SURGICAL TECHNIQUE

Intervertebral Fusion with Mobile Microendoscopic Discectomy for Lumbar Degenerative Disc Disease

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The aim of this article is to introduce a technique for lumbar intervertebral fusion that incorporates mobile microendoscopic discectomy (MMED) for lumbar degenerative disc disease. Minimally invasive transforaminal lumbar interbody fusion is frequently performed to treat degenerative diseases of the lumbar spine; however, the scope of such surgery and vision is limited by what the naked eye can see through the expanding channel system. To expand the visual scope and reduce trauma, we perform lumbar intervertebral fusion with the aid of a MMED system that provides a wide field through freely tilting the surgical instrument and canals. We believe that this technique is a good option for treating lumbar degenerative disc disease that requires lumbar intervertebral fusion.

Key words: Degenerative disc disease; Lumbar intervertebral fusion; Mobile microendoscopic discectomy; Transforaminal lumbar interbody fusion

Introduction

Lumbar disc herniation is one of the causes of low back pain¹, and surgical treatment is considered indicated for patients with severe sciatic pain that is unresponsive to conservative treatment². Although simple discectomy is adequate for most patients with disc herniation, more complex procedures such as fusion may be needed in a minority of patients with dominant low back pain and obvious Modic changes^{3,4}.

Posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) are frequently performed to treat degenerative lumbar diseases^{5,6}, minimal retraction of the thecal sac or nerve roots being required in TLIF. Recently, minimally invasive TLIF has become more frequently performed because it has the potential advantages of reduced trauma to paraspinal muscles and minimal perioperative blood loss⁷. However, minimally invasive TLIF is usually performed with naked eye vision through an expanding channel system, which provides a limited scope of operation and vision⁸. Endoscopic techniques are currently widely used to treat various lumbar diseases, such as disc herniation, spinal stenosis and degenerative disc disease, because they provide excellent vision; reduce trauma and have good results⁹. However, no endoscopic technique has yet been reported for lumbar intervertebral fusion, partly because of its inconvenience. However, the mobile microendoscopic

discectomy (MMED) system proposed by Destandau provides an adjustable visual field and does not restrict manipulation of instruments¹⁰. With MMED, the surgical instruments can be tilted freely without being restricted by the canal or compromising the wide visual field. Therefore, the purpose of this article is to introduce a new technique for lumbar intervertebral fusion with MMED for treating lumbar degenerative disc disease.

Technique

Typical Case

We here present a typical case. A 41-year-old woman had experienced low back pain for 10 years and numbness and pain in her left lower extremity for 1 year that had intensified 5 days prior to presentation. Ten years previously, her low back pain and discomfort had occurred intermittently and she had not received systematic treatment. One year previously, the low back pain had intensified with she had developed numbness and pain in her left lower extremity that could be alleviated by bed rest but was exacerbated by physical activity. Five days previously, her low back pain and numbness and pain in her left lower extremity had increased significantly and was accompanied by pain radiating down the posterior thigh to the dorsum of her left foot. Physical

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examination showed that lumbar flexion, extension, and left and right lateral flexion were limited. She had deep paravertebral tenderness on the left side of L₄₋₅ and pain radiating into the left lower extremity could be induced by tapping. The strength of the main muscles in both lower extremities was normal. She had hypoesthesia in the left leg and foot. Knee and Achilles tendon reflexes were present bilaterally and the Babinski sign was negative bilaterally. The left straight leg raising test was positive (10°), as was a strengthening test. The Patrick sign was negative bilaterally. The preoperative Oswestry disability index was 72%, and visual analog scale scores for low back and leg pain were 7 and 8 points, respectively.

Preoperative X-ray films showed that the L₄₋₅ space was narrow and endplate cartilage sclerotic (Fig. 1). CT and MRI scans showed L₄₋₅ disc protrusion towards the left and posteriorly with compression of the nerve root and endplate

inflammation of L₄₋₅ (Fig. 2). Disc protrusion was clearly visible and her symptoms of low back and left leg pain and clinical signs were consistent with an L₅ nerve root lesion combined with endplate inflammation. Conservative treatment had been relatively ineffective and her daily activities were seriously restricted. Thus, there were clear indications for surgery. Hence, TLIF of L₄₋₅ with the mobile microendoscope and percutaneous pedicle screw fixation were planned.

This patient was treated by lumbar intervertebral fusion with MMED and percutaneous pedicle screw fixation. After drainage had been removed, she commenced ambulation with a lumbar brace and reported that her lumbar and lower leg pain had improved significantly. Lumbar X-ray films and CT scan at her 6 months follow-up showed that the internal fixation and cage were well positioned (Fig. 3); additionally, her left leg and low back pain had completely resolved.

Fig. 1 (A) Preoperative anteroposterior and (B) lateral radiograph showing a narrow L₄₋₅ space and sclerotic endplate cartilage.

