Chapter 16
Unilateral Laminotomy for Bilateral Decompression (ULBD) Through Biportal Endoscopy for Lumbar Spinal Stenosis

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Abbreviations

CRP	C-reactive protein
CSF	Cerebrospinal fluid
CT	Computed tomography
EBL	Estimated blood loss
FJ	Facet joint
IAP	Inferior articular process
LF	Ligamentum flavum
LSS	Lumbar spinal stenosis
MISS	Minimally invasive spine surgery
MRI	Magnetic resonance imaging
ODI	Oswestry Disability Index

Supplementary Information The online version contains supplementary material available at [https://doi.org/10.1007/978-3-031-14736-4_16].

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J. Quillo-Olvera et al. (eds.), *Unilateral Biportal Endoscopy of the Spine*,
https://doi.org/10.1007/978-3-031-14736-4_16

RCT	Randomized controlled trial
RF	Radiofrequency
SAP	Superior articular process
SLIP	Spinal Laminectomy versus Instrumented Pedicle screw
SP	Spinous process
SPORTS	Spine Patient Outcomes Research Trial
SSSS	Swedish Spinal Stenosis Study
UBE	Unilateral biportal endoscopy
UE	Uniportal endoscopy
ULBD	Unilateral laminotomy for bilateral decompression
VAS	Visual analog scale

Introduction

Lumbar spinal stenosis (LSS) is a narrowing of the spinal canal in its transverse or anteroposterior axis, causing clinical symptoms secondary to radicular compromise. However, anatomical findings could not be congruent with the severity of clinical symptoms since an anatomically narrow canal is often asymptomatic. Spinal stenosis can be classified according to its etiology or anatomy. Regarding spinal stenosis etiology, two types have been described: congenital and, more frequently, acquired. The anatomical classification refers to which compartment the stenosis is happening, for example, the central canal, lateral recess, or foramina. Most patients will have acquired lumbar canal stenosis, often due to degenerative causes. Lumbar spinal stenosis is a degenerative process that counts for 5 cases per 100,000 habitats, and some degree of stenosis is present in up to 80% of individuals over 70 years old. It happens because the lumbar spine's bony, ligamentous, and synovial elements degenerate and overgrow, progressively compressing the neural and vascular components of epidural space [1]. Surgery for spinal stenosis is performed in 3–11.5 cases per 100,000 inhabitants per year, and it is the most common indication for spinal surgery in elderly patients over 65s. In 2007, more than 37,500 operations for spinal stenosis were performed in Medicare patients in the United States, with a total cost of almost $1.65 billion [2–4].

Rationale

Surgical intervention is generally recommended for patients who do not improve with conservative management or have severe symptoms and thecal sac compression at presentation. A systematic review showed that a surgical procedure for spinal stenosis is more effective after trying nonoperative treatment for 6 months and failing [5]. The Spine Patient Outcomes Research Trial (SPORTS) is the most extensive study that compared standard posterior decompressive laminectomy with nonoperative management in patients with lumbar spinal stenosis without spondylolisthesis. The study concluded that patients treated surgically had substantially more significant improvement in pain and function at 2 years [6]. The 4-year follow-up same study outcome reported sustained improvement in pain and function in favor of surgery [7].

Concerning if fusion is required to treat LSS in the setting of degenerative spondylolisthesis, in the 90s, two small trials showed better outcomes in patients with LSS and degenerative spondylolisthesis when fusion and laminectomy were performed at the same stage [8, 9]. However, in 2016, the Swedish Spinal Stenosis Study (SSSS), a large randomized controlled trial (RCT) that compared decompression plus fusion versus decompression alone in patients with LSS and degenerative spondylolisthesis, found no significant difference in clinical outcome or reoperation rates between the two groups at 2 and 5 years of follow-up [10]. Therefore, the authors in this chapter believe that each patient deserves a tailored and specific surgical plan covering all aspects of lumbar spinal pathology. Based on the EBM, only decompression or decompression plus fusion can be beneficial options for treating LSS. The Spinal Laminectomy versus Instrumented Pedicle screw (SLIP) RCT study demonstrated an improved physical health-related quality of life and lower rates of reoperation in patients treated with decompression plus fusion in a setting of LSS and spondylolisthesis. However, higher costs increased estimated blood loss (EBL), and longer hospital stays were also observed in those patients [11].

However, other decompression options in patients with LSS have made it possible to reduce the collateral effect of surgery on the patient. This series of so-called minimally invasive spine surgery (MISS) techniques allow for less aggressive treatment of the paraspinal tissues, preserving the stability of the spinal segment and allowing the patient to return to essential life activities sooner than with conventional surgical procedures, even in challenging cases such as obese patients or degenerative scoliosis and spondylolisthesis [12, 13].

The traditional laminectomy with partial or even complete facet joint (FJ) resection was proved to be an effective treatment. However, this extensive resection of the posterior stabilizing structure has led to a favorable outcome in early stage postoperatively but may lead to instability later. The recurrence rate is as high as 30% [14–16]. Given this, Young et al. [17] and Aryanpur et al. [18] simultaneously proposed a new decompression technique in 1988 called “bilateral subarticular fenestration” under a microscope to perform a more accurate decompression. They used a drill to undercut the FJs hypertrophied and the thickened ligamentum flavum (LF) only and at the same time preserve the posterior stabilizing structures, like spinous process (SP), interspinous ligaments, and most of the lamina and FJs.

Poletti [19] introduced the term unilateral laminotomy for bilateral ligamentectomy in 1995. However, the term “unilateral laminotomy for bilateral decompression or ULBD” was formally coined by Spetzger et al. [20] in 1997. The authors claimed that decompression via ULBD could minimize postoperative instability because only the compressive part of FJ was resected. The same authors concluded that preserving paraspinal muscle attachment and posterior tension band midline structures were associated with better clinical experience outcomes [21]. A bit later, Guiot et al. [22] reported the feasibility of ULBD under micro-endoscopy in a cadaver study in 2002. With the application of full endoscopy in spine surgery, the traditional aggressive surgical concept of decompressive laminectomy and facetectomy gradually became more selective. In 2011, Komp et al. [23] reported encouraging clinical results with the full-endoscopic ULBD technique in LSS. The authors also concluded that the capacity to decompress the neural elements bilaterally through one-side access is feasible through the uniportal endoscope, in addition to observing all the advantages associated with MISS, such as reduced EBL, shorter hospital stay, minor invasiveness, and a decreased injury to stabilizing structures of the lumbar spine. However, in some cases of LSS where a grander bony work is anticipated, the uniportal endoscopic technique may not be sufficient.

Recently, the growing acceptance of unilateral biportal endoscopy (UBE) has allowed performing addressed decompressions to a specific target, associated with the same advantages observed in MISS, but with the high-quality visualization obtained through uniportal endoscopy, with an addition: the ability to introduce standard working tools for lumbar surgery through an independent port of the endoscope.

After Soliman [24] and Eun et al. [25] reported their respective clinical experience with UBE-ULBD, it has become a more suitable option to deal with LSS. With the mutually independent working and viewing portal, UBE has several specific advantages:

- Wider surgical motion range
- Direct visualization of neural structures
- Versatility
- More instrument choices

And these advantages help surgeons perform ULBD more easily and sufficiently.

Surgical Procedure

Incision Planning and Portal Building

After general anesthesia, the patient was placed in the prone position. If only an ipsilateral decompression is planned, the skin incision should be close to the spinous process (SP). Yet, for contralateral decompression, the skin incision location should be moved 5 mm (left side) to 10 mm (right side) outward depending on the surgeon's side (Fig. 16.1).

