Chapter 13
Unilateral Biportal Endoscopy for Non-migrated Lumbar Disc Herniation

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Abbreviations

AP	Anteroposterior
LDH	Lumbar disc herniation
LM	Lumbar microdiscectomy
MISS	Minimally invasive spine surgery
MRI	Magnetic resonance imaging
PELD	Percutaneous endoscopic lumbar discectomy
RF	Radiofrequency
UBE	Unilateral biportal endoscopy

Introduction

Lumbar disc herniation (LDH) is a common degenerative spinal disease. The current standard surgery for LDH is lumbar microdiscectomy (LM). However, muscle and ligament injury from surgery can lead to postoperative back pain and muscle atrophy [1–3]. Therefore, more time may be required for functional recovery and pain control after LM.

Thus, in recent years, minimally invasive spine surgery (MISS) techniques have been developed to reduce the damage to surrounding tissues [4–7]. Percutaneous

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endoscopic lumbar discectomy (PELD) is one of the MISS techniques and has been performed using only one portal [8–11]. This conventional endoscopic surgery which is called uniportal transforaminal and interlaminar PELD is an appropriate surgical method. It can protect the posterior musculoligamentous structures better than LM. Although these procedures can remove soft disc herniation and ruptured LDH without foraminal obstruction by well-designed surgical tools, they have limited indications due to the restricted movements of the endoscope and instruments and obstructed intervertebral foramen following degenerative changes [1, 12].

Unilateral biportal endoscopy (UBE) is a new endoscopic technique that combines the advantages of interlaminar endoscopy and microscopic surgery [13–17]. In this method, two portals are used. One is for viewing with the endoscope, and the other is for using instruments, and these two portals move independently. This is enormous progress compared to the uniportal method; its property allows the surgeon to overcome the limitation of surgical indication of uniportal endoscopy [18]. Moreover, the endoscopic trajectory has the same steps as conventional microsurgery with a clear view; thus, it may help the learning curve earlier [19, 20]. UBE has many advantages such as protection of the musculoligamentous complex, a smaller incision, less postoperative back pain, and a short hospitalization period. Another advantage is that UBE causes less postoperative morbidity by reducing the incidence of epidural fibrosis and by raising the preservation of the epidural venous system [21]. Furthermore, complicated cases such as highly migrated disc herniation and herniated disc with concomitant spinal stenosis can be treated with UBE.

Such benefits of UBE surgery including simple discrimination of anatomic structures, tender manipulation of pathology with a magnified endoscopic view, and detailed operative information might contribute to getting successful results in the lumbar disc herniations.

Indications

UBE has a wider range of spectrum for indications that are similar to those for conventional LM [22].

All herniated discs such as central, lateral, foraminal, and extraforaminal; upward migrated or downward migrated; moderate to large; and recurrent lumbar disc herniations can be treated under UBE.

Limitations

1. Decompression of the exiting nerve is difficult in the foraminal stenosis with the narrow disc space and bony spur through a paraspinal approach.
2. Advanced spinal deformity and unstable stenotic spine: Instrumentation for distraction and stabilization is required in these cases.

Equipment

Endoscope: 0° or 30°, 4 mm diameter (Conmed Linvatec, Utica, NY) (Fig. 13.1)
Radiofrequency probe (ArthroCare Sports Medicine Quantum-II, USA)
One-sided protected drill burr, spherical or oval (Conmed Linvatec, Utica, NY) (Fig. 13.2)
Pressure pump irrigation system (Conmed Linvatec, Utica, NY)
Standard laminectomy instruments
Blunt muscle detacher and serial dilators (Fig. 13.3)

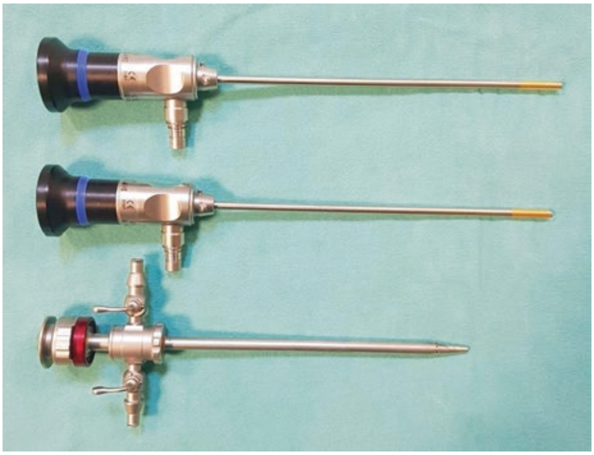

Fig. 13.1 0° and 30° endoscope and trocar

Fig. 13.2 One-side protected drill, oval and spherical

Fig. 13.3 Blunt muscle detacher and serial dilators

Surgical Procedure

There are two basic approaches which are paramedian and paraspinal (Fig. 13.4). However, modified and targeted approaches can also be adopted depending on the pathology and location [23].

Paramedian Approach

The paramedian approach is applied for pathologies of central and lateral recess on the spine.

1. Position and anesthesia

   The UBE is performed with the patient under general anesthesia on a radiolucent operating table. The patient is placed in the prone position over the rolling pad in a flexed position (Fig. 13.5). A waterproof surgical drape is applied after sterile preparation.
2. Target point

   The spinous process is identified on the anteroposterior (AP) position, and the midline is created on that spinous process under C-arm fluoroscopic guidance.

