11 Far-out Syndrome Decompression Using Unilateral Biportal Endoscopy

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11.1 Introduction

Far-out syndrome (FOS) is one type of lumbosacral transitional vertebrae (LSTV). LSTV is a various anatomical variant of lumbosacral junctional area. There are four types of LSTV [1, 2]. Among them, type 2 shows the pseudo-articulation between L5 transverse process and sacral ala, and in addition, the foraminal height is decreased than normal structure. Therefore, FOS is defined as the compression of L5 nerve root in the far-out area by the pseudo-articulation of the L5 transverse process and the sacral ala (Fig. 11.1). The gold standard treatment of FOS is a conventional microscopic decompression surgery or lumbar fusion surgery [3–6]. However, due to the development of endoscopic surgery system, we can treat this lesion sufficiently using unilateral biportal endoscopy (UBE) technique. Basically, this surgical approach is the same as the Wiltse approach that contains enough decompression far laterally [7].

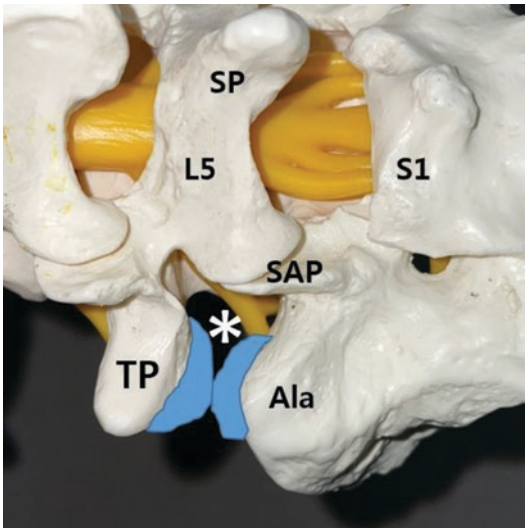

Fig. 11.1 This figure shows the fundamental concept of an extra-foraminal lesion. The blue overlaid areas indicate the pseudo-articulation of the hypertrophied transverse process and sacral ala. The exiting L5 nerve root is compressed in the narrow area (*)

11.2 Indications and Contraindications

Indication and contraindication are very similar with conventional microscopic decompression surgery. The FOS lesion combined with foraminal

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stenosis at L5/S1 level and the recurrent FOS can also be treated by this technique. However, grade 2 or higher spondylolisthesis and segmental instability are contraindicated in this technique.

11.3 Special Instruments

Zero-degree endoscope is most commonly used in UBE surgery. Radiofrequency (Arthrocare®) probe is essential to control intraoperative bleeding. The arthroscopic drill system with saline drain portal and high-speed electrical drill is commonly used to drill out the bony structure (Fig. 11.2). The scope-retractor is also useful in preventing nerve root damage. The curved Kerrison punch is very useful to decompress the foraminal lesion. All conventional surgical instruments are available in this technique (Fig. 11.3).

11.4 Anesthesia and Position

Both endotracheal general anesthesia and epidural anesthesia are available in this surgery. The authors prefer epidural anesthesia because it is a less invasive procedure and less loading on cardio-pulmonary function than general anesthesia. The patient is always placed on a Wilson frame in the prone position. In addition, less lumbar lordosis using elevation of Wilson frame can make the operation comfortable because this induces the widening of foraminal area and it also reduces the intra-abdominal pressure. In addition, the compression stockings prevent thrombosis in the lower extremities during the surgery. The Foley catheter is usually inserted to check the perioperative urine output (Fig. 11.4).