Take the left-side procedure as an example. The working portal incision was ideally set at 1/3 to 1/2 of the lower pedicle to facilitate decompression for the upper edge of the lower lamina. At the same time, the viewing portal (cranial incision) was at 2.5–3 cm (depending on the patient's fat thickness) to the working portal. It is suggested to do a crosscut through facia to facilitate smooth water flow. With the

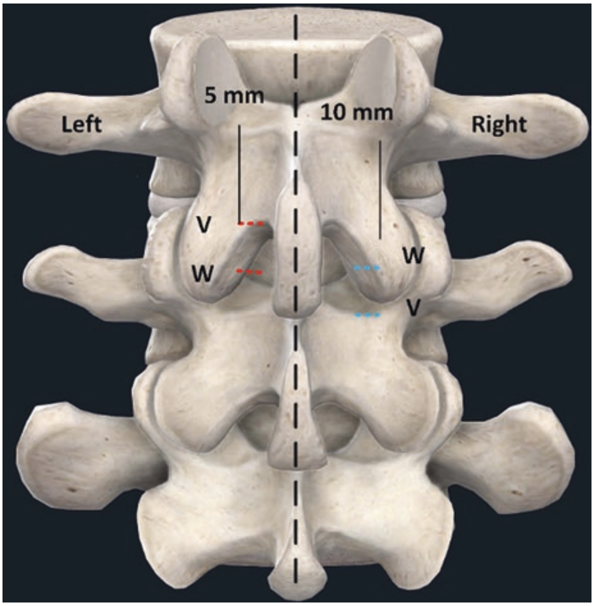

Fig. 16.1 The skin incision in UBE-ULBD in different operation sides

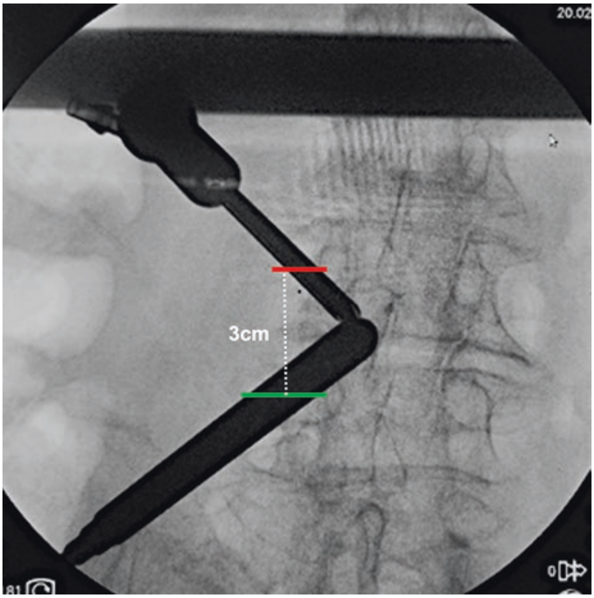

Fig. 16.2 The initial docking site of the two portals under an AP view of the C-arm

inserted dilators addressed to the upper SP base, the attachment of the multifidus muscle is stripped to reach the spinolaminar junction (Fig. 16.2).

Ipsilateral Decompression

After identifying the spinolaminar junction, dissect the soft tissue around the interlaminar window to create a working space (Fig. 16.3a). Herein, the external layer of ligamentum flavum (LF) is removed to expose the bony margin of the SP base, the inferior edge of the upper lamina, the ipsilateral inferior articular process (IAP), and the superior border of the inferior lamina (Fig. 16.3b, c).

Bone removal can be performed following this sequence:

1. Bone removal begins in the spinolaminar junction. The surgeon requires to undercut the base of the SP and the inferior border of the upper lamina to detach

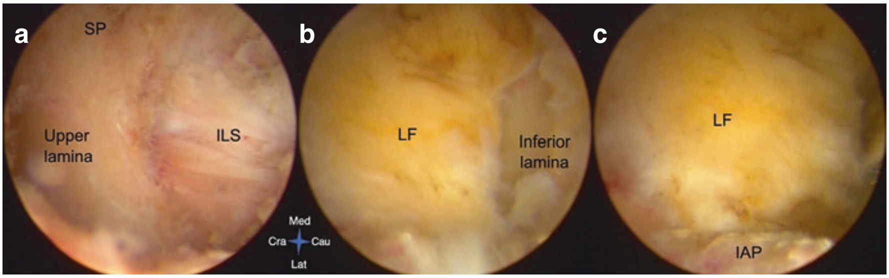

Fig. 16.3 Landmarks of working space. (**a**) The upper lamina and the spinous process (SP) bordering the cranial interlaminar space (ILS). (**b**, **c**) After outer layer removal of LF, the IAP and inferior lamina are identified. *Cra* cranial, *Cau* caudal, *Med* medial, *Lat* lateral, *LF* ligamentum flavum, *IAP* inferior articular process

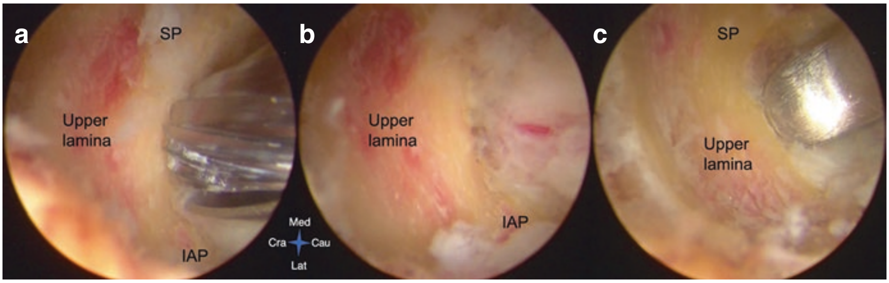

Fig. 16.4 Spinolaminar junction undercut. (**a**) The upper lamina and the base of the spinous process (SP) are drilled out. (**b**) The medial aspect of the IAP is also removed. (**c**) The cranial attachment of LF is released. *Cra* cranial, *Cau* caudal, *Med* medial, *Lat* lateral, *LF* ligamentum flavum, *IAP* inferior articular process

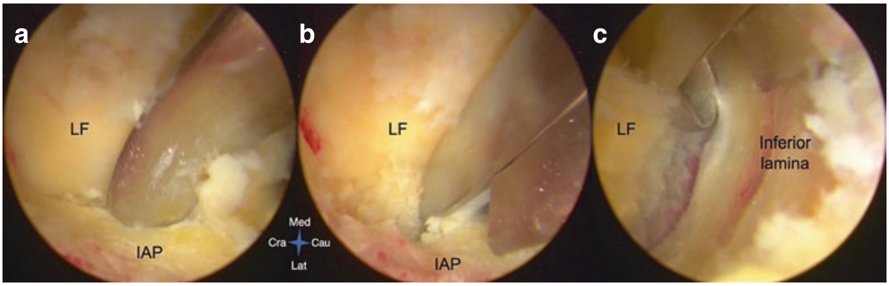

Fig. 16.5 Circumferential bone removal sequence. (**a**) The lateral extension of LF is detached. (**b**) The IAP is undercut. (**c**) The superior border of the inferior lamina is removed, and the LF is detached from it. *Cra* cranial, *Cau* caudal, *Med* medial, *Lat* lateral, *LF* ligamentum flavum, *IAP* inferior articular process

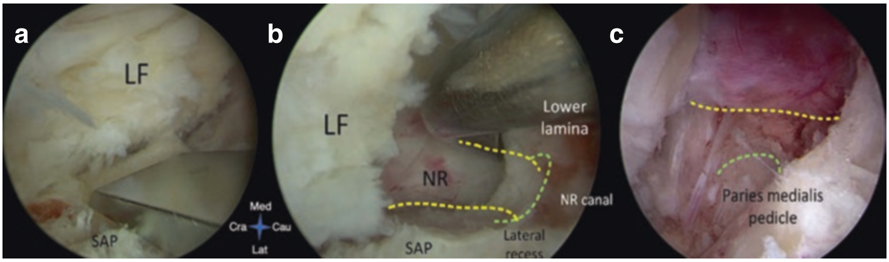

Fig. 16.6 Ipsilateral subarticular decompression. (**a**) The ipsilateral SAP is removed medially. (**b**) The traversing nerve (NR) is identified. (**c**) Lateral recess decompression is concluded, and the paries medialis pedicle (medial wall of the pedicle) is observed. *Cra* cranial, *Cau* caudal, *Med* medial, *Lat* lateral, *LF* ligamentum flavum, *SAP* superior articular process

the cranial insertion of LF. A curved-ending-tip dissector could be used in this step (Fig. 16.4).