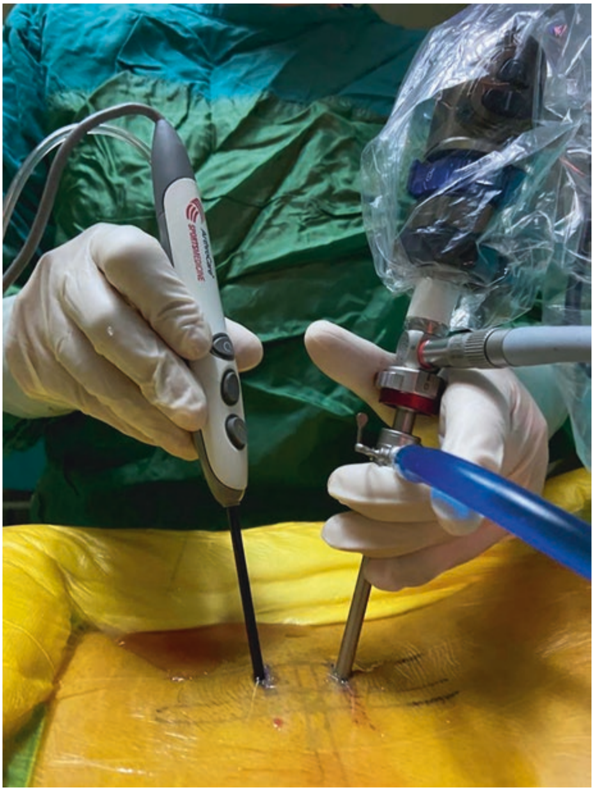

Fig. 13.4 Intraoperative image of UBE

Fig. 13.5 Patient position

Then, the interpedicular line is determined on the medial side of the pedicle. After that, the target level is identified. Two entry points for endoscopic and working portals are made about 1 cm above and 1 cm below the ruptured disc level at the ipsilateral interpedicular line for the paramedian approach (Fig. 13.6).

3. Working portal

The first skin incision for the working (caudal) portal is opened around 1 cm horizontally above the target point. Then, serial dilators are inserted into the potential space located between fascicles of the multifidus muscles, which is also defined as the multifidus triangular space in the lamina (Fig. 13.7). Interlaminar soft tissue is dissected from the distal margin of the spinolaminar

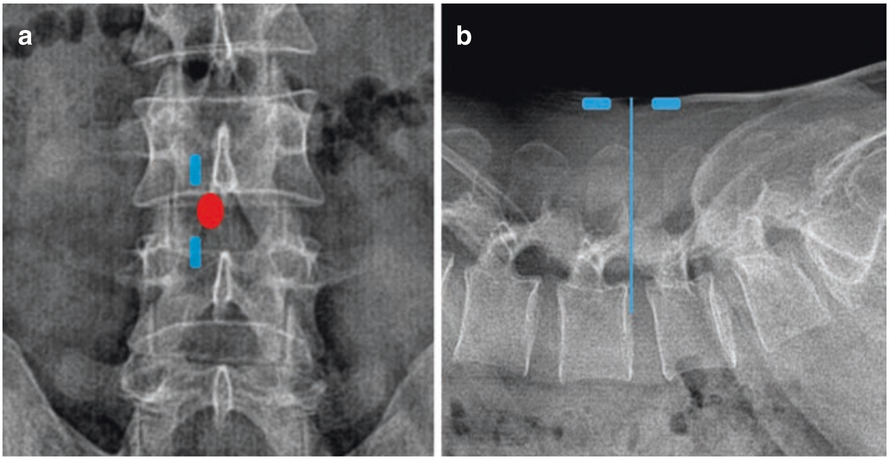

Fig. 13.6 Skin points of the two portals for paramedian approach in the lumbar spine. (**a**) AP view. (**b**) Lateral view

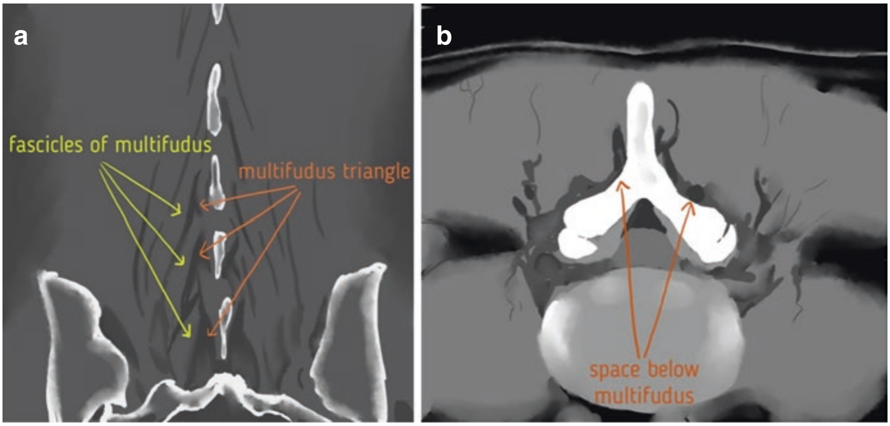

Fig. 13.7 Here are the potential spaces between fascicles of the multifidus muscle, which is also defined as the multifidus triangle for the paramedian approach. Two portals are made in the multifidus triangle. (**a**) Coronal view. (**b**) Axial view

junction to the medial side of the facet joint to prepare enough visual space for allowing to work in earnest with blunt muscle detacher.

4. Endoscopic portal

   The second skin incision for the endoscope (cranial) portal is opened 7 mm horizontally about 2–3 cm away from the first incision (Video 13.1). Either a 0° or 30° endoscope is inserted through the cranial portal after insertion of the trocar.