Fig. 2 Preoperative CT and MRI scan images showing L₄₋₅ disc protrusion towards the left posterior side with endplate inflammation of L₄₋₅. (A) Cross-sectional CT and (B) cross-sectional MRI showing a large disc protrusion at L₄₋₅ level that is seriously compressing the dural sac. (C) Sagittal MRI showing endplate inflammation of L₄₋₅.

Fig. 3 Lumbar X-ray film and CT image 6 months postoperatively. (A) Postoperative anteroposterior and (B) lateral radiographs showing that the pedicle screw system was in good position with no loose or breakup. The postoperative cross-sectional CT (C) showed that the cage was in good position with no displacement.

Surgical Technique

After induction of general anesthesia, the patient was placed in a prone position. The L₄₋₅ intervertebral space and puncture site of vertebral pedicle were located and marked under C-arm fluoroscopy. After routine disinfection and draping, a longitudinal incision was made on the left about 2.5 cm lateral to the spinous process. The subcutaneous tissue and deep fascia were incised sharply, bleeding being controlled by bipolar coagulation. Scissors were inserted beside the spinous process to distract the paraspinal muscle, after which the conical working (outer) tube and obturator were inserted in the required orientation. The obturator was then removed and the soft tissue in the tube was cleared to expose the inferior border of the lamina, inferior articular process of L₄ and the interlaminar space. Next, the operating (inner) tube was inserted followed by installation of the endoscope, light and imaging system.

The inferior border of the lamina and inferior articular process of L₄ were partially removed using a high speed burr and Kerrison ronguers. The ligament flavum was fully exposed, elevated and removed and the dural sac and L₅ nerve root exposed. An enlarged fenestration was created by resection of the medial part of the L₄ inferior articular process and the L₅ superior articular process. The dural sac and L₅ nerve root were gently pushed medially and protected by small wads of cotton. The posterolateral side of the disc was then fully exposed and a bipolar hemostasis probe was used to achieve hemostasis. The annulus fibrosus was cut sharply and the disc material in the intervertebral space completely removed. The MMED was easily tilted, enabling the disc and cartilage endplates to be completely curetted off with various angles of long-handle curettes. The disc space was rinsed with saline water using a special long irrigator until the debris had been cleared and the bony endplate exposed, after which the inner tube and endoscopic system were removed and the intervertebral space distracted and tested with a mold under direct vision. Autologous and allograft bone were grafted into the disc space, followed by an intervertebral cage of appropriate size filled with bone. The

position of the cage and reduction were confirmed under fluoroscopy, the cotton wads removed and the surgical field washed and checked.

Next, percutaneous screws were inserted with fluoroscopic guidance. Firstly, Jamshidi needles were used to cannulate the pedicles of L₄ and L₅ using the so-called bull's-eye technique. Then, a K-wire was inserted and the expanding channel put in place. A tap was used to prepare the screw tract, after which the percutaneous pedicle screws were inserted. The connecting rods were then measured and inserted percutaneously. After the position of fixation had been confirmed with anteroposterior and lateral fluoroscopy, the screws were locked under compression. A thin drainage tube was inserted into the fenestration site through the incision. Finally, the 2.5 cm incision for decompression and the four 1 cm incisions for puncture were sutured. Intravenous antibiotics were administered for 2 days postoperatively (Video S1).

Discussion

Lumbar intervertebral fusion under MMED is appropriate for treating patients with complex lumbar disc herniation accompanied by Modic changes in the lumbar endplate and with low back pain that is much more severe than their leg pain, patients with low back pain clearly related to degenerative disc disease or lumbar instability, and patients with isthmic spondylolisthesis (I, II degree) and complex spinal stenosis accompanied by degenerative lumbar spondylolisthesis, lumbar instability or scoliosis.

The MMED system used in this procedure has the following characteristics.

1. It consists of three parts, namely an outer working sleeve, inner operation sleeve and endoscope. The two sleeves are attached to each other by a chute structure. The sleeves are cone-shaped with a disc-shaped cross section, thus enabling protection of soft tissue and facilitating attachment to the vertebral plate.

2. The sleeves are movable and not fixed to the operation table. They are balanced in an erect position in the incision and can be moved or swung if necessary.
3. The lens of the endoscope is close to the field of operation and can be moved with the sleeves, enabling adjustment of the depth and angle and providing an excellent visualization as “the eyes are inside”.
4. Within the operation sleeve, there are an 8 mm surgical instrument canal, 4 mm endoscope canal and 4 mm aspirator canal. With all these canals, instruments can be used separately without interfering with each other.

This surgical procedure has the following advantages:

1. The field of operation is adjustable and anatomical structures such as nerves and the dural sac can be seen clearly through the endoscope. During the procedure, surgical instruments are less limited by the canals than with the METRx (Medtronic, Sofamor Danek, Memphis, TN, USA) system^{11,12}. The sleeves can be tilted at any angle according to the need to decompress the proximal, distal, lateral and contralateral spinal canals as well as the nerve root canals.
2. The intervertebral disc and cartilaginous endplate structure can be scraped from all directions and the intervertebral space can be cleaned thoroughly by altering the angles of the sleeves.
3. In contrast with open surgery, all required procedures, including segmental interlaminar fenestration decompression, discectomy, scraping of cartilaginous endplate and intervertebral bone grafting are performed with the aid of the endoscope; thus, the procedure can be performed with greater finesse and more safely. When intervertebral test mold and cage implantation is needed, the inner operation sleeve can be removed and outer working sleeve retained, making the procedure minimally invasive.