2. Then, the medial aspect of the ipsilateral IAP is undercut. After lateral extension detachment of LF, a Kerrison rongeur could be helpful to remove the IAP medially. However, care must be taken not to excessively remove the IAP to avoid the risk of iatrogenic instability (Fig. 16.5).
3. The ipsilateral superior articular process (SAP) undercutting can be completed with different tools to achieve lateral recess decompression. The bone should be removed enough to expose the transversing nerve root, not only the dural sac's lateral border. Different landmarks could be used as endpoints of the lateral recess decompression, such as identifying the "paries medialis pedicle" (medial wall of the pedicle) or freely mobilizing the traversing nerve root (Fig. 16.6).
4. For the following "over-the-top" manipulation, the LF must be preserved intact as much as possible since it protects the neural elements during bone removal.

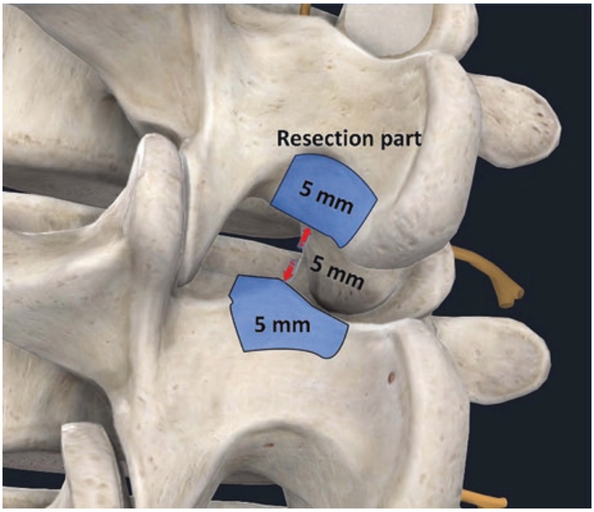

Fig. 16.7 Suggested bone removal area to address the contralateral side in a sublaminar trajectory. The blue highlighted area below the superior and inferior spinous processes should be removed

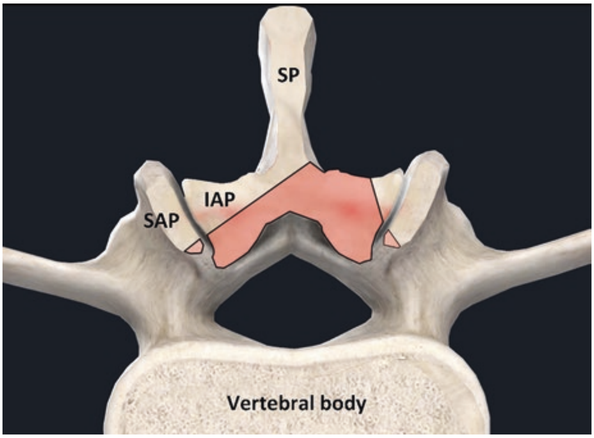

Fig. 16.8 The cross-sectional area of the anatomical scheme is highlighted in orange as the bone resection extent during a UBE-ULBD procedure. *IAP* inferior articular process, *SAP* superior articular process, *SP* spinous process

Contralateral Decompression

Undercutting the base of the spinous process to reach the contralateral side and decompressing it with a sublaminar trajectory are suggested. For this reason, the authors recommend removing at least 5 mm of the base of the superior and inferior spinous processes (Fig. 16.7) at the index level. This will allow access to the contralateral side and removal of the ventral aspect of the upper and lower laminae. The advantage of preserving the dorsal surface of both laminae is that it is not necessary to detach the muscles that adhere to them; it also avoids performing total laminectomies, which allows a direct view of the contralateral IAP and SAP.

A wider laminectomy is unnecessary to cross the midline (Fig. 16.8). About 3–4 mm sublaminar bone removal is enough. Passing over the LF, it is easy to find the medial part of the contralateral IAP. In addition, tight fibrous connections between LF and capsular ligament can be found during dissection of the medial surface of the IAP. Therefore, we recommend detaching the LF from the bony IAP surface with a blunt-tip dissector and reaching its ventral aspect. With the LF separated from the IAP, the surgeon could use a high-speed drill, Kerrison of different sizes and tips, and chisels to undercut the IAP.

The curve chisel may be more efficient but has a higher possibility of causing neural elements' injury. The medial border and the tip of the SAP will be exposed after appropriate IAP resection. Here, use a curette to detach the deep layer of the LF insertion underneath the SAP. And cut off the tip of the SAP until the contralateral "paries medialis pedicle" is observed.

Undercut the SAP further to reveal the shoulder, and the axilla of the transversing root means sufficient decompression. Ensure that the transversing nerve root canal is unobstructed by using a curette or a nerve hook. If not, perform the decompression again. The deep layer of the LF is suggested to be maintained intact until all bone work is done.

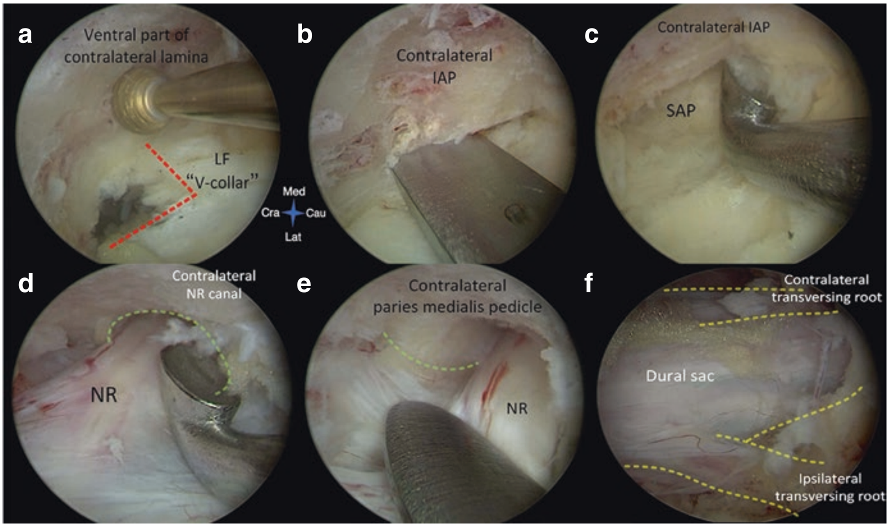

Fig. 16.9 A sequence of contralateral lumbar decompression during a UBE-ULBD. (**a**) Undercutting the contralateral lamina. (**b**) Undercutting the contralateral IAP. (**c**) Ventral SAP removal and decompressing the traversing nerve root (NR). (**d**) Completing the contralateral traversing NR decompression. (**e**) The contralateral paries medial pedicle (medial wall of the pedicle) is identified. (**f**) Side-to-side decompression with both traversing nerves and the dural sac exposed. *Cra* cranial, *Cau* caudal, *Med* medial, *Lat* lateral, *IAP* inferior articular process, *SAP* superior articular process, *LF* ligamentum flavum, *NR* nerve root

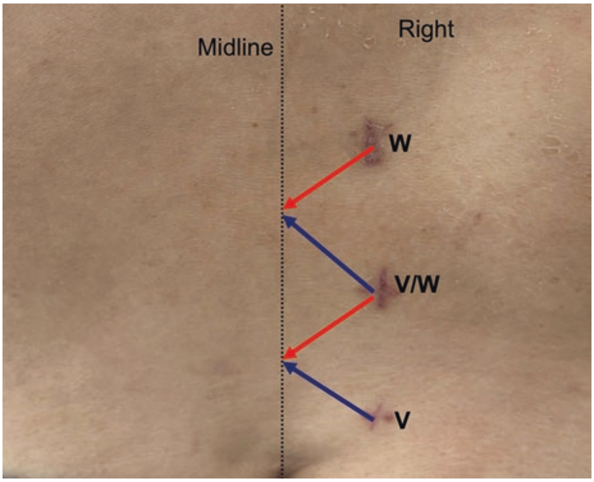

Fig. 16.10 Picture of the surgical wounds on the tenth day postoperatively. A UBE-ULBD L4–L5 and L5–S1 was performed on this patient on the right side. A black dotted line represents the midline. On the right side, the purpose of wounds is illustrated with arrows and capitals (W; working portal—red arrow, V; viewing portal—blue arrow)

Finally, the LF can be removed. First, it is suggested to explore and detach the epidural space between LF and dural sac with a nerve hook. In most of the cases, between both, there is a fat tissue layer; however, sometimes meningovertebral tight adhesions or ligaments can be found, especially in the midline. The surgeon can also distinguish the midline in the ligamentum flavum, identifying a "V-shape." It is also called a "V-collar." So, before flavectomy, dissect the flavum carefully and then remove it with the Kerrison punch (Fig. 16.9).