   For continuous saline irrigation, a pressure pump irrigation system is connected to the endoscope and is set to a pressure of 30–50 mmHg during the procedure. Simple water pressure control using the height of the saline bag on the fluid stand is also possible. For this, hanging the saline bag 170 cm high from the ground or holding it 100 cm high from the patient would be enough to achieve the safe pressure practically. A controlled continuous fluid flow is essential to prevent the extreme rise of the epidural pressure. Furthermore, the continuous flow of saline irrigation clears the endoscopic surgical view and prevents bleeding in the operative field. The irrigation saline flows from the cranial portal to the caudal portal.

5. Triangulation

   Surgical instruments are inserted through the working portal (Fig. 13.8). Then, these two portals make a triangular shape on the interlaminar space (Figs. 13.9 and 13.10). After triangulation, the soft tissue overlying the lamina and ligamentum flavum is cleaned with the radiofrequency probe. Following this completed exposure, the surgical endoscopic view is clearer due to the expansion of the interlaminar space with irrigation saline.

6. Laminotomy and discectomy

   The upper border of the lower lamina and medial border of the facet are removed ipsilaterally as needed with a one-side protected drill and Kerrison punches (Fig. 13.11). The ligamentum flavum is dissected and removed until full

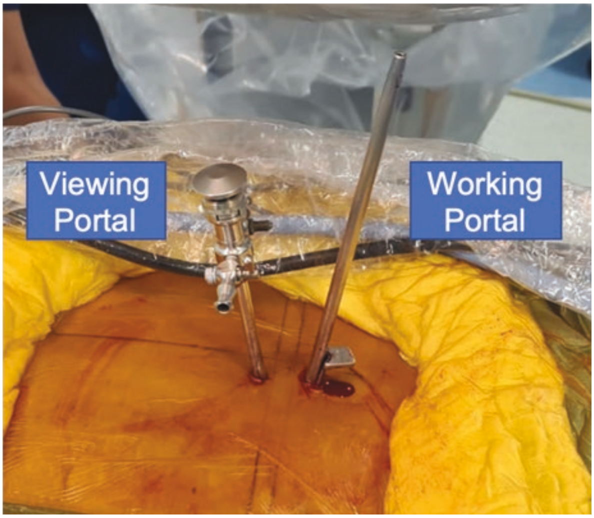

Fig. 13.8 Both portals are created in a triangular shape. (*Image courtesy of Javier Quillo-Olvera M.D.*)

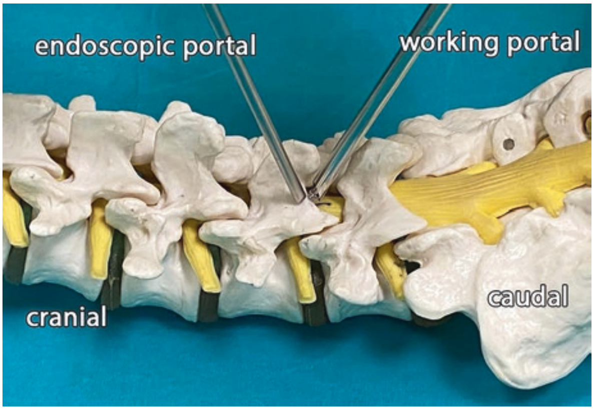

Fig. 13.9 Example with an anatomical model of how triangulation should be performed with both ports addressed to the target

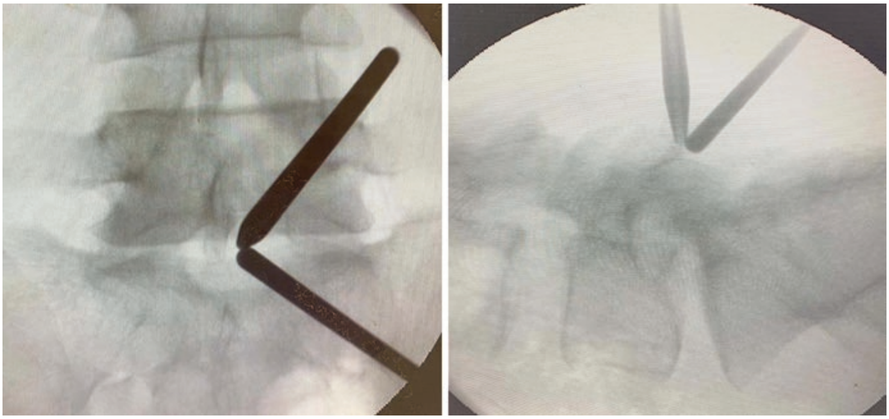

Fig. 13.10 Triangular approach was verified with the C-arm. Left: AP view. Right: Lateral view

identification of the lateral border of the nerve root (Fig. 13.12). However, the ligamentum flavum should be left intact as much as possible to act as a protective shield for neural structures.

The nerve root is gently retracted (Fig. 13.13). Annular incision, disc fragment dissection, and ruptured fragment removal are performed carefully. After checking the nerve root is free and disc space is decompressed using a 90° hook dissector, a minivac drain is placed temporarily and the skin is sutured with a 3:0 absorbable suture.