The following points should be considered when performing this procedure:

1. Care must be taken to localize the intervertebral space and the site of pedicle screw insertion pre-operatively. The working and operating sleeves should be located and directed towards the intervertebral space.
2. This procedure must be performed by surgeons with extensive experience in endoscopic surgery. It requires good hand-eye coordination between what is visible on

the screen, the aspirator in the left hand and the instrumentation in the right.

Therefore, it is not recommended that beginners use this technology.

3. The usage of the power drill should be translator, downward pressure being contraindicated. After exposure of the ligamentum flavum insertion, the ligamentum flavum should be lifted and cut with as little decompression as possible.
4. During cage implantation, the major part or the whole body of inferior articular process and the medial part of superior articular process should be removed to achieve full lateral decompression, thus avoiding stretching of the nerve root.
5. If contralateral undercutting decompression is necessary during the procedure, the sleeves can be inclined and the dural sac pressed down and protected with cotton pads, this allows decompression of the nerve root canal by undercutting the spinous process.
6. The intervertebral disc and cartilage endplate should be scraped thoroughly from all directions during the procedure. During implantation of the test mold into the intervertebral space, care must be taken to ensure the intervertebral space is open and not loosened by movement of the test mold.
7. During cage implantation, the nerve root should be pushed medially with cotton pads until intervertebral bone grafting has been achieved. Cage implantation should be anterior of the intervertebral space so as to facilitate the recovery of lumbar lordosis.
8. The borders of the pedicle should be clearly identified prior to percutaneous pedicle screw fixation. After implantation of the pedicle screws, percutaneous placement of the connector bar should be confirmed with C-arm X-ray machine in anteroposterior and lateral position in case of failure of the bar connection.

Supporting Information

Additional Supporting Information may be found in the online version of this article on the publisher's web-site:

Video S1 Intervertebral fusion under mobile microendoscopic discectomy.

References

1. Yang H, Liu H, Li Z, et al. Low back pain associated with lumbar disc herniation: role of moderately degenerative disc and annulus fibrous tears. *Int J Clin Exp Med*, 2015, 8: 1634–1644.
2. Dohrmann GJ, Mansour N. Long-term results of various operations for lumbar disc herniation: analysis of over 39,000 patients. *Med Princ Pract*, 2015, 24: 285–290.
3. Phillips FM, Slosar PJ, Youssef JA, Andersson G, Papatheofanis F. Lumbar spine fusion for chronic low back pain due to degenerative disc disease: a systematic review. *Spine (Phila Pa 1976)*, 2013, 38: E409–E422.
4. Cao P, Chen Z, Zheng Y, et al. Comparison of simple discectomy and instrumented posterior lumbar interbody fusion for treatment of lumbar disc herniation combined with Modic endplate changes. *Chin Med J (Engl)*, 2014, 127: 2789–2794.
5. Song D, Chen Z, Song D, Li Z. Comparison of posterior lumbar interbody fusion (PLIF) with autogenous bone chips and PLIF with cage for treatment of double-level isthmic spondylolisthesis. *Clin Neurol Neurosurg*, 2015, 138: 111–116.
6. Jalalpour K, Neumann P, Johansson C, Hedlund R. A randomized controlled trial comparing transforaminal lumbar interbody fusion and uninstrumented posterolateral fusion in the degenerative lumbar spine. *Global Spine J*, 2015, 5: 322–328.
7. Lee WC, Park JY, Kim KH, et al. Minimally invasive transforaminal lumbar interbody fusion in multilevel; comparison with conventional transforaminal interbody fusion. *World Neurosurg*, 2015, 85: 236–243.
8. Ahn J, Tabaraee E, Singh K. Minimally invasive transforaminal lumbar interbody fusion. *J Spinal Disord Tech*, 2015, 28: 222–225.

- 9.** Li M, Yang H, Yang Q. Full-endoscopic technique discectomy versus microendoscopic discectomy for the surgical treatment of lumbar disc herniation. *Pain Physician*, 2015, 18: 359–363.
- 10.** Destandau J. A special device for endoscopic surgery of lumbar disc herniation. *Neurol Res*, 1999, 21: 39–42.

- 11.** Kulkarni AG, Bassi A, Dhruv A. Microendoscopic lumbar discectomy: technique and results of 188 cases. *Indian J Orthop*, 2014, 48: 81–87.
- 12.** Kunert P, Kowalczyk P, Marchel A. Minimally invasive microscopically assisted lumbar discectomy using the METRx X-tube system. *Neurol Neurochir Pol*, 2010, 44: 554–559.