11 Endoscopic Percutaneous Discectomy

Ali Guven Yorukoglu, Luigi Manfrè, and Altay Sencer

11.1 Introduction

Lumbar disc herniations, being the most common pathology in the lumbar spine, are a major cause of back pain as well as radiating leg pain. Statistics show that about 85% of population has experienced back pain with or without leg pain, at least once in their life [1–8]. A small but significant part of those patients with major or progressive neurologic problems like deteriorating neurologic deficits or symptoms of cauda/conus syndrome or who did not benefit from medical management are candidates for major or minor surgical procedures. Microsurgical discectomy is still accepted as the golden standard of surgical treatment. Nucleoplasties and foraminal injections, laser discectomies, and percutaneous endoscopic discectomies can be described as minor or minimally invasive surgical procedures [1–4, 9–17].

In the last three decades, minimally invasive endoscopic surgical techniques have been widely adopted in different fields of medicine, with the evolution and refinement of surgical endoscope. Minimally invasive procedures to lumbar spine date back to 1948, as Valls et al. described a percutaneous technique for aspiration biopsy in the diagnosis of vertebral body lesions [18]. In 1970s, Hijikata and Kambin, separately, defined a posterolateral approach for percutaneous central nucleotomy [6, 19]. After the first visualization of intervertebral disc space with a

A. G. Yorukoglu
RIWOspine GmbH, Knittlingen, Germany

Istanbul Spine Center, Florence Nightingale Hospital, Istanbul, Turkey
e-mail: ali-gueven.yoeruekoglu@riwospine.com

L. Manfrè
Minimal Invasive Spine Therapy Department, Mediterranean Institute of Oncology, Catania, Italy

A. Sencer (✉)
Department of Neurosurgery, Istanbul University Medical School, Istanbul, Turkey

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modified arthroscope at the first half of 1980s, endoscopic lumbar discectomy techniques showed improvement [4, 20–24]. But introduction of surgical microscope into neurosurgery during this time period and its widely accepted use caused a slowdown or cessation in endoscopic neurosurgical procedures including endoscopic disc surgery. Descriptions of "Yeung Endoscopic Spine System (YESS)" by Yeung and full-endoscopic interlaminar technique by Ruetten mark the comeback of endoscopic disc surgery [25–27]. Today, providing higher postoperative patient comfort, endoscopic lumbar discectomy has become a significant alternative to conventional MD in the management of lumbar disc herniations.

Various techniques have been described, but mainly, minimally invasive endoscopic approaches to the lumbar spine can be classified into two major categories: transforaminal (TF) and interlaminar (IL). IL approaches can be summarized as endoscopy assisted techniques and full-endoscopic techniques. Endoscopy assisted IL approaches have been pioneered and popularized by Destandeu (also called after him) [16]. These systems have been further developed by various companies and are still used. But their main disadvantage is that the operation is performed not through the working channel of the endoscope but through tubular dilators, and the endoscope is used only for visualization, like the microscope. Therefore, these approaches called "endoscopy assisted" and, because the purpose of this chapter is to describe the fully endoscopic technique, they will not be mentioned further.

11.2 Indications and Standard Approaches

Common indications for full-endoscopic discectomy do not differ from the widely accepted indications of microdiscectomy [27–32]. Today, all kinds of lumbar disc herniations that need surgical treatment can be operated via using an operating microscope and can also be operated by percutaneous full-endoscopic approach; all lumbar levels, all locations from median to far-lateral and all types from protrusions to sequestered fragments. Therefore, indications for full-endoscopic discectomy will not be discussed here.

The choice between transforaminal and interlaminar approaches for full-endoscopic discectomy is based on the principles previously defined by Ruetten et al. [28, 33–35]. Transforaminal approach, providing direct access to the pathology (disc), is usually considered as first choice but because of anatomic limitations IL approach is recommended to be chosen in cases with the following criteria:

(a) When sequestering material is migrated beyond the lower edge of cranial pedicle or over the middle of the caudal pedicle.
(b) When foramen is overlaid by iliac crest on lateral plain radiographs.

The surgeon's experience and preference also play a major role in this decision (Figs. 11.1 and 11.2) [28, 33, 34].

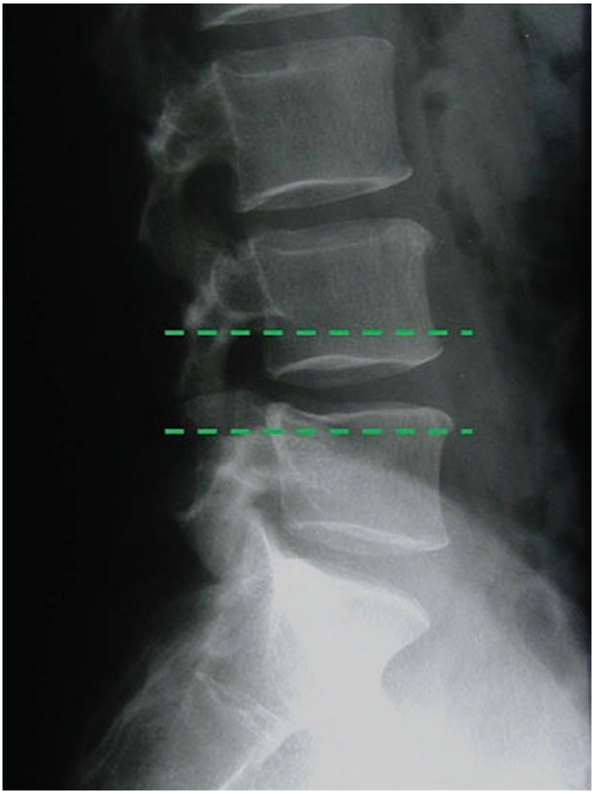

Fig. 11.1 Easy access area with transforaminal approach

11.3 Surgical Techniques

11.3.1 Interlaminar (IL) Approach

For the comfort of the patient and surgeon, the operation is performed under general anesthesia, if there are no contraindications. The patient is placed on the operating table in prone position. Shoulders and pelvis are supported by gel cushions to relieve the pressure on the thorax and abdomen (Fig. 11.3). The spine may be slightly flexed for easier access into the interlaminar space. The C-arm is positioned under the radiolucent operating table allowing sterile biplanar X-ray.