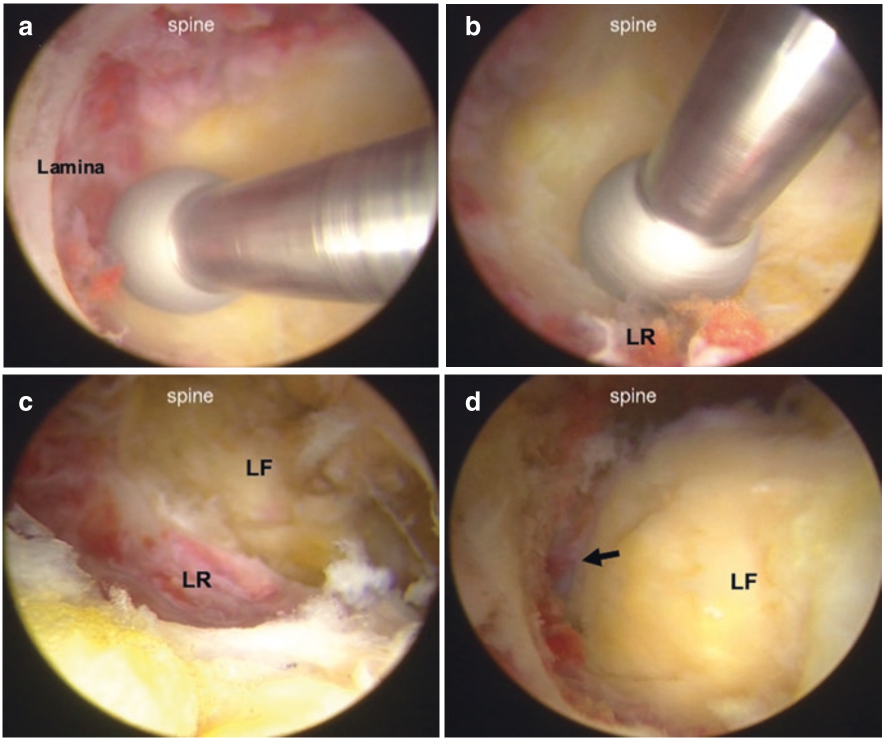

Fig. 13.11 Limited laminotomy is performed until identifying the ligamentum flavum attachments. (**a**) Circumferential bone removal starting with superior lamina. (**b**) The lateral recess (LR) is undercutting ipsilaterally. (**c**) The ligamentum flavum (LF) is identified. (**d**) Bone removal stops until the LF attachments (black arrow) are observed. (*Images courtesy of Javier Quillo-Olvera M.D.*)

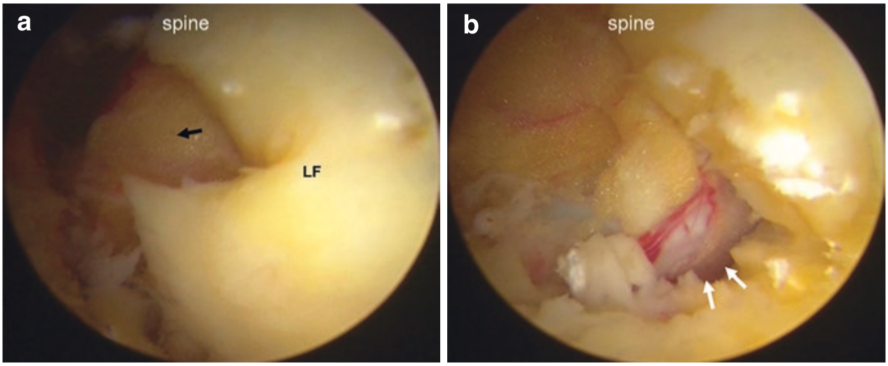

Fig. 13.12 Ligamentum flavum (LF) is dissected from the lamina and removed until identifying the lateral border of the dural sac and the traversing nerve. (**a**) The epidural space (black arrow) is exposed after partial flavectomy. (**b**) The lateral border of the dural sac (white arrows) is apparent after lateral flavectomy. (*Images courtesy of Javier Quillo-Olvera M.D.*)

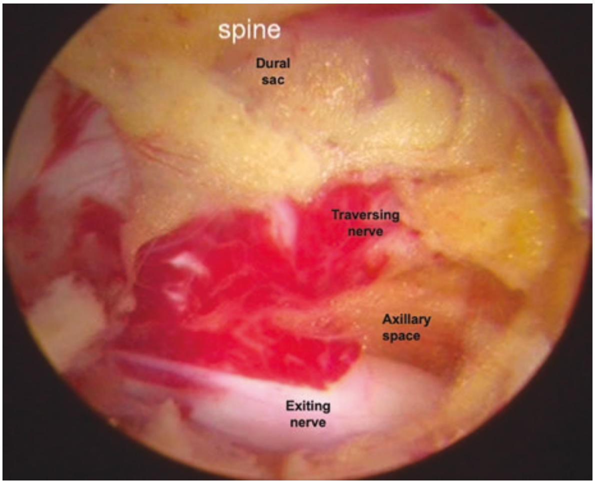

Fig. 13.13 The neural elements were confirmed with the endoscope. (*Image courtesy of Javier Quillo-Olvera M.D.*)

Illustrated Cases

Case 1

A 66-year-old male presented severe pain in both legs, with being more severe on the left side. Preoperative lumbar MRI showed a central ruptured disc of L4–L5 level (Fig. 13.14). We performed UBE discectomy successfully (Fig. 13.15). After surgery, the ruptured disc was thoroughly removed. Postoperative MRI showed complete removal of the disc particles (Fig. 13.16 and Video 13.2).

Case 2

A 49-year-old female patient had severe radicular pain in the left leg. Preoperative lumbar MRI showed extruded disc herniation in the L5–S1 level (Fig. 13.17). We performed a paramedian UBE approach (Fig. 13.18). After UBE discectomy, post-operative MRI showed that extruded disc was completely removed and S1 root was well decompressed (Fig. 13.19 and Video 13.3).

Paraspinal Approach

In central, paracentral, and foraminal disc herniations, the paramedian approach is adequate. In disc herniations of far lateral and intraforaminal, basically, the pathologies which are on lateral of pedicle midline, the paraspinal (paravertebral) approach is applicable [23] (Fig. 13.20).

