The clinical application of “jetting suture” technique in annular repair under microendoscopic discectomy
A prospective single-cohort observational study
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Abstract
To introduce a new designed suture technique in annular repair under the microendoscopic discectomy (MED) surgery and to evaluate the clinical application of the technique in annular repair under MED with at least 2-year follow-up period. A new method of annular repair was designed and named “jetting suture” technique. Thirty consecutive patients with lumbar disc herniation were enrolled in the prospective single-cohort observational study. Patients were followed up at intervals of preoperative, postoperative 1 week, 3 months, 6 months, 1 year, and last follow-up. The clinical outcomes were evaluated by using Japanese Orthopaedic Association (JOA) score, Oswestry Disability Index, and modified Mcnab criteria.

The procedure was successfully performed in all cases. No case required conversion to an open procedure. The mean age of patients was 36.6 years. Average blood loss was 45.8 ± 10.2 mL. The preoperative symptoms were alleviated significantly after surgery. All the standardized measures improved significantly at the last follow-up, including JOA score (10.1 to 26.6; \( P < 0.05 \)) and Oswestry Disability Index (75.3 to 9.6; \( P < 0.05 \)). Improvement rate of JOA score was 86.4%. Approximately 83.4% of patients reported good or excellent outcomes based on modified Mcnab criteria. No postoperative complication and recurrence of disc herniation was reported.

The designed “jetting suture” technique in annular repair under MED can be performed safely and effectively. It could be a viable alternative to annular repair under lumbar discectomy.

Abbreviations: JOA = Japanese Orthopaedic Association, MED = microendoscopic discectomy, ODI = Oswestry Disability Index.

Keywords: annular repair, discectomy, jetting suture, microendoscopy, technique

1. Introduction
Lumbar disc herniation is one of the most treated spine problems. Open discectomy is considered the standard treatment method and achieve favorable outcomes. However, it also could cause postoperative segmental instability and low back pain with the incidence rate of 11% to 15%.[1] Nowadays, the use of microendoscopic discectomy (MED) for the treatment of primary lumbar disc herniation has become fairly well-accepted.

Since MED was firstly introduced by Foley and Smith[2] in 1997, several studies have reported that MED is less invasive than conventional open discectomy and could provide similar short and long-term outcomes.[3,4] MED has been proved to be an effective alternative to open discectomy with the advantages of minimally tissue damage and excellent visualization.[5,6]

Despite satisfied clinical outcome in MED surgery, recurrences of disc herniation cannot always be prevented as open discectomy. Recurrent disc herniation is the major problem after discectomy, and it is regarded as one of the most common causes of reoperation. Previous studies reported that recurrent herniation occurred in 5% to 15% of cases surgically treated for primary lumbar disc herniation[7–9] and earlier in MED surgery.[10]

Nowadays, the annular repair has become increasing recognized as a valuable adjunct to discectomy in prevention of recurrent disc herniation.[11] However, there was no study focused on the annulus suture technique under MED surgery until now. In our study, we designed and performed a new suture technique of annular repair under MED surgery for patients with lumbar disc herniation and prospectively investigated the primary clinical outcomes.

2. Materials and methods
Between September 2012 and July 2013, 30 patients with the diagnosis of 1-level lumbar disc herniation were enrolled in our prospective single-cohort observational study. All the patients
provided informed consent, and the research was conducted after the approval of the ethic committee of our hospital. All the cases were diagnosed with lumbar disc herniation and underwent the annular repair under MED surgery in our hospital. Informed consent was obtained from all patients. All patients failed to response to conservative treatment for at least 3 months, including bed rest, limited duty, NSAIDs, muscle relaxants, and physiotherapy. Preoperative diagnosis was based on clinical symptom, detailed neurological examinations, x-ray, computed tomography (CT), and magnetic resonance imaging (MRI) of lumbosacral spine.

Exclusion criteria included: successful nonoperative measures; concomitant spinal stenosis; cauda equine syndrome; previous operative procedures on the same disc level; clinical and radiographic evidence of congenital anomalies, marked instability, ossified fragment, or infection.

Patients were assessed preoperatively and postoperatively (at 1 week, 3 months, 6 months, 1 year, and last follow-up time). The Japanese Orthopaedic Association (JOA) score for low back pain was evaluated before and after surgery as an index of clinical outcomes. Improvement rate of JOA score was calculated as (postoperative score – preoperative score)/29 – preoperative score) x 100%. Oswestry Disability Index (ODI) score[12] was used to evaluate low back pain and functional state. Macnab classification[13] was used to evaluate patients’ satisfaction.

In addition, perioperative and postoperative complications, including the recurrence of disc herniation and additional surgery, were also recorded. A diagnosis of recurrence was defined as the development of new symptoms and MRI showing compatible lesions in the same segment.