The steps to perform bilateral decompression through a unilateral laminotomy (ULBD) are exemplified in Video 16.1. The surgeon must remember that this procedure is intended to preserve stabilizing structures (facet joints, lamina, interspinous ligaments, paraspinal muscles) as much as possible. The biportal endoscopic technique or UBE also allows us to have a sublaminar trajectory by undercutting the contralateral lamina avoiding the total laminectomy or facetectomy for neural decompression, thus preventing further iatrogenic instability. The UBE-ULBD is a powerful option for decompressing the neural elements in the lumbar region for central and subarticular stenosis.

In cases where multilevel decompression is required, it is suggested to use the caudal incision as a portal to the next level. For example, the caudal incision will be used for the next level's working portal on the right side. The same incision will be used as a viewing portal on the left side (Fig. 16.10).

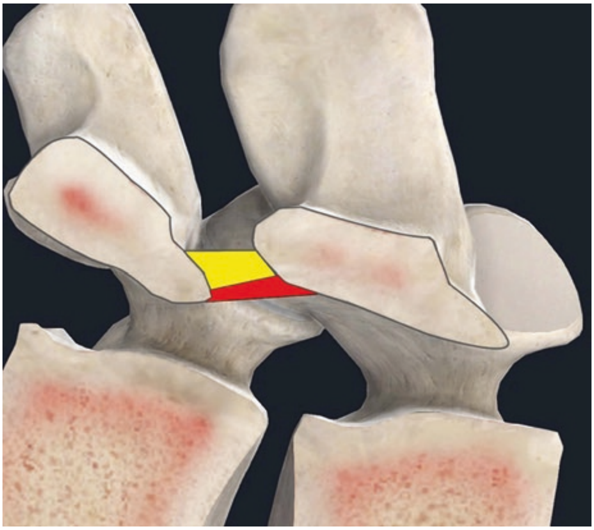

Fig. 16.11 The attachments of LF to the laminae (sagittal section). The yellow area represents the external layer of LF. The red area, the deeper

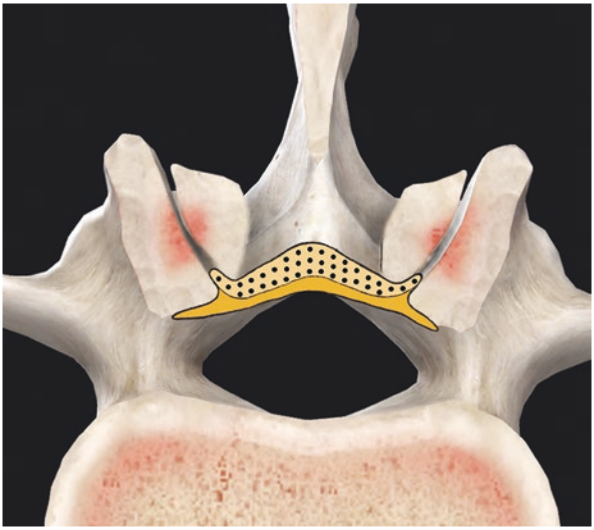

Fig. 16.12 The attachment of LF to the lamina (cross section). The black dotted yellow area represents the external layer of LF. The yellow area below represents the deeper

Surgical Anatomy of Ligamentum Flavum Applied to Biportal Endoscopy

The anatomy of the ligamentum flavum is essential, especially in endoscopic procedures, including UBE. According to the previous studies, the LF has been interpreted as a ligament divided into two layers—external and deep layers. However, Viejo-Fuertes et al. [26] defined the two layers based on the fiber's orientation. Other studies [27, 28] have found that external and deep LF layers are divided

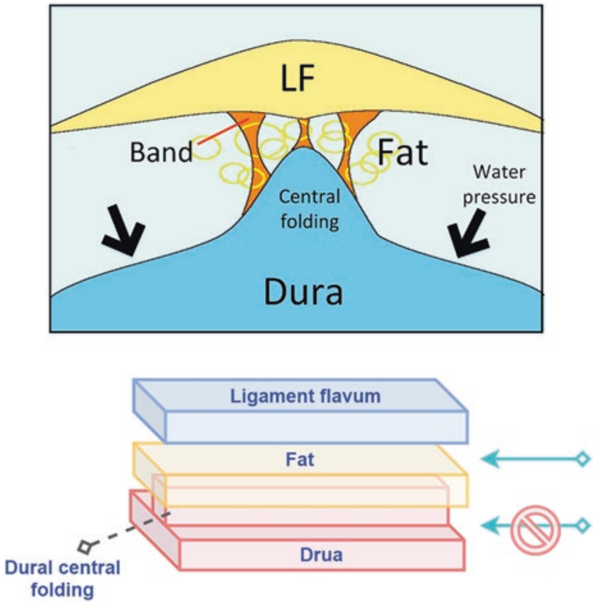

Fig. 16.13 "Sandwich theory" for safe resection of LF

according to their bony insertions. The external layer fills the dorsal aspect of the interlaminar space, and it extends from the anteroinferior edge of the cranial lamina to the posterosuperior edge of the caudal lamina. At the same time, the deep layer extends from the ridge of the cranial lamina to the anterosuperior and anteroinferior part of the caudal lamina (Figs. 16.11 and 16.12).

A recent study [29] suggested a distinct conclusion indicating that the so-called superficial or external layer of the LF may be the extension of the interspinous ligament; despite the controversial issue regarding the two-layer structure, the LF should be well identified in UBE-ULBD.

A proper dissection of the external LF layer leads to correctly identifying the edge of bone structures, such as the laminae, the base of the SP, and the medial surface of the IAP and SAP, and at the same time, the over-drilling of bone structures could be avoided by observing directly the bony landmarks.

Furthermore, as already mentioned, the dissection of the deep layer of the LF must be careful due to the fibrous bands and meningovertebral ligaments connecting the LF to the dura, and the intermediate fold forms precisely in the midline. In addition, there is epidural fat covering this central fold and these ligamentous structures; therefore, it can be easy to cause a dural tear at this site.

According to the author's "sandwich theory" (Fig. 16.13), the dorsal surface of LF, epidural fat tissue, and dura form a three-tiered structure that must be identified. The Kerrison rongeur is supposed to enter the upper-middle layer (over the fat tissue) to avoid dura injury.