Skin points in lateral position for the paraspinal approach are nearly the same as the paramedian approach. In this approach, the difference is about the AP position. Two portals are opened in the paraspinal area. These entry points are formed along the imaginary line connecting the tips of the transverse processes, which are 1 or 1.5 cm far from the vertebral body of the foraminal disc level for the paraspinal approach (Fig. 13.21). Initially, the working portal is formed at the junction of a

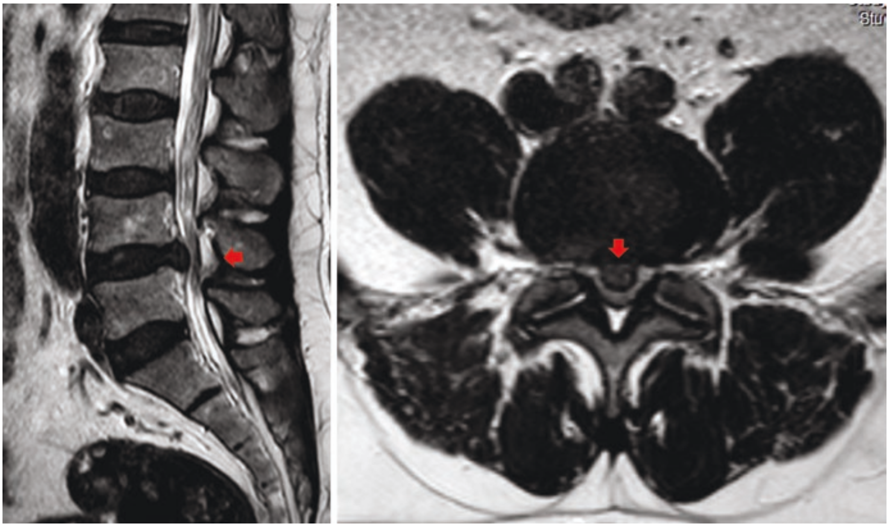

Fig. 13.14 Case 1: Preoperative lumbar MRI showing a central LDH at L4–L5 (red arrows) causing severe central spinal stenosis

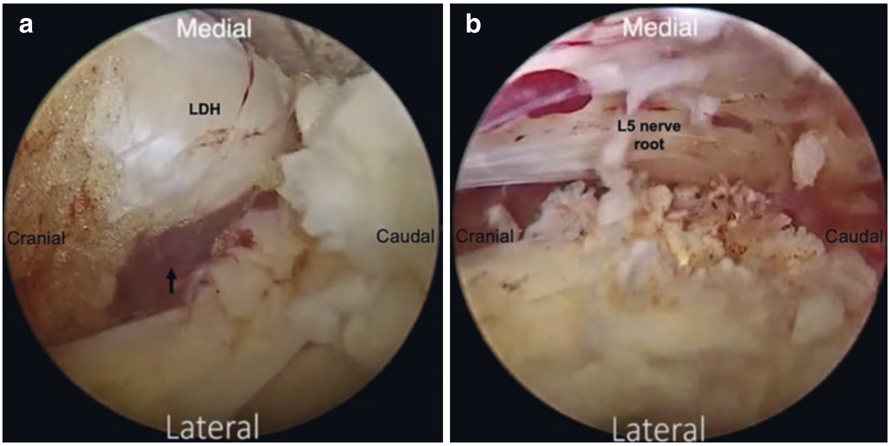

Fig. 13.15 Intraoperative endoscopic view during Case 1 surgery. (**a**) Identification of the lumbar disc herniation (LDH) in the ventral epidural space (black arrow). (**b**) The left-sided L5 nerve root was decompressed

point 1 cm lateral to the lateral border of the pedicle and the lower endplate. Secondly, the endoscopic portal is formed on the lower margin of the transverse process of the upper vertebrae under the C-arm. The target points are the isthmus in the AP view, and the middle of the foramen in the lateral X-ray view.

Paravertebral UBE approach principles are the same as the paramedian UBE approach. This approach is no different from the endoscopic version of the "Wiltse" approach that is known in microsurgery.

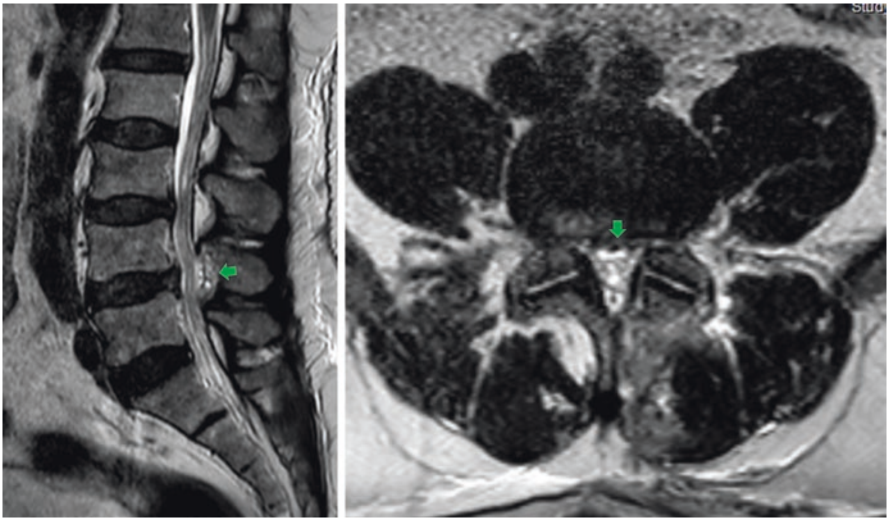

Fig. 13.16 Case 1: Postoperative lumbar MRI. Acceptable decompression was achieved at L4–L5 with the UBE technique