2.1. Surgical techniques

All patients were operated on by the same junior spinal surgeon. Before surgery, the special injector with a suture is prepared (Fig. 1). A suture was put into the syringe of 20mL with an 18# needle of 20cm by inhaling saline, and 2mm was left out of the needle. The injector was used during the annular repair procedure.

Surgery was carried out under general anesthesia with patients in genu-pectoral position on the Hall frame. Under C-arm fluoroscopic guidance, a longitudinal paraspinous skin incision of 25mm was made. After nerve roots and dural sac were identified and protracted, a longitudinal incision in the annulus was made using the knife blade. Disc material was curretted out using pulposus clamp. Final movement of nerve roots was checked to ensure they were free and not entrapped.

After that, the needle point of prepared injector was inserted into the residual space of removed disc at the depth of 2cm through the normal annulus at one side of the incision. The suture in the syringe was then partly pushed into the residual cavity of disc through the needle by jetting the saline in the syringe. We called the process “jetting suture” technique. The suture was pulled out from the annulus incision using pulposus clamp. Then, another suture was also injected from another side of annulus incision and pulled out. The ends of 2 sutures which were pulled out from the annulus incision were knotted. Then, by pulling either end of the other 2 ends, the last suture could cross the annulus incision through the normal annulus. After that, the suture was tightened and knotted outside the annulus, and the annulus incision was closed. The retractors were then removed and incision was closed in layers. The schematic diagrams and endoscopic photos of annular suture were respectively shown in Fig. 2 and Fig. 3.

2.2. Statistical analysis

Continuous variables were presented as the mean ± standard deviation (SD). The paired Student t tests were used for data comparisons between preoperative and follow-up time points using the SPSS. P < 0.05 was accepted as significant.

3. Results

3.1. Demographics

Demographic and clinical characteristics data are summarized in Table 1. There were 30 patients enrolled in the study, including 18 female and 12 male patients. The mean age at surgery was 36.6 years (range 18–72 years). The mean duration of symptoms was 8.2 months. The group consists of 19 patients who underwent surgery at L4-L5, and 11 at L3-S1. The mean operative time was 102.4 ± 23.5 minutes. The mean operative time was 114.3 ± 34.9 minutes for the first 15 cases, and 90.5 ± 19.0 minutes for the last 15 cases. The mean blood loss was 45.8 ± 10.2 mL. The mean follow-up time was 26.7 months (range 24–30 months).

3.2. Clinical outcomes

The annular repair under MED surgery was performed successfully in all the cases. Outcome measures were recorded at preoperative, postoperative 7 day, 3 months, 6 months, 1 year, and the last follow-up. The trends of JOA score and ODI along the whole follow-up period were observed. The preoperative symptoms were alleviated significantly after surgery. JOA score and ODI showed significant improvements immediately after surgery and were maintained until the last follow-up (Fig. 4). The JOA score improved to 26.6 ± 4.3 at the last follow-up from preoperative 10.1 ± 5.2 (P < 0.05). The mean improvement rate of JOA score at last follow-up was 86.4%. The ODI improved to 9.6 ± 3.2 at the last follow-up from preoperative 75.3 ± 22.1 (P < 0.05). In addition, there was no significant difference for the JOA score and ODI between any of the postoperative follow-up points, which indicated the stable clinical outcomes postoperatively. The global results according to modified Macnab criteria were 83.4% excellent or good outcomes, 13.3% fair outcomes, and 3.3% poor outcomes at the final follow-up.

Adverse problems were also recorded. No conversion to open discectomy surgery was required. There were no serious complications occurring in the group, such as nerve root injury, dural tear, or spondylodiscitis. Until the final follow-up, there
was no case suffering from recurrence of disc herniation through the MRI examination (Fig. 5).

4. Discussion

Microendoscopic discectomy enables spine surgeon to extract the herniated disc and decompress the nerve root through direct posterior approach with smaller skin incision. It minimizes iatrogenic injury to paraspinal muscles and posterior osteoligamentous structures, which are important to preserve the lumbar stability.[14,15] Although MED and open discectomy achieved similar clinical outcomes and success rates,[16,17] MED was proved to be superior to open discectomy for causing less irritation of nerve root,[18] less operative blood loss, less requirement of postoperative analgesia,[14] short hospital stay, and short time to return to work.

For LDH, real recurrent herniation was the most common cause of reoperations. Recurrent lumbar disc herniation occurred in more than 10% of patients and was associated with substantial healthcare costs.[19] Matsumoto et al.[20] retrospectively reviewed 344 patients who underwent MED surgery and found that the recurrence rate and reoperation rate at a mean follow-up of 3.6 years were 10.8% and 6.4%, respectively. Teli et al.[21] reported that the rate of recurrent herniation was 11.4% in MED surgery group, which was higher than microdiscectomy or open discectomy.