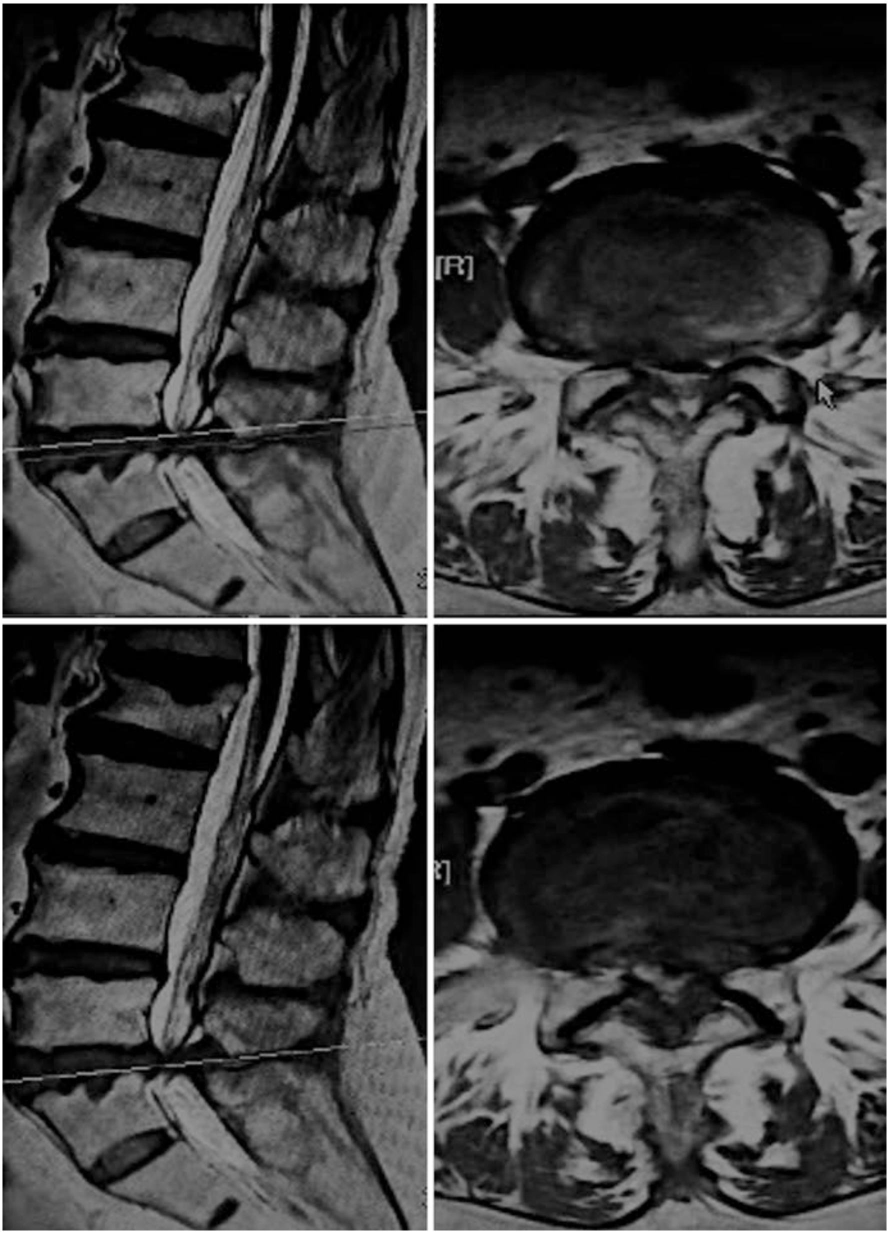

Fig. 16.14 Preoperative lumbar MRI from Case 1. A severe central spinal stenosis involving both lateral recesses can be observed at L4–L5

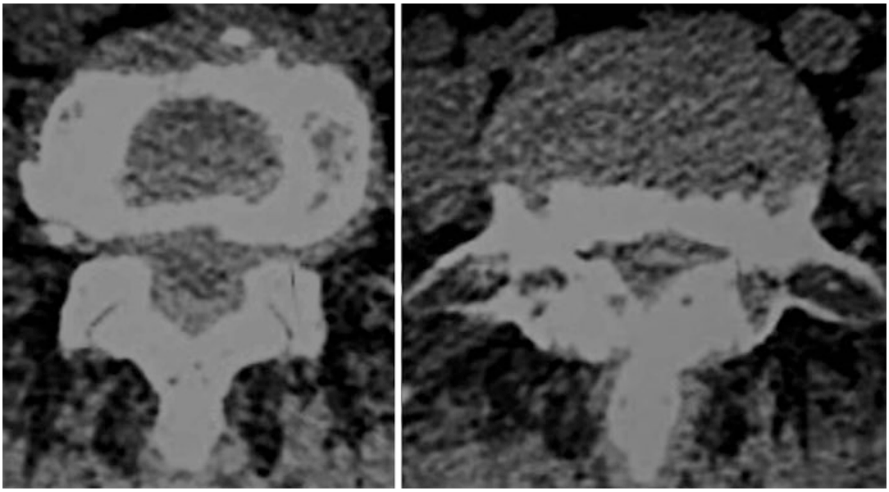

Fig. 16.15 Preoperative lumbar CT scan from Case 1. Overgrowth of facet joints and resulting stenosis of the lateral recesses from both sides are noted at L4–L5

Illustrated Cases

Case 1

A 78-year-old female complains of severe radicular pain radiating down her right leg. The pain in the right leg goes down along the anterior thigh and lateral surface of the calf. However, the patient feels sensitivity disturbances such as numbness in both legs. The neurologic examination demonstrated bilateral great toe dorsiflexion and plantar flexion weakness (4/5), and bilateral ankle reflex was absent. Preoperative lumbar MRI revealed severe central spinal stenosis at L4–L5, with bilateral narrowing of both lateral recesses (Fig. 16.14). The CT scan confirmed the finding (Fig. 16.15). The following procedure was planned because symptoms on the right side also included the ones from the L4 nerve root: UBE-ULBD L4–L5 on the left side to decompress the ipsilateral L5 nerve root, and a contralateral approach (left to right) to release the right-sided L4 and L5 nerve roots (Fig. 16.16). The postoperative immediate lumbar CT scan corroborated sufficient decompression ipsilaterally and a proper undercutting of the lateral recess and foramen on the right side at L4–L5 (Fig. 16.17). No intraoperative and postoperative complications were reported. The patient was discharged on the second day after the surgery. The radicular pain on the right leg improved immediately after the procedure. At the 6-week follow-up visit, we noted normal strength in the dorsiflexion of the great toe and plantar flexion bilaterally.

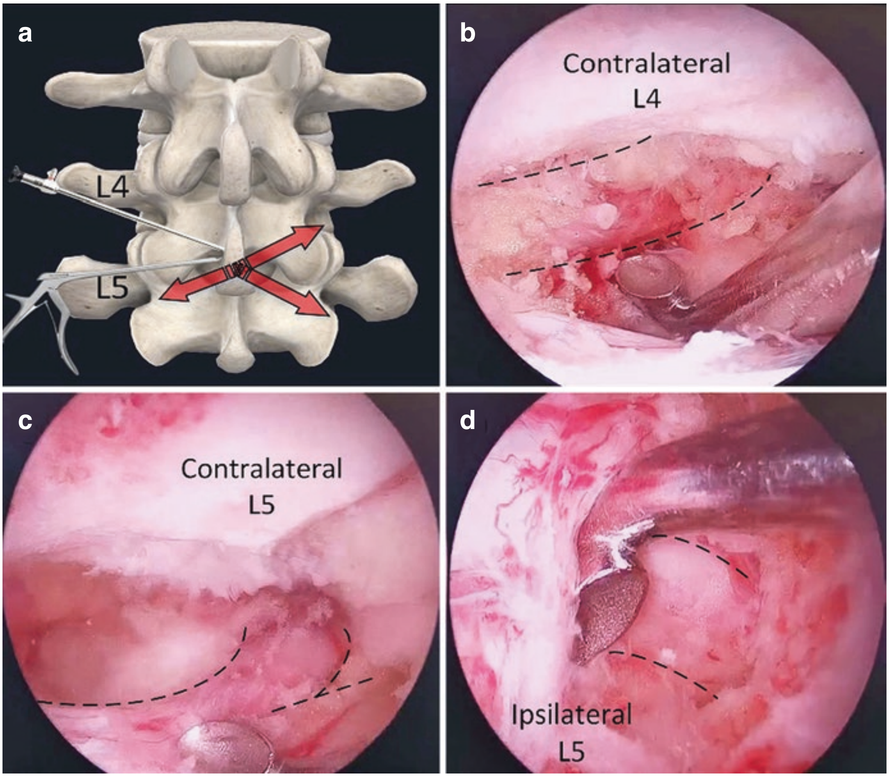

Fig. 16.16 Intraoperative images through the endoscope from Case 1. (**a**) Anatomical scheme showing the surgical planning at L4–L5; the red arrows point the trajectories to follow for decompressing the neural structures involved in the pathology. The intermittent black lines on (**b**, **c**) represent the nerves decompressed. (**b**) L4 exiting nerve root decompressed on the right side contralateral to the UBE-ULBD approach. (**c**) The L5 traversing nerve root decompressed on the right side. (**d**) The curette palps the ipsilateral L5 traversing nerve root (left side). The intermittent black line shows the intervertebral disc

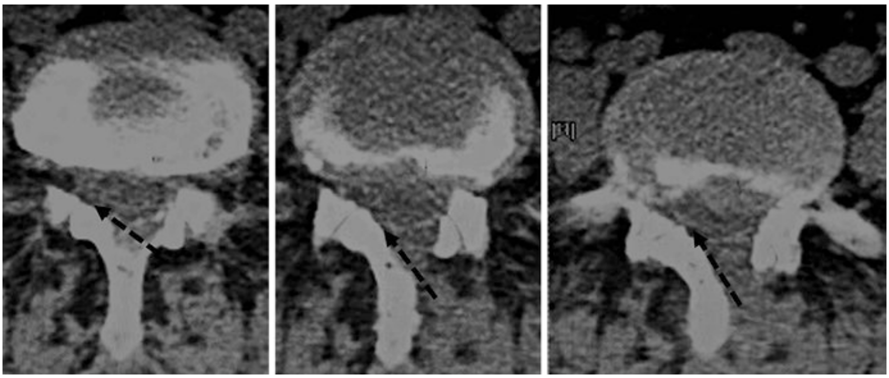

Fig. 16.17 Postoperative lumbar CT scan from Case 1. Sufficient bilateral decompression was achieved through the UBE-ULBD procedure at L4–L5 (three cross-sectional cuts). The intermittent black arrow shows the approach trajectory in the three axial views