Under fluoroscopic control, a skin incision (about 5 mm) is made slightly paramedian to the midline on targeted interlaminar space (actually, as close to midline as possible) and ideally, also through the muscle fascia (Figs. 11.4, 11.5, 11.6, and 11.7).

The dilator is bluntly inserted under fluoroscopic control to the lateral edge of the interlaminar space. An experienced surgeon can directly position the dilator on the lig. flavum, but for inexperienced surgeons, it is safer to head for facet joint and feel bony structures (Figs. 11.8 and 11.9).

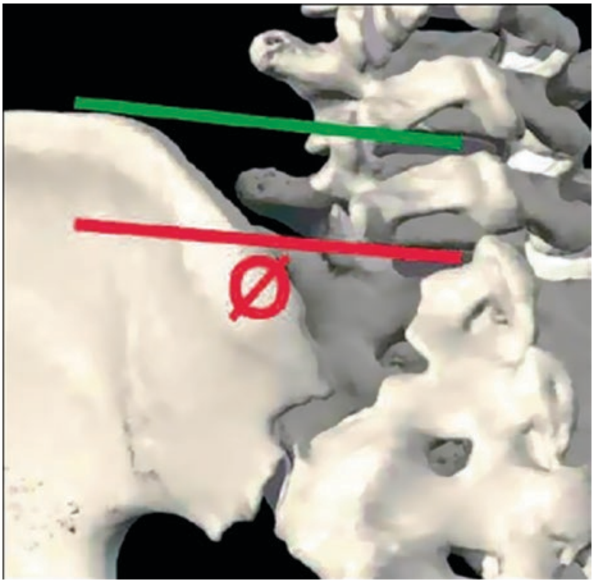

Fig. 11.2 Iliac crest preventing direct access to L5–S1 (red line)

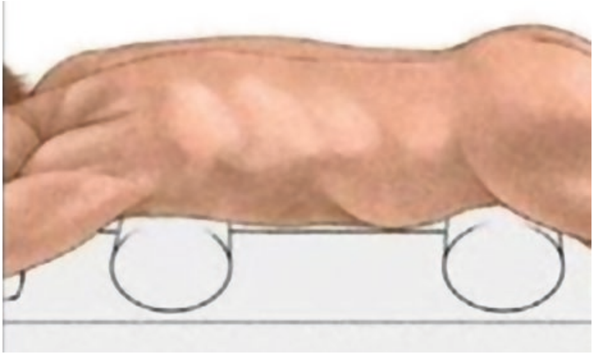

Fig. 11.3 Patient positioning for IL and TF approaches

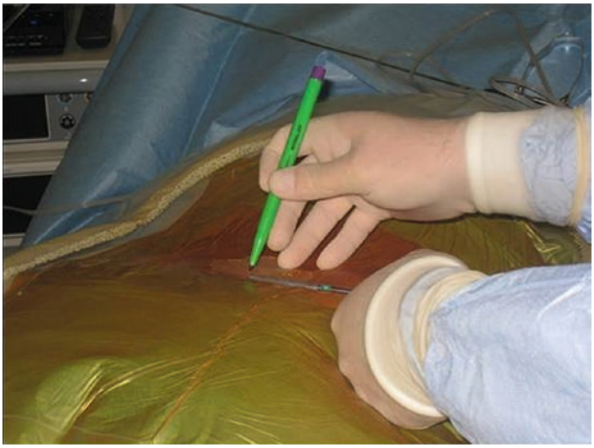

Fig. 11.4 Marking of skin incision for IL approach

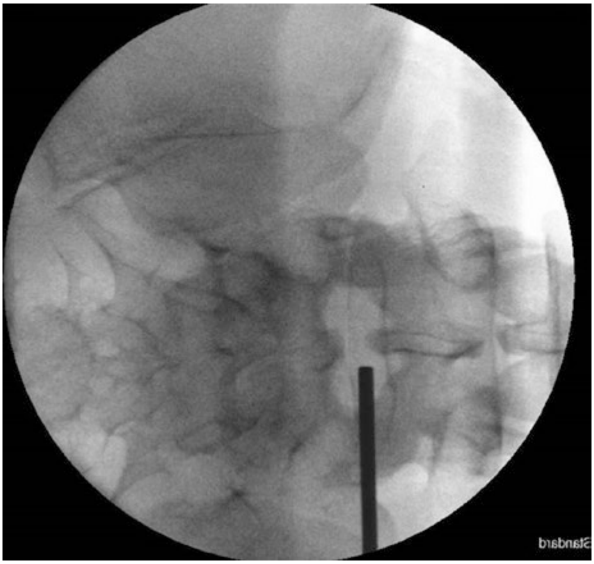

Fig. 11.5 Ideal entry point from skin on X-ray

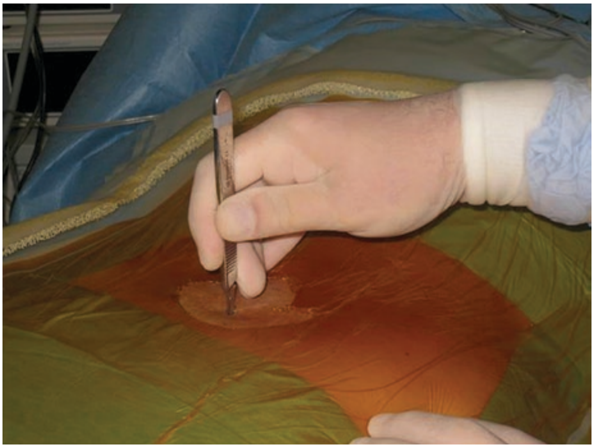

Fig. 11.6 Making of skin incision

After lateral fluoroscopic control for the avoidance of uncontrolled direct spinal canal penetration through ligamentum (lig.) flavum, the working sleeve with the beveled opening is placed over the dilator with the opening pointing medially (Figs. 11.10, 11.11, and 11.12).

