinical symptoms than a traditional discectomy. R-M score showed resemblent score aspect at follow up period after 1 year. Conclusively, the presence at a clinical symptoms are taken a favorable turn faster at early postoperative states in microscopic lesionectomy.

Discussion

We report here the early results of microscopic lesionectomy in 22 patients with herniated lumbar discs and compare these to the outcomes of 38 patients who underwent traditional discectomy. From the above-mentioned data(see Table 4), the clinical outcome(excellent & good) showed 90.9% of satisfaction degree in case of the microscopic lesionectomy and 87.2% in case of the traditional discectomy. The satisfaction degree after the surgical operation entirely turned out

to be similar. However, referring to the Fig. 2, 3, the satisfaction degree of the microscopic lesionectomy turned the favorable improvement dramatically in less than a short-term month comparing that of the traditional discectomy. This suggests that the performance of the microscopic lesionectomy would be more efficient for the purpose of the rapid favorable progress from the point of view of the patient. In addition, the microscopic lesionectomy indicated the statistically significant small figures also in the hospital stay, operation time, blood loss and complication, comparing the traditional discectomy (Table 4), which means, for the operation of the patient with the lumbar disc herniation, that the microscopic lesionectomy is more advanced method than the traditional discectomy.

Traditionally, microdiscectomy-related neural decompression was achieved by excision of the herniated disc material, resection of as much intervertebral tissue as possible, and curettage of the end plate[2,20]. This technique operated from the presumption that the likelihood of reherniation would be reduced by increasing the amount of resected disc tissue[20,21], and aggressive removal of the intervertebral lumbar disc has thus been advocated by many spinal surgeons. Yet, extensive disc removal could significantly decrease the buffering capacity of the spinal components to loading, leading to change within the facet joints, increased mobility, and, eventually, post-operative instability[5,10]. Aggressive removal of lumbar discs is also associated with increased risk of excessive blood loss, prolonged operative time, and intraoperative complications.

The present study suggests that one of the main advantages of posterior microscopic lesionectomy is less post-operative pain than is normally experienced after traditional discectomy. This translates into a shorter hospital stay and quicker recovery and rehabilitation.

Palmer S.[14] reported that minimally invasive surgery in which the METRx-MD system is used is clinically effective and cost effective. Patient satisfaction was high. Complications rates were comparable with those associated with traditional microdiscectomy procedures. Findlay et al.[4] also mentioned a similar success rate with a 10-year follow-up of the outcome of lumbar microdiscectomy. Silvers et al.[18] reported that the time before return to work was significantly shorter in patients undergoing microscopic discectomy than in those receiving the traditional operation. Microscopic lesionectomy proved to be superior in both clinical results and cost effectiveness. The outcomes of 150 patients with herniated lumbar discs treated by microscopic lesionectomy or traditional discectomy were retrospectively reviewed after an average of 3 years. Microscopic lesionectomy resulted in less intraoperative bleeding, shorter hospitalizations, and more rapid return to work. Nystrom et al.[13] and Singhal et al.[19] concluded that outpatient lumbar microscopic lesionectomy reduced the risk of nosocomial complications and saved health care dollars. Taken together, the present and previous reports of microscopic lesionectomy indicate that it is a safe, non-traumatic procedure for the removal of lumbar disc herniations and gives very good long-term results.

According to the literature, percutaneous, microendoscopic, and traditional discectomy procedures are associated with satisfactory clinical outcomes in 91% of cases. We observed excellent results in 20 patients (91%), a rate comparable to those for other endoscopic and traditional discectomy operations. Outcome analysis in the present study included data regarding improvement of symptoms, patient satisfaction, economic and functional capacity, and quality of life.

Percutaneous endoscopic discectomy offers many advantages over other minimally invasive surgical lumbar discectomy techniques, including reduction of tissue trauma, visualization of the nerve root, and allowance of bony decompression (i.e. spinal and lateral recess stenosis). The initial microendoscopic discectomy(MED) system was limited, however, in that the endoscope was not reusable, image quality was inconsistent, and working space within the tubular retractor was restrictive[15]. Also, neurosurgeons are generally more familiar with microscopic approaches than endoscopic ones. Compared with other percutaneous procedures, microscopic lesionectomy using the METRx™ system has several advantages, including increased image quality, variable tubular retractor size, increased available working room within the tubular retractor, decreased per-case cost, and a shallower learning curve[12]. Improvements in optics and working channel space have made the procedure both easier and safer. The most impressive advantage of the METRx™ system over other percutaneous procedures is that it allows surgeons to address not only contained lumbar disc herniation, but also sequestered disc fragments and lateral recess stenosis by varying the approach location. A prospective multicenter clinical study has shown the efficacy of this system in treating lumbar disc disease[1]. Indeed, microscopic lesionectomy can increase patient safety and post-operative patient outcomes, and thus advance the treatment of spinal disorders.

Conclusion

According to our data, microscopic lesionectomy using a tubular retractor is a less invasive method of lumbar disc excision and results in smaller scars, faster recovery, and fewer complications than standard lumbar open discectomy. The potential benefits of small incisions, limited tissue disruption, enhanced visualization and illumination, shorter hospital stays, and faster recovery times have all incentivized the pursuit of these technologies. Good surgical results have been achieved using METRxTM as a tubular retractor, and the technique

has the advantage of being able to vary the approach according to the location of the disc herniation.

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Commentary

Related to the paper, I would like to point out three things. One is limitation. Neurosurgeons are more familiar with the microscope. Therefore, in order for neurosurgeons to conduct this procedure described in this paper, additional facility (specifically tubular retractor of METRx system) must be supplied.

The second is lesionectomy concept. This is hidden jewel concept. Every neurosurgeon often has experienced the excellent pain relieve after removing the ruptured disc. The removal of 'the lesion' only itself could be sufficient to some patients to relieve the symptom of herniated disc. A policy of removing much more disc is not adequate to the old age, or to those who need to return to the work early. Thus the lesionectomy concept can receive attention in the advanced age society.

Third, the tubular retractor made the authors focused 'the lesion', which is important target to relieve the symptoms. To have good results with lesionectomy, it needs much more efforts of the preparation such as strict correlation with clinical symptoms, neurologic examination, and radiologic structural findings(eg. facet hypertrophy, thickened ligament flavum, facet cyst, herniated disc, or etc).

As many are aware of, standard traditional microdisectomy has been golden standard in herniated lumbar disc(HLD). Despite of the limitation, we are expecting the developing idea of minimal invasive procedure in this paper could give less risk, but better results confront to the HLD patients by any of neurosurgeons.

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