Fig. 16.18 Preoperative lumbar X-rays and MRI from Case 2. The superior panel shows the lumbar X-rays. The inferior panel shows the lumbar MRI. The axial view on T2-weighted image at L3–L4 (right side) demonstrated lateral lumbar stenosis

Case 2

A 66-year-old male patient complained of severe electric shock-like pain in his right leg for 8 weeks, which did not subside with conservative measures or the use of opioids. The pain radiates to the anterior aspect of the thigh and lateral surface of the calf of the right leg. Also, numbness on the right leg was felt by the patient. Neurological examination revealed weakness (4/5) in dorsiflexion and plantar flexion of the right ankle and an absent patellar reflex on the right side. Preoperative X-ray images did not demonstrate sagittal or coronal balance disorders. However, lumbar MRI showed proximal foraminal stenosis at L3–L4 on the right side

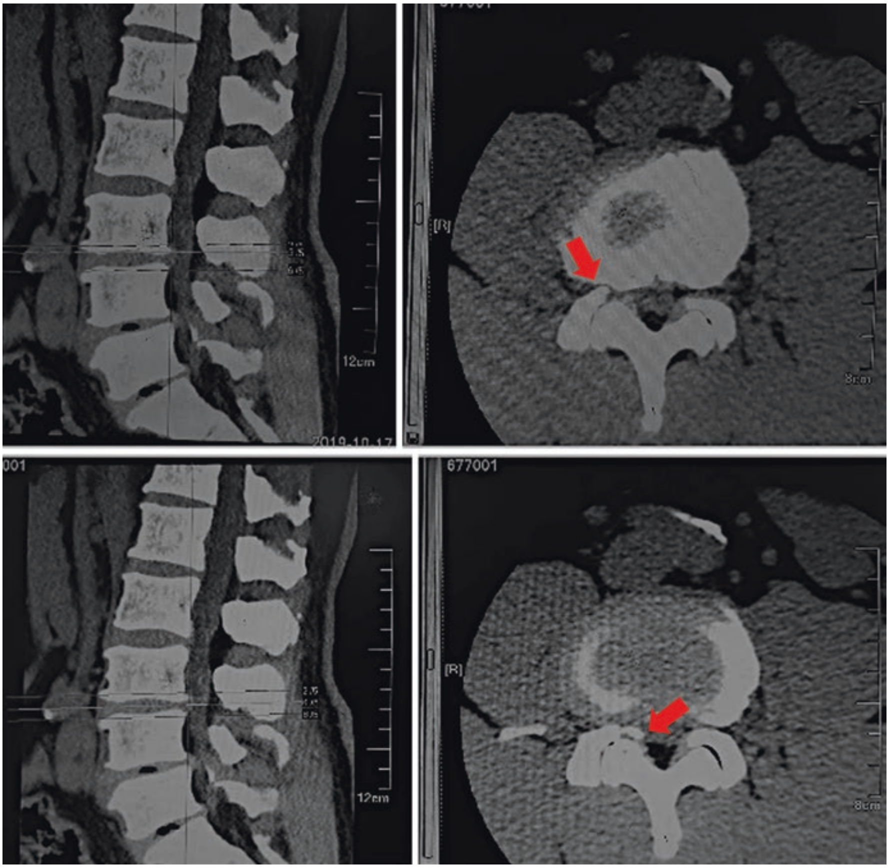

Fig. 16.19 Preoperative lumbar CT scan from Case 2. The superior panel shows the cross-sectional view of L3–L4 at the inferior height of foramen. Hypertrophy of the L4 SAP on the right side is noted (red arrow). The inferior panel shows the cross-sectional view of L3–L4 at the lateral recess height. The red arrow points to the flavum osteophyte on the right side

(Fig. 16.18). The preoperative lumbar CT scan showed medial facet bone osteophyte, probably associated with calcification at the lateral insertion of the flavum (Fig. 16.19). The surgical planning was a UBE-ULBD from the left side to address the approach to the contralateral side and decompress the L3 and L4 nerves on the right side. The initial landmark was the spinolaminar junction at L3–L4 on the left side (Fig. 16.20a); then through a sublaminar trajectory, the L3 exiting nerve was reached (Fig. 16.20b); and caudally, the L4 traversing nerve along its course in the lateral recess was decompressed (Fig. 16.20c, d). The procedure turned out to be successful, being able to adequately decompress the contralateral L3 and L4 roots on the right side, in addition to the central canal (Fig. 16.21). Postoperative CT scan

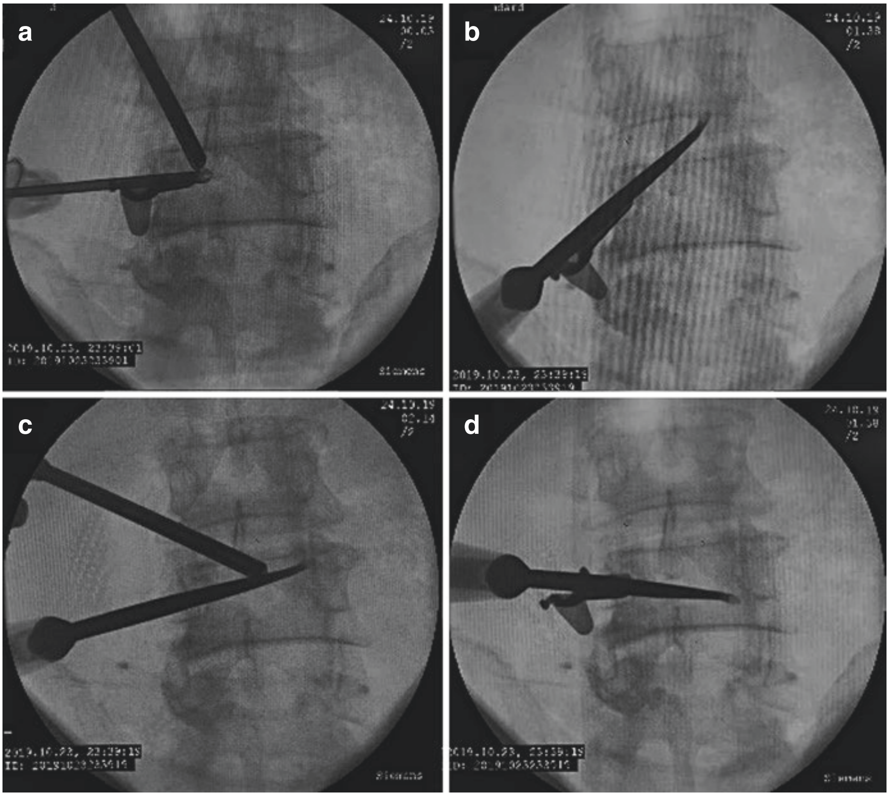

Fig. 16.20 Intraoperative images from the C-arm during the UBE-ULBD with contralateral decompression at L3–L4. (**a**) The triangulation is addressed to the spinolaminar junction on the left side. (**b**) The midline is crossed, and the contralateral decompression of the L3 exiting nerve is performed. (**c**) The contralateral undercutting of the lamina and medial facet joint is done. (**d**) The L4 traversing nerve is released through its entire course