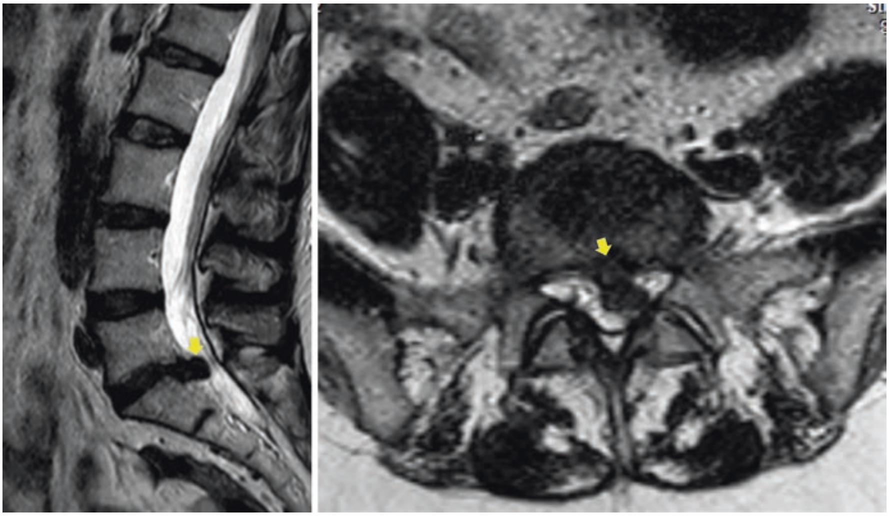

Fig. 13.17 Case 2: Preoperative lumbar MRI shows an extruded LDH (yellow arrows) on the left side at L5–S1

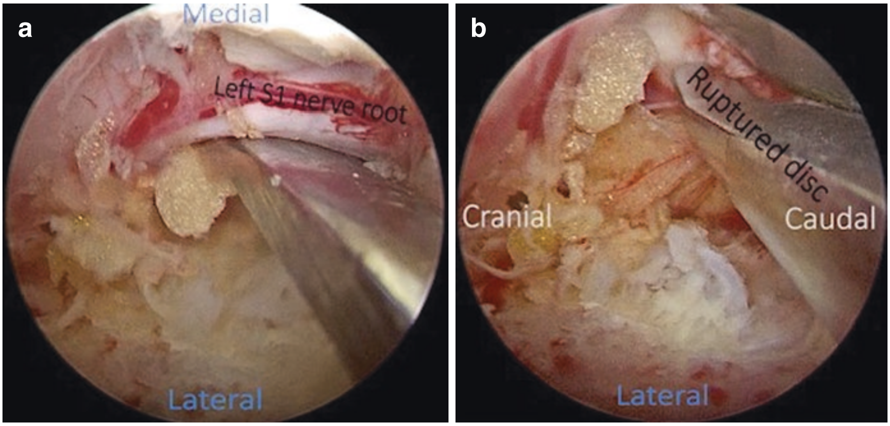

Fig. 13.18 Intraoperative images with the endoscope from Case 2. (**a**) After bone removal, the left S1 nerve root has been exposed. (**b**) The disc herniation is identified below the left S1 nerve

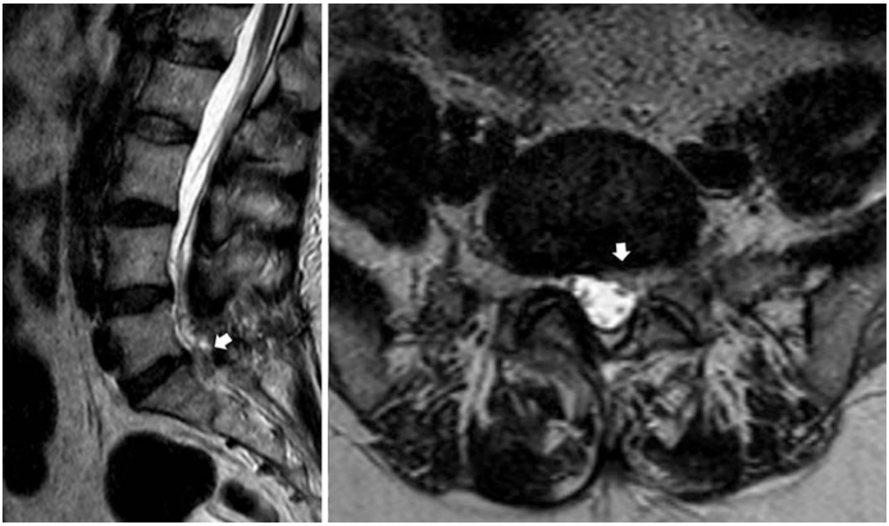

Fig. 13.19 Case 2: Postoperative lumbar MRI. The white arrows point to L5–S1 after discectomy