As the next step, dilator is removed, endoscope (usually, a 25° optic) is placed and the operation is continued under direct endoscopic view and continuous high-pressure saline irrigation (Fig. 11.13).

Following cauterization and removal of the surrounding soft tissues, mainly paraspinal muscle remnants, lig. flavum is exposed (Fig. 11.14). Usually, radiofrequency (RF) is used for coagulation; it is safe and effective.

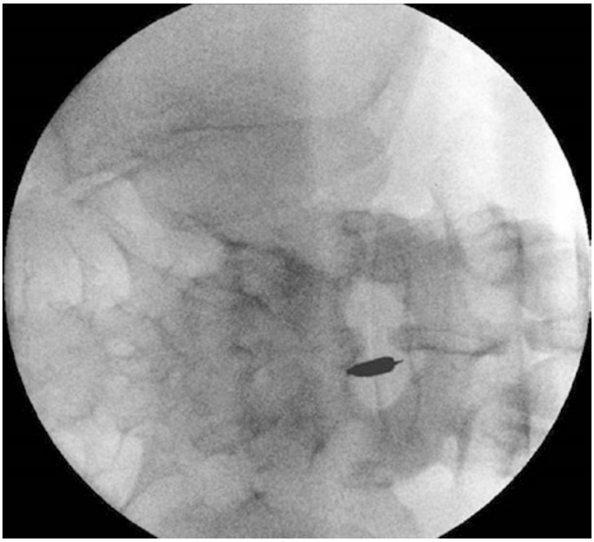

Fig. 11.7 Making of skin incision (Fig. 11.6) ideally through fascia and its fluoroscopic control

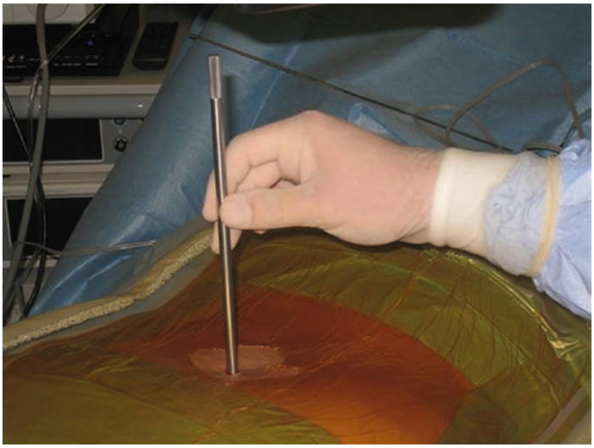

Fig. 11.8 External view of inserted dilator pointing laterally

A 3–5 mm medial incision of the flavum is adequate. For an easy and safe incision into the ligament, working sheath must be pushed down against the ligament to keep it hard and stretched. After incising, the last layer of lig. flavum, usually a small space, is encountered just under the ligament. This space provides a safe zone when advancing the incision from medial to lateral by using the scissor. Incision should be advanced as laterally as possible to reach the lateral aspects of neural structures and if necessary, bone can be removed by drill or Kerrison rongeurs (Fig. 11.15). Care must be taken to make the first incision into ligament medially because later, if necessary, advancing the incision medially would be technically more challenging.

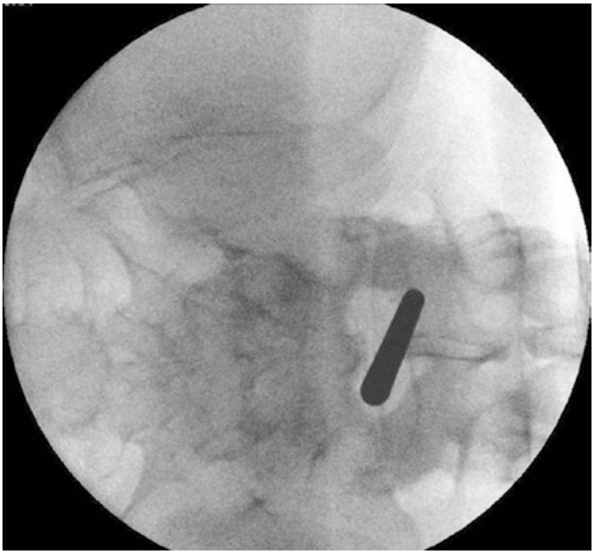

Fig. 11.9 On X-ray, dilator is on lateral bony structures

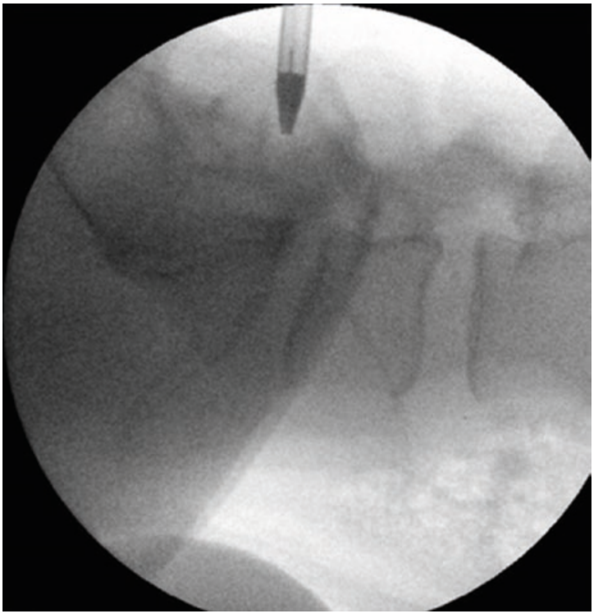

Fig. 11.10 On the lateral X-ray view, dilator is seen just outside the spinal canal

After accessing the spinal canal and removal of epidural fat tissue, dura mater and nerve roots are visualized (Fig. 11.16).

Retracting nerve root medially by dissector, the beveled opening of the working sleeve is lowered through the incision in the ligament over dissector and rotated 180°, and in this way, the sleeve can be used as a nerve root retractor, retracting the root medially and exposing lateral epidural space and herniation (Fig. 11.17).