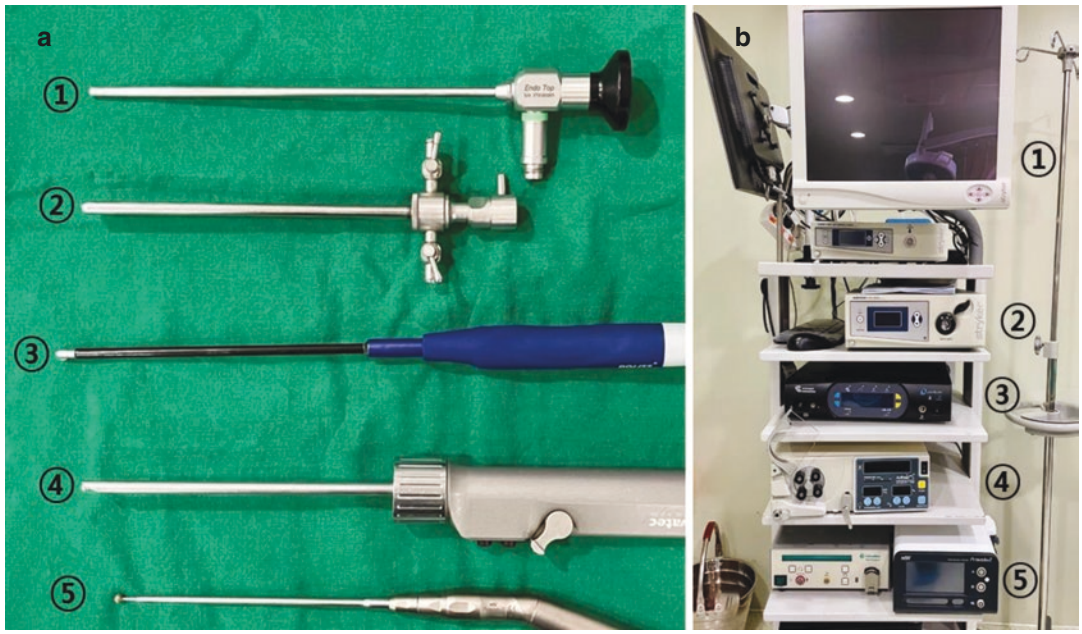

Fig. 11.2 UBE instruments. (**a**): ① Zero-degree endoscope. ② Sheath for endoscope. ③ RF probe device. ④ Arthroscopic drill system with saline drain tube. ⑤ High-speed electrical drill. (**b**): ① Monitor for endoscope. ② Light source generator of endoscope. ③ RF probe device generator. ④ Automatic irrigation pump. ⑤ Electrical drill system

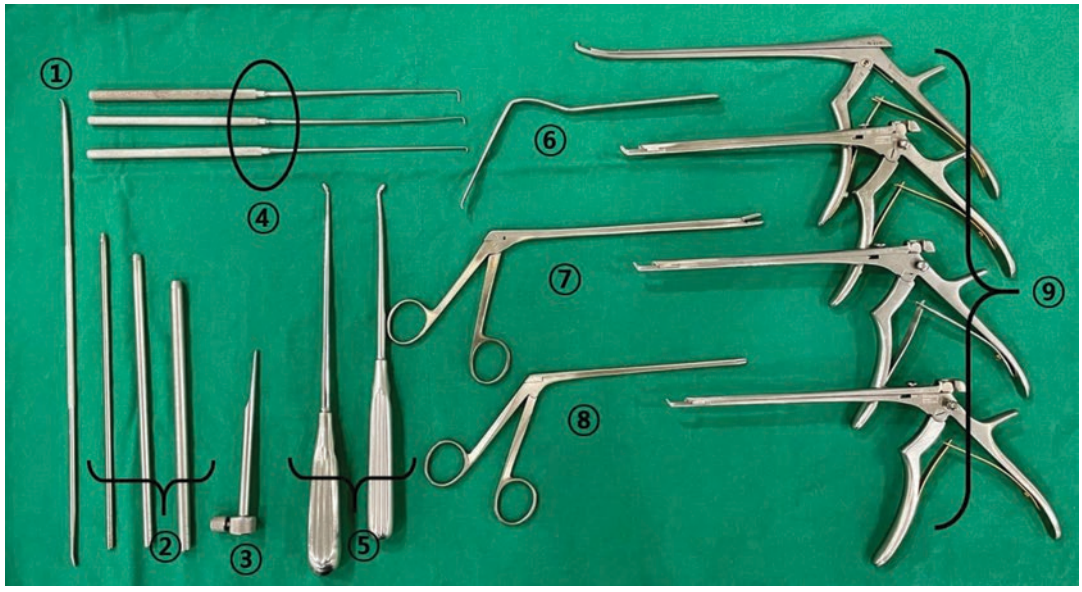

Fig. 11.3 UBE instruments. ① Double-ended dissector. ② Serial dilators #1 ~ #3. ③ Scope retractor. ④ Blunt/ball-hook. ⑤ Angled curettes. ⑥ Root retractor. ⑦ Alligator forceps. ⑧ Pituitary forceps. ⑨ Kerrison punch & curved punch

Fig. 11.4 UBE position. ① Wilson frame with elevation. ② Knee band. ③ Compression stockings for anti-thrombosis. ④ Foley catheter is inserted

11.5 Surgical Steps

1. **Identify the location of two portals and make portals (left side approach) (Fig. 11.5)**