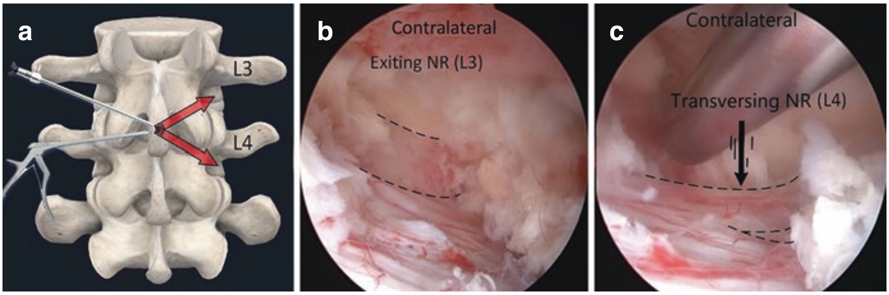

Fig. 16.21 Intraoperative images through the endoscope from Case 2. (**a**) Anatomical scheme showing the surgical planning at L3–L4 on the left side; the red arrows point the trajectories to follow during the contralateral decompression. The intermittent black lines on (**b**, **c**) represent the nerves decompressed. (**b**) L3 exiting nerve root (NR) decompressed on the right side contralateral to the UBE-ULBD approach. (**c**) The L4 traversing nerve root decompressed on the right side. The dural sac medial to the nerves is also released from the central stenosis

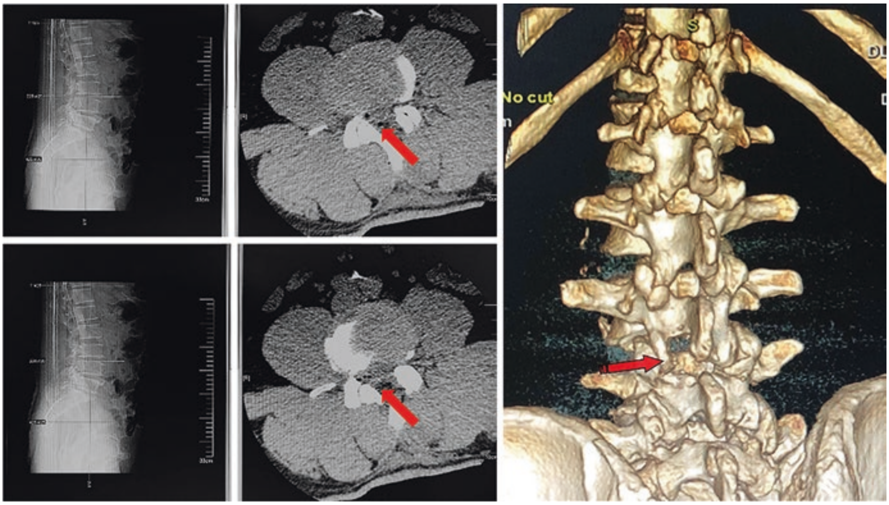

Fig. 16.22 Postoperative lumbar CT scan from Case 2. The red arrows point out to the decompression sites and the contralateral trajectory. Left side: special attention should be put on the proximal foramen and lateral recess decompression on the right side. The 3D reconstructed CT scan (right side) shows the interlaminar bone defect after the UBE-ULBD at L3–L4. But the preservation of the facet joint on the approach side can be noted

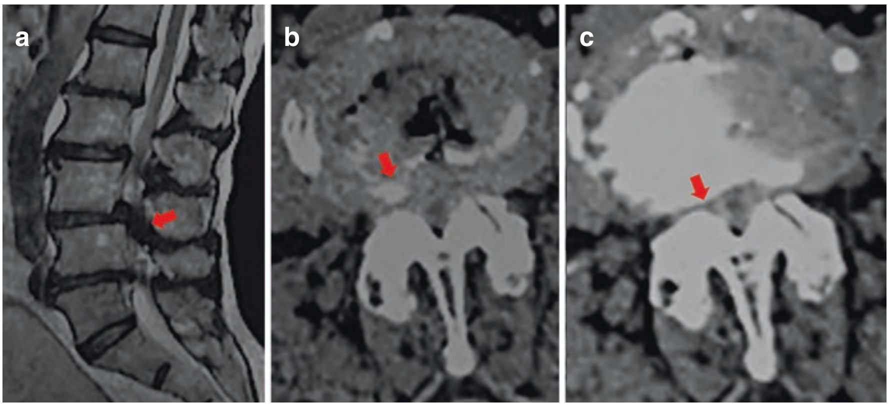

Fig. 16.23 Preoperative images from Case 3. (**a**) The T2-weighted sagittal view of the lumbar MRI demonstrated central canal stenosis at L3–L4. (**b**) The axial view of the lumbar CT scan shows stenosis on the foraminal area (red arrow) at L3–L4 on the right side. (**c**) The axial view at the height of lateral recesses shows bilateral stenosis of the subarticular area at L3–L4 predominantly on the right side (red arrow)

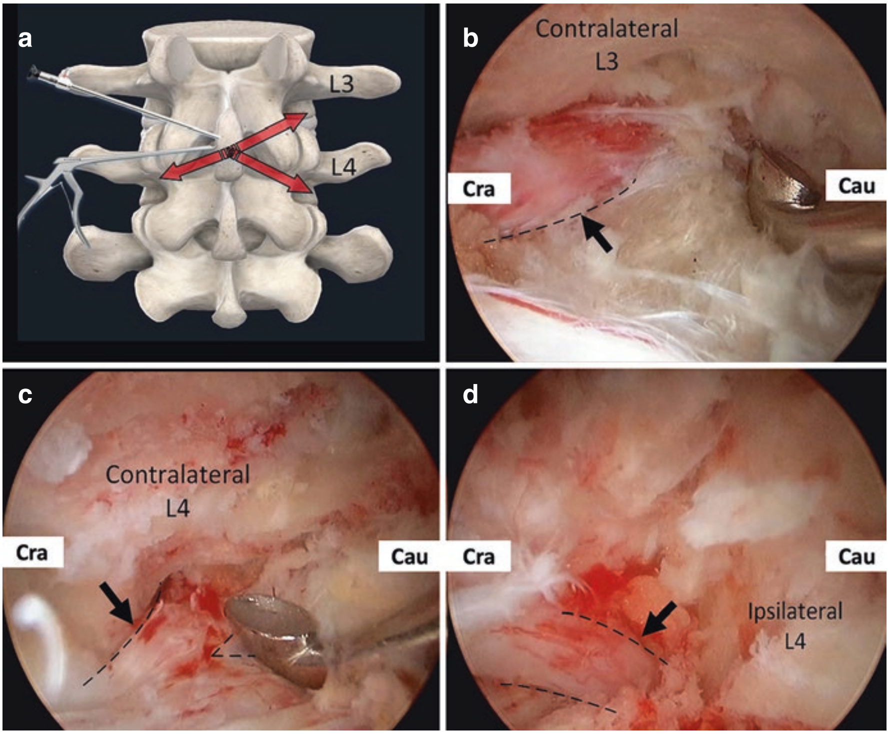

Fig. 16.24 Intraoperative images through the endoscope from Case 3. (**a**) Anatomical scheme showing the surgical planning at L3–L4 on the left side; the red arrows point the trajectories to follow during the ipsilateral and contralateral decompression. (**b**) The decompressed exiting L3 nerve root (black arrow) can be observed. (**c**) The L4 traversing nerve root on the right side is pointed by the black arrow, while on the ipsilateral side (**d**) the other L4 nerve is observed (black arrow)

demonstrated sufficient bone decompression and joint preservation on both sides at L3–L4 (Fig. 16.22). The patient immediately improved his right leg's pain and sensory disorders and was discharged on day 2 after surgery with mild analgesics such as paracetamol. At the 12-day postoperative visit, a complete improvement in the strength of the right ankle was observed.