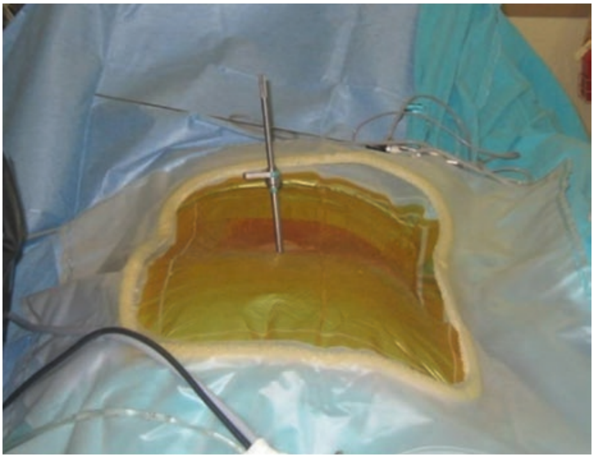

Fig. 11.11 Insertion of beveled working sleeve

Following the cauterization of the epidural veins, discectomy is performed. After the pressure on the root and dural sac has been relieved, accessing the disc space and removal of the entire disc material is up to the surgeon's choice. When the surgeon is satisfied, the operation can be terminated by taking out the sheath and endoscope.

Use of working sleeve as retractor is rather safe and efficient, but in some cases, for example, if the fragment is very big or if it is located in the axilla, the surgeon may prefer not to lower the working sleeve into the epidural space and do an exploration first with help of dissector or RF probe.

A single suture may be necessary for skin closure. Compared to the TF approach, IL approach provides more mobile access, in which the surgeon can conduct the sleeve and endoscope cranially and caudally, and bony resection can be achieved as necessary with the help of drills to remove migrated fragments [25, 28, 33, 34, 36] (Figs. 11.18 and 11.19). Capture of C-arm images and recording of operation are recommended for educational and medicolegal purposes.

11.3.2 Transforaminal Approach (TF)

Usually, we prefer to perform TF approach also under general anesthesia. The patient's position is the same as described for IL approach (Fig. 11.3). Three slightly different techniques are described for TF approach:

11.3.2.1 Posterolateral Transforaminal

In this technique, disc space is accessed by a 45° horizontal angle (Fig. 11.20). Incision is usually made 8 to 10 cm lateral to midline at the targeted disc level [26, 27, 37]. This technique provides adequate access into the disc space, but not to the posterior aspect of disc space, posterior longitudinal ligament (PLL), or anterior epidural space without extensive drilling of facet joint, a major disadvantage for most herniations. On the other hand, this approach is very useful for intradiscal pathologies, like discitis.

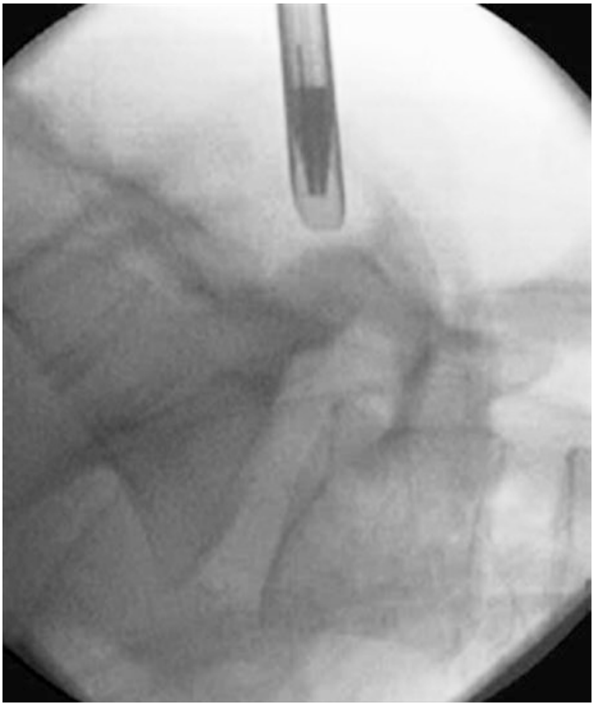

Fig. 11.12 Lateral X-ray view of working sleeve outside the canal

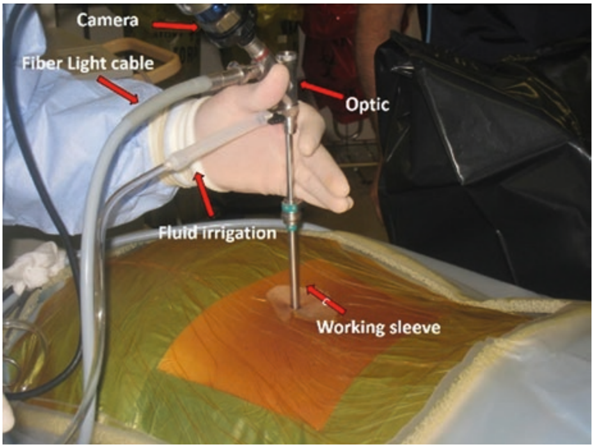

Fig. 11.13 Working with endoscopic view

11.3.2.2 Far-lateral Transforaminal

Disc space is accessed with a horizontal angle of 15° (Fig. 11.21). First introduced by Ruetten, this approach provides easy access to PLL and anterior epidural space [28, 33, 36]. Because of its convenience (easy and direct access to herniation area, no need for bone drilling), it is the most common applied technique today. Location of incision is determined by anatomic landmarks under fluoroscopic guidance and