Figure 2. The schematic diagrams (A–H) of annular suture after the microendoscopic discectomy.

Figure 3. The endoscopic photos of annular suture during the surgery. The white arrow refers to the annular defect after discectomy and the black arrow refers to the dural sac.
Development of novel techniques to prevent recurrent lumbar disc herniation is warranted to decrease the morbidity and healthcare costs associated with recurrent disc herniation. Annular repair is perceived as a potential therapy. In vitro laboratory experiments indicated that repairing the annulus fibrosus after discectomy can be beneficial for retaining intradiscal material. In the study by Chiang et al., a mechanical loading test was conducted in the porcine spine model to investigate the reliability of the annular repair. The results showed that the annular repair assisted preservation of the competence of disc and could withstand increased stresses.

As a new technique, annular repair is attracting more attention of clinical surgeons. Bailey et al. conducted a prospective, multicenter, single-blind, randomized, and controlled clinical study to investigate the outcomes associated with repairing the annulus fibrosus with Xclose Tissue Repair System after lumbar discectomy. The results showed that annular repair after lumbar discectomy can achieve positive clinical effect and reduce the risk of reoperation due to recurrent herniation.

To deal with the annular defect after discectomy, perioperative suture is the most straightforward solution. Previous study indicated that annular reconstruction by direct suture could diminish the risk of recurrent disc herniation. However, no report has combined the 2 techniques of MED and annular repair together. In our study, we designed “jetting suture” technique and performed annular repair under MED surgery successfully for the patients with lumbar disc herniation. We prospectively reviewed the clinical outcomes of 30 patients underwent annular repair under MED surgery with at least 2 years follow-up. The JOA score and ODI improved significantly after surgery and 83.4% patients reported “excellent” or “good” satisfaction for the surgery. As for the recurrent herniation, no reherniation was reported at the last follow-up time. In the study by Bailey et al., second surgical procedure for reherniation was reported in 9.7% at 2-year follow-up in annulus suture group with Xclose Tissue Repair System with open discectomy. In addition, the relative short-term follow-up in our study may have not yet observed recurrent herniation. Further comparisons with other reports of annulus repair method under microendoscopic discectomy are needed.

The aim of annular repair is to close the pathway for any future herniation of disc material. Exposure limitations could limit the

### Table 1

| Characteristics                  | All the patients |
|----------------------------------|------------------|
| Number of cases                  | 30               |
| Age, y                           | 36.6 (18–72)     |
| Sex (female/male)                | 18/12            |
| Mean duration of symptom, mos    | 8.2              |
| Surgical disc level              |                  |
| L4-L5                            | 19               |
| L5-S1                            | 11               |
| Mean follow-up time, mos         | 26.7 (24–30)     |
| Mean operation time, min         | 102.4±23.5       |
| Early 15 cases                   | 114.3±34.9       |
| Last 15 cases                    | 90.5±19.0        |
| Mean blood loss, mL              | 45.8±10.2        |

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**Figure 4.** The trends of JOA score and ODI during the follow-up time. JOA = Japanese Orthopaedic Association, ODI = Oswestry Disability Index.

**Figure 5.** A 28-year-old female patient suffered from lumbar disc herniation of L5-S1. The preoperative and postoperative MRI of lumbar spine showed that the herniated disc was removed and there was no recurrent disc herniation at the last follow-up time. MRI = magnetic resonance imaging.
implementation of annular repair procedure. However, the procedure of annular repair was performed after MED in all the cases in the present study. No conversion to open discectomy was required and no other complications were reported. The annular repair under the MED surgery is technically challenging. During the repair process, the propulsion of suture into the residual cavity of disc is the key technique. We introduced the “jetting suture” technique to propel the suture forward. In addition, the designed technique could achieve full-thickness suture of annulus.

A study by Nowitzke defined the learning curve for MED and revealed that the asymptote seems to develop at approximately 30 cases. In our study, the surgical time was longer in the initial cases and progressively tended to stable thereafter. Despite the MED has been widely used, the combination of annular repair with MED could not be easy at the beginning. Adequate expertise and mastery of the technique will be the key point of lowering the learning curve.

There are several limitations to this study, the most significant being the lack of a control group in which patients with lumbar disc herniation are treated with MED surgery only or with other methods. The relatively small number of patients and relatively short follow-up time are other shortcomings of our work. These deficiencies could cause certain influence on the clinical efficiency of the intervention. Further large-scale and comparative clinical studies are needed to investigate long-term outcomes.

5. Conclusions

The new designed “jetting suture” technique in annular repair under MED can be performed safely and effectively. The research suggests that it could be a viable alternative to annular repair after lumbar discectomy. A randomized controlled trial is necessary to prove the efficacy and safety of our new intervention.

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