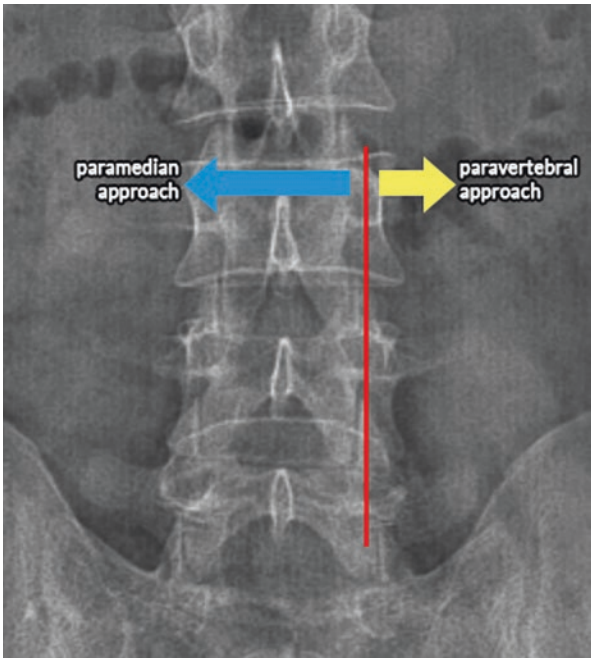

Fig. 13.20 The two basic approaches in UBE depend on the pathology and location

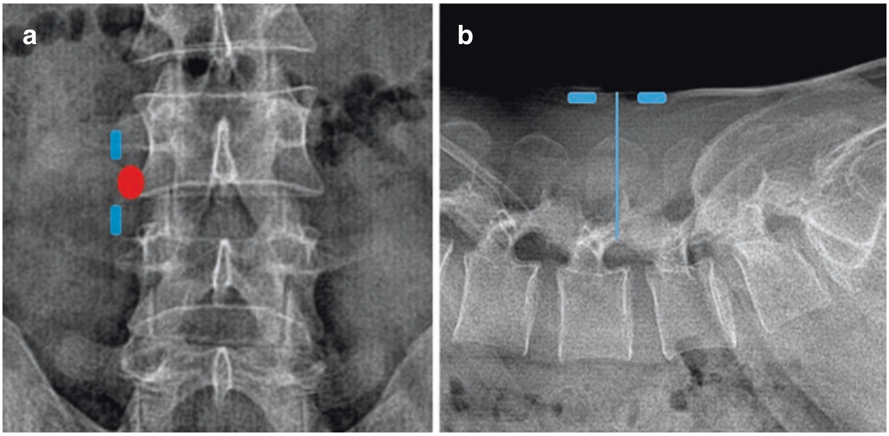

Fig. 13.21 Portal entrances for paramedian approach. (**a**) AP view. (**b**) Lateral view

Serial dilators are inserted through the skin incision in the direction of the isthmus. Following removal of the dilators, the blunt muscle detacher is moved into the transverse process, and soft tissue on the isthmus and the lateral border of the facet joint is dissected. Then, an endoscope is inserted into the trocar from its sheath, and an RF probe is inserted in the working portal. After triangulation, an RF probe is used to clean the soft tissue on the upper transverse process, isthmus, and superior

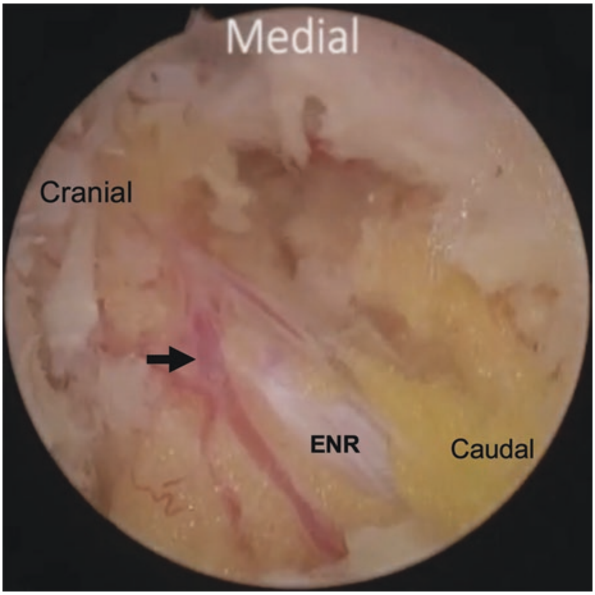

Fig. 13.22 Endoscopic view through a paraspinal (paravertebral) lumbar approach with UBE. (**a**) Dorsal branch of the segmental artery. (**b**) Exiting nerve root

facet joint. Firstly, the isthmus is found; in doubting situations after isthmus is viewed, a control check must be done with fluoroscopy. After that, lateral facetectomy is applied partially with an arthroscopic burr, and then it is enlarged with Kerrison punches. Here, the movement should be towards the distal pedicle, disc space should be reached, and bone resection should be applied cranially to find nerve root (Fig. 13.22). After the intertransverse ligament is carefully removed, then the exiting root is explored. Here, the dorsal branch of the segmental artery should be seen (Fig. 13.22). Then, this artery must be coagulated with an RF probe; otherwise, bleeding might be too much for surgery to continue with ease. Nerve root ganglion should not be manipulated at the best, and no irritation should be done with the help of a retractor [23]. The ruptured disc is removed, and discectomy is done under endoscopic view.

Illustrated Case

Case 3

A 54-year-old female complained of radicular pain in her left leg. The preoperative lumbar MRI showed disc herniation at the left extraforaminal area at L4–L5 (Fig. 13.23). A paraspinal (paravertebral) approach for L4–L5 on the left side was planned with UBE. During the surgery, the LDH was ablating with the RF probe, and the exiting L4 nerve root was decompressed (Fig. 13.24). Postoperative lumbar MRI showed sufficient decompression at the extraforaminal area at L4–L5 on the left side (Fig. 13.25 and Video 13.4).