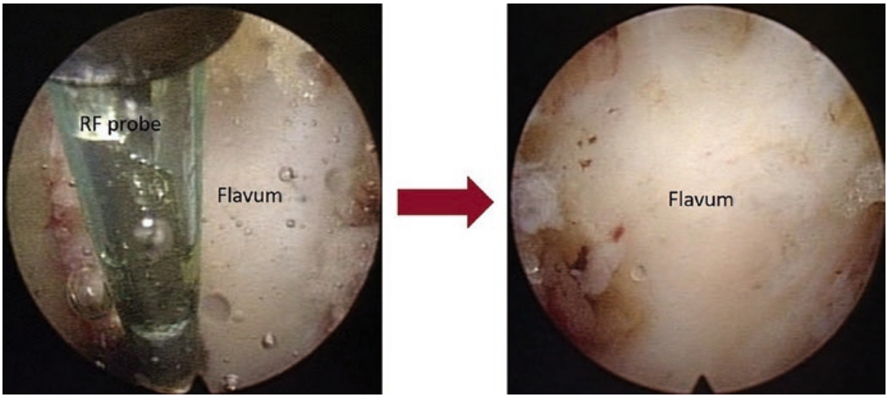

Fig. 11.14 Coagulation of muscle remnants with RF probe and exposure of lig. flavum

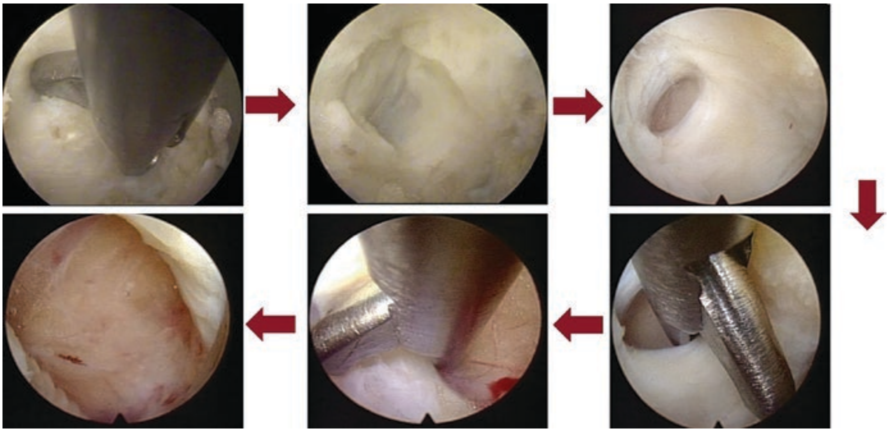

Fig. 11.15 Making the lig. flavum incision under endoscopic view with scissor. After the last layer of ligament is cut, incision is carried forward laterally

not by measurements. We consider this technique as the golden standard for transforaminal access. Surgical steps for this technique are as follows:

Patient's position and operating room arrangement are the same as for IL approach. First, on lateral X-rays, posterior aspect of facet joints is marked on patient's skin as a vertical line. This line limits the insertion incision anteriorly. More anterior and lateral punctures can cause visceral organ injury (Fig. 11.22).

Then C-arm is positioned in AP view and set parallel to endplates at targeted level. On patient's skin, a horizontal line is drawn from disc level to cross the first line (Fig. 11.23). The crossing point of two lines is marked as an incision point for entry.

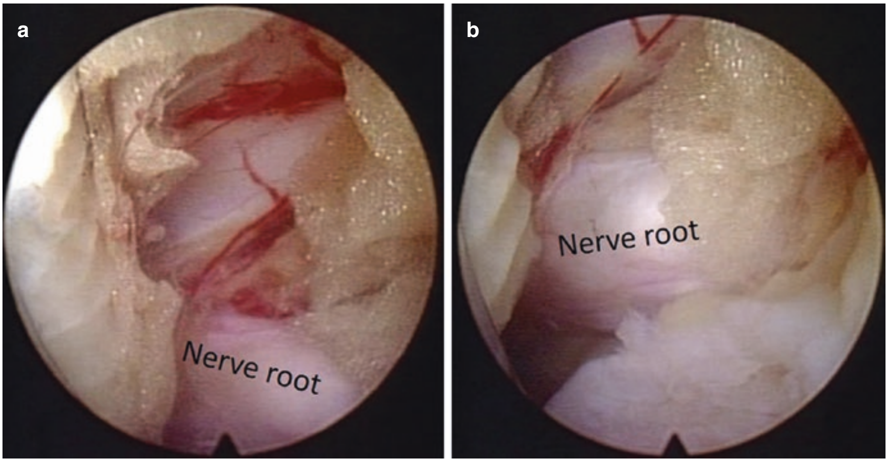

Fig. 11.16 Visualization of neural structures after removal or mobilization of epidural fat (**a**) and insertion of dissector to retract nerve root exposing herniation (**b**)

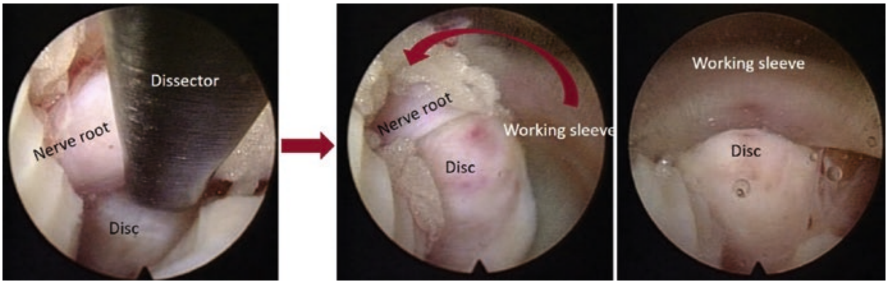

Fig. 11.17 After retraction of nerve by dissector, beveled working sleeve is lowered into epidural space and rotated 180°, retracting nerve root medially and exposing herniation

Next, a 5 mm incision is made on the skin mark. An atraumatic spinal needle is advanced to the target under fluoroscopic control. The target point is dorsal aspect of annulus fibrosis on lateral view, midpedicular line on AP view (Fig. 11.24).

Next step is advancement of guide wire through spinal needle. Then spinal needle is removed and a cannulated dilator is placed over guide wire (Fig. 11.25). When dilator is placed firmly in the foramen entrance (a hammer can be useful), the wire is removed. Care should be taken to keep the dilator at the foramen during this step because it can easily come off. In this case, the procedure should be restarted all over, otherwise uncontrolled movements with the dilator at the foramen may cause exiting root damage.

After dilator is placed in foramen, a working sleeve with beveled opening is positioned over the dilator and dilator is removed. Working sleeve can be placed laterally or medially according to location of herniation (Fig. 11.26).