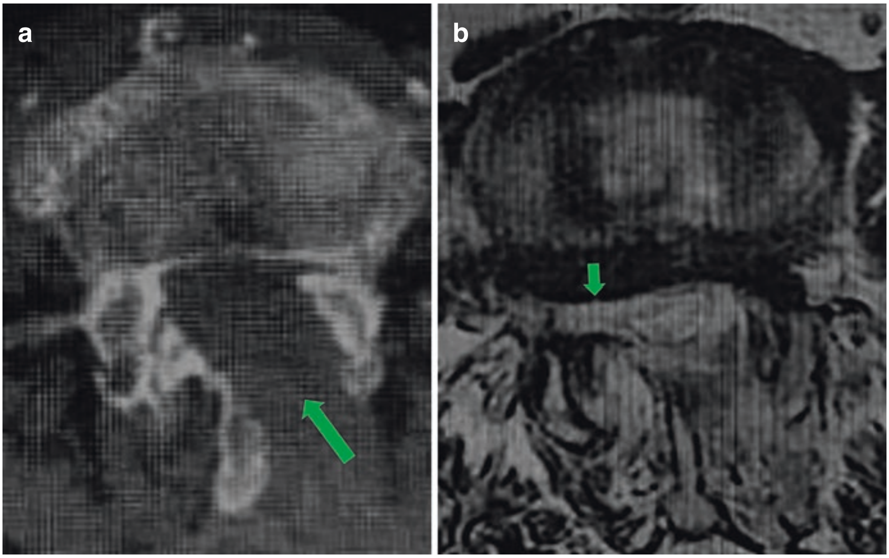

Fig. 16.25 Postoperative images from Case 3. (**a**) The axial view of the lumbar CT scan at L3–L4 shows sufficient central and bilateral subarticular decompression (green arrow). (**b**) The T2-weighted axial view of the lumbar MRI confirmed a foraminal decompression (green arrow) at L3–L4 on the right side

Case 3

A 70-year-old female patient complains of radicular pain radiating to her right leg. The pain descends through the anterior thigh and the medial aspect of the calf until it reaches the right ankle. Moreover, the patient also reports numbness in both legs. These symptoms make it hard for her to walk. The neurological examination showed significant 3/5 weakness in dorsiflexion of both ankles, in addition to bilateral abolition of the patellar reflex. Preoperative lumbar MRI demonstrated significant central narrowing canal at L3–L4 (Fig. 16.23a), while a predominantly right-sided lateral recess and proximal foraminal stenosis due to significant spondylosis were seen on preoperative CT scan at L3–L4 (Fig. 16.23b, c). Therefore, a UBE-ULBD for L3–L4 on the left side was planned (Fig. 16.24a) with a contralateral extended approach to reach the L3 and L4 nerves (Fig. 16.24b–d). Immediate postoperative lumbar MRI and CT images demonstrated adequate central and lateral decompression at L3–L4, consistent with the patient's considerable immediate postoperative clinical improvement (Fig. 16.25).

Discussion

Throughout this chapter, we have highlighted the potential benefits of the biportal endoscopy to decompress the neural elements in cases of lumbar spinal stenosis (LSS). In addition, the authors have noted the following particular advantages associated with the UBE:

1. The high-quality imaging obtained with the arthroscope and the continuous saline irrigated throughout the procedure make the UBE technique a genuine water-based endoscopic procedure.
2. The surgeon's ability to handle the instrument and the endoscope independently provides versatility to the UBE technique, safety during manipulation of critical anatomy, and confidence during the surgery.
3. The surgeon's familiarity with standard instruments for spinal surgery.
4. Minimal muscle damage compared with open surgery and less intraoperative radiation than other full-endoscopic techniques.
5. Surgeons with experience in other minimally invasive decompression procedures such as tubular or full endoscopy could shorten the learning curve in biportal endoscopy.
6. Other spine regions like the cervical or thoracic can be decompressed through UBE.
7. Besides, in the unilateral laminotomy for bilateral decompression (ULBD) procedure, we consider that biportal endoscopy compensates for the shortcomings observed in uniportal endoscopy (UE). For example, in interlaminar UE, the instrument can only be used through the same trajectory as the endoscope; the point is that if the surgeon requires to reach a specific location, the endoscopic system needs to be also mobilized together with the tool, and sometimes it is not possible because of intricated spaces within the spinal canal. Moreover, the surgeon could damage the expensive spinal endoscope if forced levering is done. However, in UBE, the instrument and the endoscope have some degree of freedom, and if needed, reorganization of both can be done to reach enough visibility of complex anatomy and the surgical instrument.

Unilateral laminotomy with bilateral decompression (ULBD) through MISS procedures is associated with less damage to important paraspinal tissues with a biomechanical role, such as paravertebral muscles, interspinous and supraspinous ligaments, and of course facet joints. Therefore, this procedure in a minimally invasive fashion is associated with a lower risk of iatrogenic postoperative instability [19, 30, 31].

In addition, several studies have shown that UBE-ULBD for the treatment of LSS can get sufficient and adequate decompression of the neural elements similar to open or microsurgical techniques [32–34].

UBE-ULBD aims to achieve the same or similar enlargement of epidural space for decompressing the neural elements than UE or microsurgery. The bony structures removed through UBE-ULBD are the ipsilateral partial laminotomy, the undercutting of the base of the spinous process, and the medial facet, but all the techniques for performing ULBD can get the same. The main differences that make UBE-ULBD special among the other methods are the high-quality vision under a water environment and the versatility of using the technique through two ports. The endpoint of the UBE-ULBD is to observe the neural elements free. Bilateral decompression of the lateral recess is confirmed by observing the medial wall of both inferior pedicles at the index level.

In addition, an extra advantage associated with endoscopic techniques (uniportal or biportal) concerning open or microsurgery is the preservation of the facet joint and minor damage to the paravertebral muscles related to the approach [34].

A concern in ULBD is decompression of the ipsilateral lateral recess. However, in UBE, the surgeon can reorganize the endoscope and the instrument in the surgical field so that the attack trajectory on the ipsilateral facet joint could be compelling, with less restriction than in the UE, and using a lens of 30°, by rotating it, the undercutting of the IAP and SAP can be performed preserving the FJ as much as possible.

Eum et al. [35] were the first to report encouraging clinical outcomes in patients with LSS treated with UBE-ULBD. The authors included 58 patients in their study, all of whom achieved sufficient decompression of the neural elements. According to the Macnab satisfaction criteria, 47 patients rated the procedure excellent or good. The complications presented were three cases with postoperative headache, durotomy noted in two patients, postoperative numbness in two patients, and epidural hematoma in one patient.

Li et al. [36] reported the results of a systematic review comparing the clinical effectiveness and safety between UBE-ULBD and microsurgery for LSS. The authors included seven articles that met the methodological quality. Allocation of the groups was as follows: 288 patients were included in the UBE group and 234 in the microsurgery group. The authors found no superiority between any of the groups concerning hospital stay. UBE was found to require less operative time than microsurgery. Patients in the UBE group had a better postoperative VAS score for back pain than those in the microsurgery group.

UBE was superior to microsurgery only on the first postoperative day regarding the postoperative leg VAS score. In addition, the authors found no differences in postoperative ODI, complications, revision rate, or cross-sectional area of the dura between the two groups. Finally, the authors reported that the UBE group had lower C-reactive protein (CRP) levels only on the first day than the microsurgery group. However, the authors conclude that the most important difference between UBE and microsurgery remains technical, considering image quality, ability to use two independent ports, and ability to use tools familiar to the surgeon as the most important advantages of UBE over microsurgery.

Also, an RCT from 2019 focused on UBE versus microscopic lumbar decompressive laminectomy included 64 patients divided into two groups (UBE versus microscopic) with 32 patients in each group. The study reported no significant difference in postoperative clinical outcomes at 1-year follow-up between the two groups. Therefore, no inferiority was demonstrated in the clinical effectiveness of the UBE technique compared to microscopy in the decompression of the LLS [37].

Another systematic review by Pao [38] from 2021 found that the most frequent complication in UBE-ULBD was a dural tear, with an incidence that varies from 1.5% to 9.7%. Most of these tears were small and could be treated without converting the procedure. However, a tear greater than 10 mm requires direct repair to prevent cerebrospinal fluid (CSF) leakage [39]. This chapter discussed how the surgeon must be careful when performing the flavectomy and how the intermediate dural fold usually has a higher risk of being damaged due to its anatomical characteristics.

Other complications are epidural hematoma, which can be prevented by performing adequate hemostasis with the radiofrequency (RF), bone wax, hemostatic matrices, and leaving postoperative epidural drainage. In addition, neurological disorders associated with increased hydrostatic pressure in the epidural space, such as postoperative headaches or chronic subdural hematoma following lumbar UBE-ULBD, have been reported [40, 41].

Conclusions

Based on the most recent evidence on biportal endoscopy for the treatment of lumbar spinal stenosis, unilateral laminotomy with bilateral decompression is usually effective and associated with encouraging clinical outcomes with a lower complication profile. In addition, the same advantages related to other minimally invasive procedures, such as a shorter hospital stay and a faster return to daily activities, are perceived with biportal endoscopy. However, it is recommended that the surgeon interested in this technique consider the systematized process discussed in this chapter to decompress the lumbar spinal stenosis to ensure similar results.

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