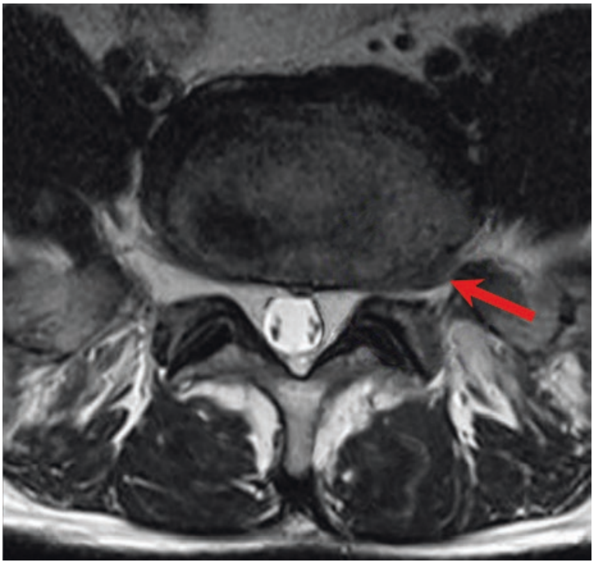

Fig. 13.23 Axial view at L4–L5 on the lumbar MRI from Case 3. The red arrow points to an extraforaminal LDH on the left side

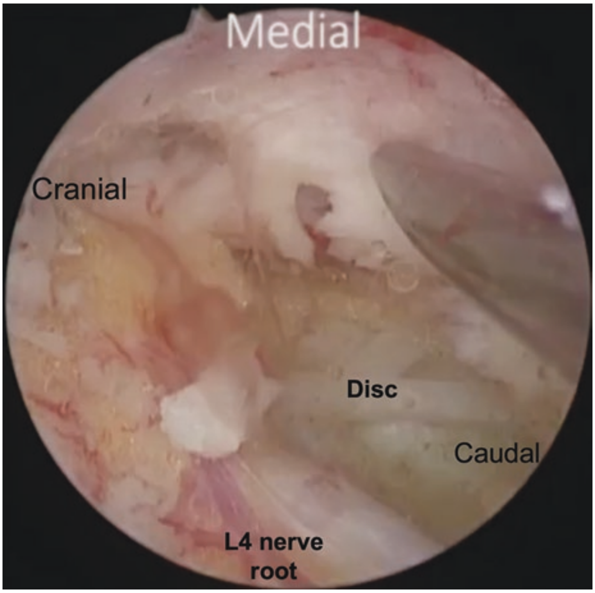

Fig. 13.24 Intraoperative endoscopic view of the L4 nerve root after discectomy through a UBE paraspinal approach. The extraforaminal disc space is observed

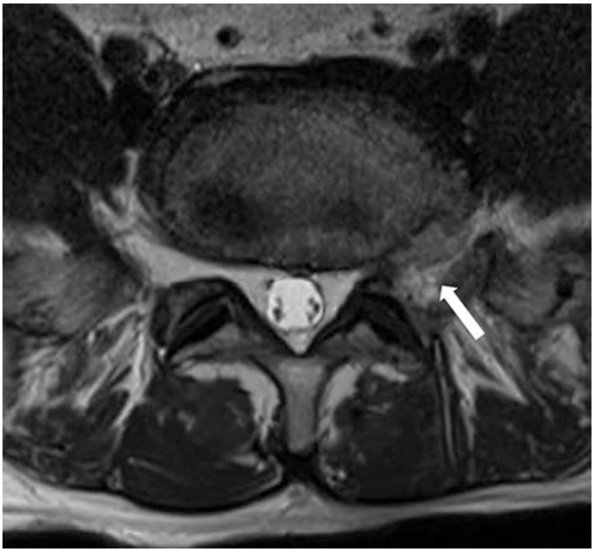

Fig. 13.25 The immediate postoperative axial view on the MRI of L4–L5 showed complete decompression of L4 on the extraforaminal left-side area

Advantages

For surgeons:

- Easy handling
- Familiar surgical anatomy and approach
- Minimal muscle injury
- Use of the standard surgical instruments as in microscopic discectomy
- Easy pressure control of continuous fluid irrigation thanks to biportal system
- Better and wider visualization
- Reduced bleeding: Continuous irrigation of saline allows better bleeding control
- A migrated ruptured disc can be handled

For patients:

- Minimal muscle and bone damage
- Less pain
- Early rehabilitation
- Reduced hospital stay
- Early return to work [24–26]

Complications and Avoidance

Possible complications of the UBE technique are classified into early and late.

1. Early complications

    - Dural tears: Incidental durotomy is a rare complication during the procedure. Using collagen fibrin patches such as TachoSil can be directly repaired for small dura tears with no neural incarceration under endoscopic view [27].
    - Increased cerebrospinal pressure and neurological dysfunction: Constant inflow of irrigation without proper outflow may cause fluid to collect in the limited area of the spinal canal, which may increase cerebrospinal fluid pressure; then, it can lead to neurological dysfunction such as headache, neck pain, seizure, or cerebral edema [28–30]. The surgeon should always attempt to ensure a good inflow and outflow system while maintaining irrigation pressure at an average of 30–50 mmHg [31].
    - Epidural hematoma: Careful hemostasis before the closure is a key to preventing hematoma formation. The surgeon should consider keeping a soft suction drainage tube to drain irrigation fluids and blood for the first postoperative day [32].

2. Late complications

    - Infection: The infection rate after UBE surgery is very low. However, excessive usage of RF may cause fat and tissue necrosis leading to a high risk of infection [23].
    - Recurrence: UBE allows a targeted approach to the annular rupture site without violation of the normal annulus. Annuloplasty can be done in all disc herniations, reducing the risk of recurrence.

Conclusion

UBE can be an effective treatment modality for LDH. The anatomic trajectory and endoscopic view are similar to that of conventional LM. It provides an exceptional and extraordinary navigation experience to the spinal canal, which makes the procedure safer by enhancing the view of neural and vascular structures. UBE discectomy has quite sufficient and direct fragmentectomy, and discectomy to that in LM resulted in the same clinical outcomes while preserving the spinal tissues. Considering adequate indications, UBE is a highly feasible alternative endoscopic technique to microsurgery.

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