Fig. 11.18 Exploration for cranially migrated fragment

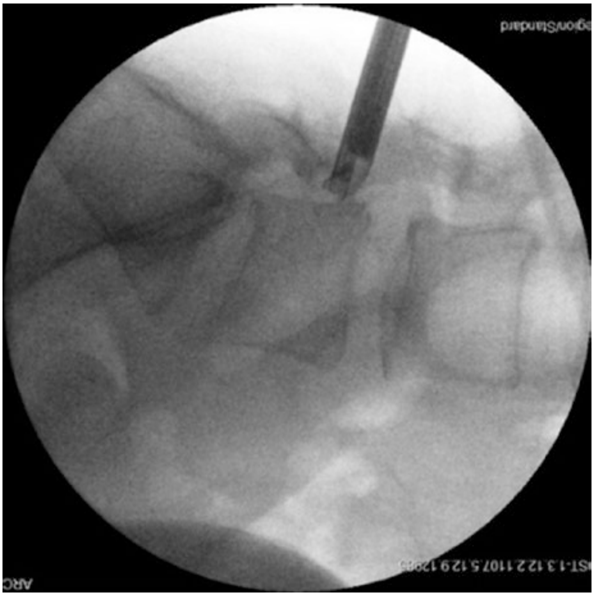

Fig. 11.19 Exploration for caudal migration

Next, endoscope (25° view) is placed through the working sleeve, and the procedure is continued under direct view with pressurized irrigation. Cauterization of remnants of surrounding tissues with RF provides hemostasis and a clean view, a great help for recognizing anatomic landmarks. Three anatomic landmarks should be identified: epidural space, horizontal fibers and PLL, and disc space (Fig. 11.27).

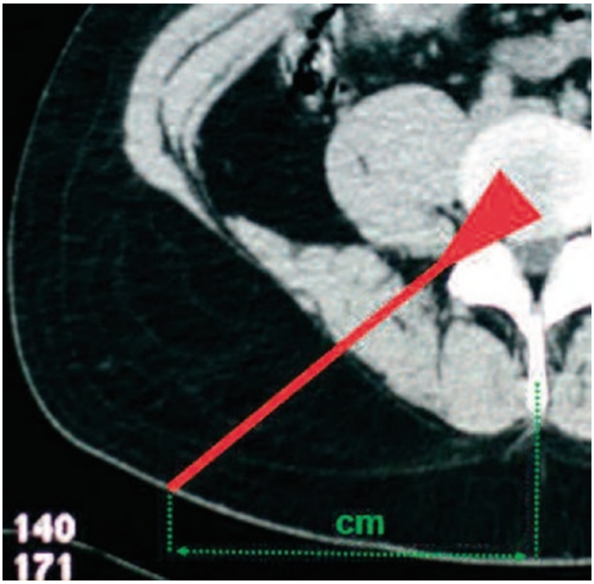

Fig. 11.20 Easily accessible area by posterolateral approach

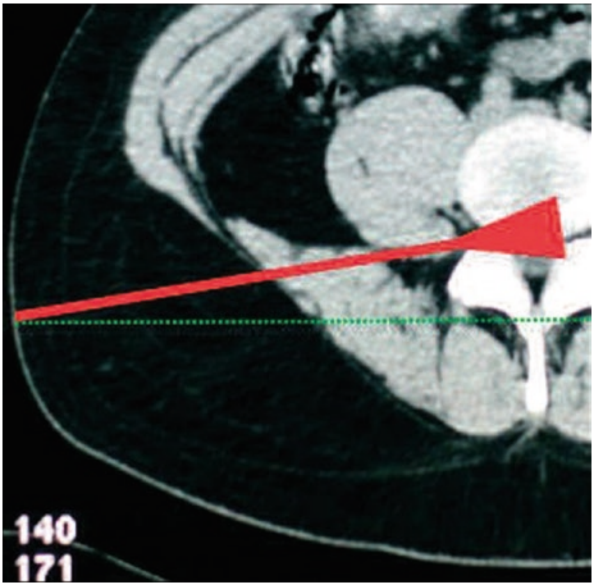

Fig. 11.21 Easily accessible area by far-lateral approach

Horizontal fibers are cut piece by piece and cauterized with RF allowing a larger view, until herniation is recognized. After annular defect has been found and herniated fragment has been removed, free fluctuation of PLL and direct visualization of epidural space indicate that adequate decompression has been achieved (Fig. 11.28).

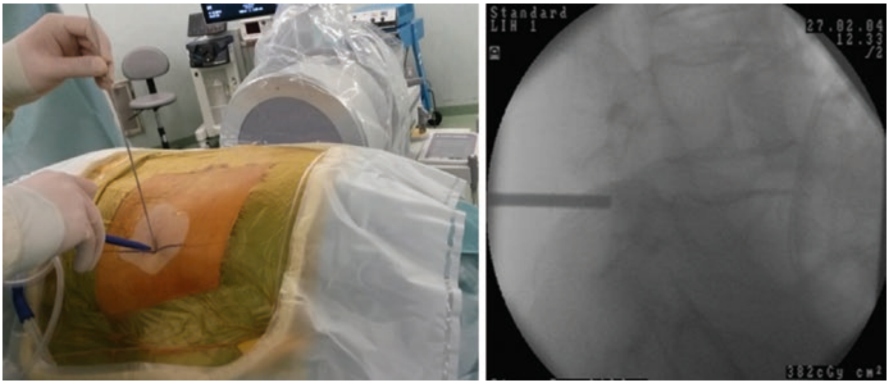

Fig. 11.22 For marking of incision site, a line is drawn, approximately parallel to posterior margins of facet joints on lateral view

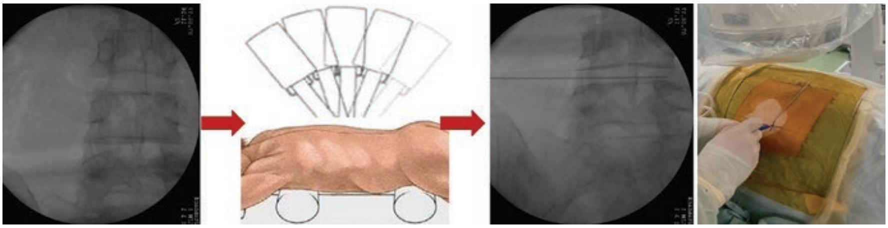

Fig. 11.23 C-arm is positioned parallel to endplates at targeted level, and a line is drawn from disc level to cross the first line

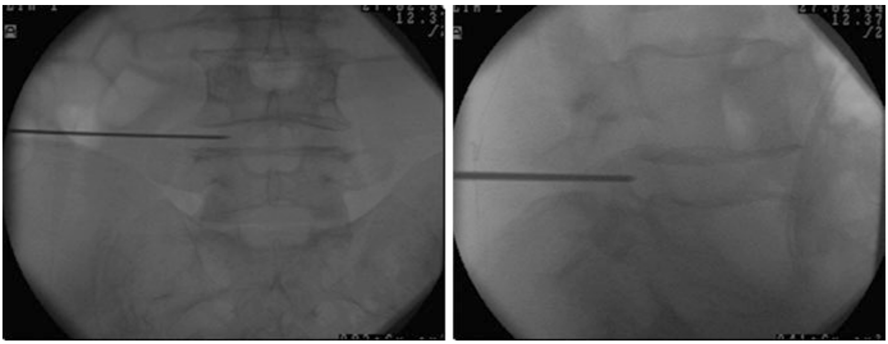

Fig. 11.24 Target point is midpedicular line on AP view and dorsal margin of annulus fibrosis on lateral view

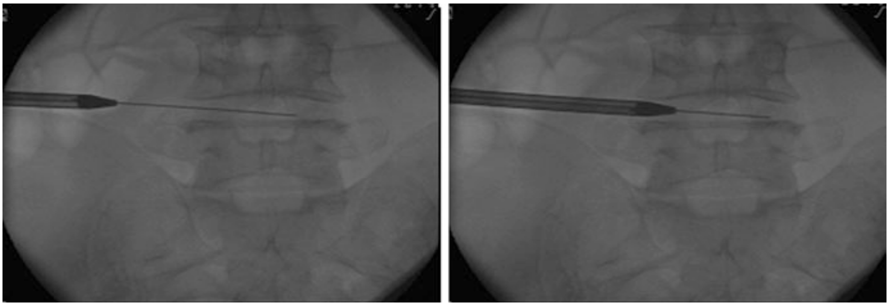

Fig. 11.25 Placement of dilator in foramen over guide wire

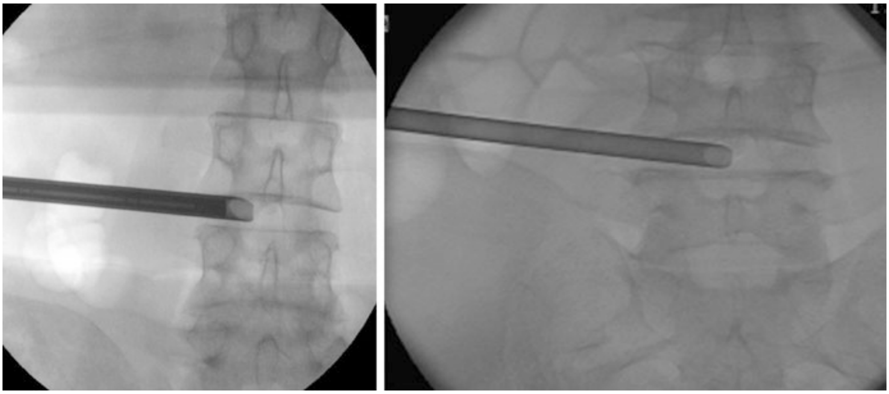

Fig. 11.26 Working sleeve can be placed laterally or medially according to the location of herniation

11.3.2.3 Extraforaminal

At far-lateral (extraforaminal) herniations, herniated fragment may cause the root to relocate in the foramen. In this case, starting the operation directly in the foramen may cause exiting root injury. Therefore, it is safer to start the operation at the caudal pedicle outside the foramen. This should be the target point for insertion of working sleeve. Then, under endoscopic view and with identification of anatomic landmarks, working sleeve is mobilized, and exiting root, together with herniation, is recognized and fragment is removed (Fig. 11.29).

Although full-endoscopic approach can be considered as the least invasive method for far-lateral herniations, extraforaminal technique, where working sleeve cannot be stabilized in the foramen and extensive knowledge of anatomic landmarks are needed, is the most difficult endoscopic technique. Therefore, it should be carried out by experienced surgeons who adequately master lateral transforaminal approach, in order to reduce complication level.

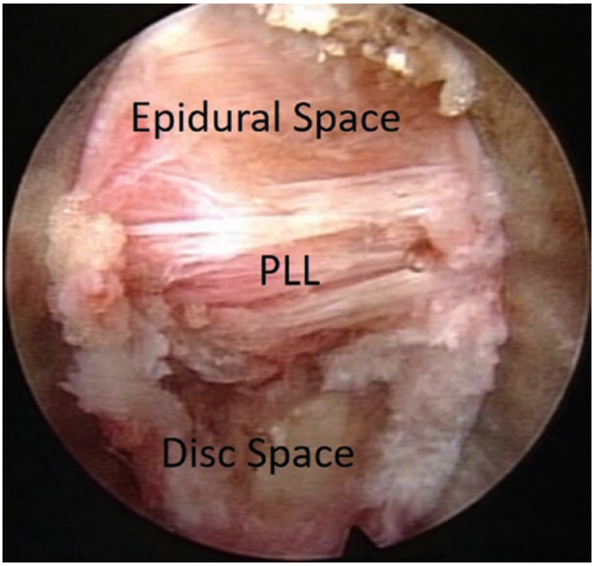

Fig. 11.27 Epidural space, PLL, and disc on endoscopic view

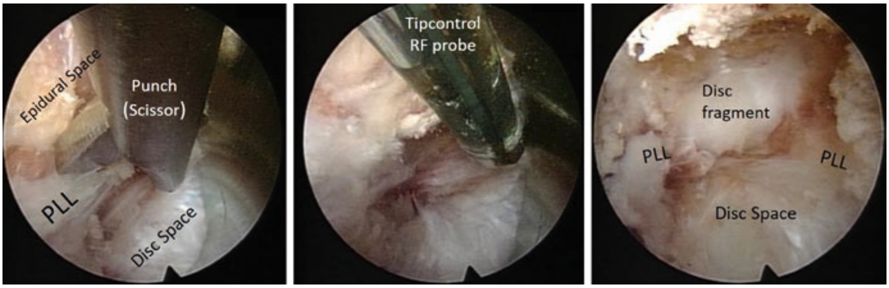

Fig. 11.28 Cutting of fibers and PLL, exploration with RF probe, and uncovering of herniated fragment

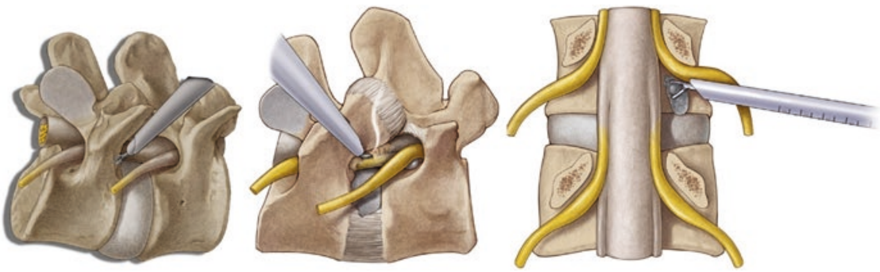

Fig. 11.29 For extraforaminal herniations, caudal pedicle is targeted, anatomical structures explored, and fragment removed without stabilizing working sleeve in foramen

Although we use the abovementioned criteria for selection between IL and TF approaches, many surgeons worldwide prefer far-lateral TF approach for all kinds of lumbar herniations. Experience, direct access to disc space, and convenience of local anesthesia, if necessary, are the most important factors for this choice. Foraminoplasty techniques like the use of reamers or drills, to enlarge the foramen, are needed to access some fragments through foramen [38–42]. Using a more posterolateral approach to avoid iliac crest and with help of foraminoplasty techniques, L5–S1 discectomies can also be performed by TF approach, but it requires a greater level of expertise. Indeed, the choice between TF and IL approaches depends mostly on the surgeon's experience.

11.4 Postoperative Care

Usually, bed rest is not recommended, and patients are discharged on the same day or the day after. Mild pain killers can be initiated.

11.5 Complications

Complications of full-endoscopic discectomy are not different than those of microdiscectomy [28, 43, 44]. The learning curve may play an important role, but in experienced hands, rates are the same. Motor and sensorial deficits are reported below 3%. Dural tears may occur, but usually do not necessitate repair. As to our knowledge, major vessel injury, although a possibility, has not been reported with the IL approach, yet.

Recurrence and reoperations, early or late, are reported about 5–10%, and the rate is similar to the microdiscectomies [28, 43, 44]. In a clinical series of 232 patients operated with IL or TF full-endoscopic technique, published by Ruetten et al. in 2007, there was 92% success rate, together with 6% recurrence (patients who needed a reoperation) [28]. In this series, histopathological examination showed that, at least 75% of recurrent disc material was made up by endplates. Recurrence rate in this series is slightly more than in series with extensive disc removal but slightly lower than in series with removal of sequestrated fragment only [28]. To avoid large incisions in PLL or annulus could help to reduce recurrence.

One must keep in mind that, anatomic orientation can easily be lost with misplacement of the working sleeve [45]. With lateral or medial placement, confusion may occur in the identification of the anatomic structures which may lead in prolonged operation time and iatrogenic injury. Also, inappropriate manipulation of neural elements may result in transient or permanent motor deficits [45].

11.6 PELD for Recurrent Herniations

Recurrence is one of the most important problems for surgeons dealing with lumbar disc surgery, microdiscectomy, or PELD. Its rate varies from 5% to 20%, about 6–10% from a modern and realistic view [41, 43, 44, 46] and, as abovementioned, there is no difference concerning type of surgery. But another debate is on the selection of type of surgery for recurrent herniation. Although open microdiscectomy may seem more suitable, actually, PELD is equally safe and effective, too, independent from type of previous surgery. Choice of approach (IL or TF) again depends on the experience of surgeon. Both approaches require greater expertise. At IL approach, working sleeve is targeted to bony structures laterally, and epidural space is exposed by drilling of facet joint. For TF approach as well, foraminoplasty techniques may be required. But excellent visualization with 25° optics, chance of rapid rehabilitation, limited anatomic trauma reducing need for stabilization surgery are important advantages of PELD in contrast to its difficult learning curve.

11.7 Conclusion

Full-endoscopic surgery is a sufficient and safe supplementation and alternative to microdiscectomy. Similar success rates are reported for both, microdiscectomy and PELD, varying from 75% to 100%. Recurrence rate is similar too, between 5% and 10% [44]. At the same time, there are advantages of reduced traumatization, like greater patient comfort, better wound healing, shorter hospital stay, and of the operation technique, like excellent visualization, direct and easy access at obese patients. The success and advantages of PELD have also been shown in recent studies and meta-analyses [28, 30–32, 35, 36, 44, 47–49].

Clinical and cadaveric studies also indicate that, in near future, PELD will find a greater application area, including decompression of spinal stenosis or treatment of intradural pathologies, like untethering of filum terminale [50–54].

11.8 Highlights

- PELD is safe and effective for surgical treatment of lumbar disc disease.
- Results and complication rates of PELD and microdiscectomy are similar in experienced hands.
- Advantages of PELD are excellent visualization, minimal tissue traumatization, postoperative patient comfort, and easy access at obese patients.
- Disadvantages are difficult learning curve and, maybe, cost of new and high-technology equipment.
- Extensive knowledge of anatomy and radiological landmarks is of essential importance for PELD surgery.

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