   Setting the true anteroposterior (A-P) image under fluoroscopic guidance is the first step for this surgery. Especially, the L5-S1 level has the most lordotic angle, it is very important to apply the fluoroscopic device a cranial angle to get the accurate A-P image (Fig. 11.6). The UBE surgery utilizes two portals, one is an endoscopic portal for endoscope and the other is an instrumental portal for surgical instruments. We describe the surgical steps as the point of view of the left side approach. First, we identify the L5 and S1 pedicles and disc space, and also the lateral margin of vertebral body on A-P view. The skin incision is made 1–2 cm laterally to the lateral margin of vertebral body. This location will be more lateral than UBE paraspinal approach. Because, the target of paraspinal approach is the facet joint or isthmus, on the contrary, the target of FOS surgery is pseudo-articulation of transverse process (TP) - sacral ala. The instrumental portal is made 1 cm below the intervertebral foramen level and the endoscopic portal is made 1 cm above this level. Usually, the distance of two portals is about 2–2.5 cm and the size of incision is

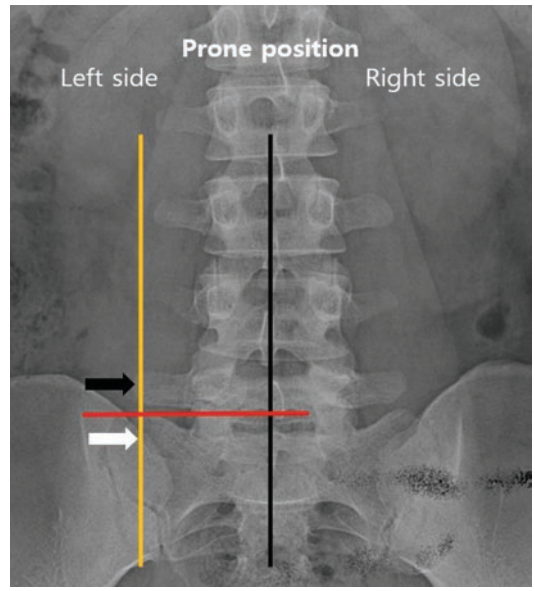

Fig. 11.6 True A-P image of L5-S1 level. Black line: mid vertical line. Red line: intervertebral foramen line at L5/S1. Yellow line: 1–2 cm lateral line from vertebral body. Black arrow: cranial-scope portal (1 cm cranially from red line). White arrow: caudal-instrument portal (1 cm caudally from red line)

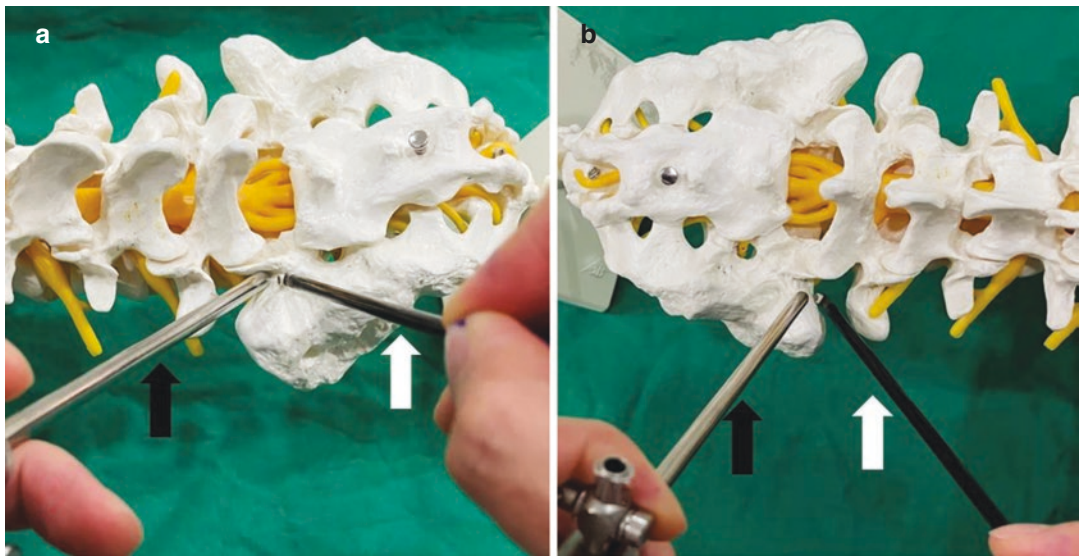

Fig. 11.5 Basic concept of UBE surgery. (**a**): Left side approach for FOS decompression. (**b**): Right side approach for FOS decompression. Zero-degree endoscope (black arrow) and RF probe (white arrow)

about 1 cm. We always make instrumental portal firstly and it is very important that the incision should penetrate the fascial layer to maintain the continuous outflow of the irrigation saline during the surgery. After incision, serial dilators are inserted sequentially. At this point, the landing point of first dilator is very important. The aim of FOS decompression surgery is removal of the pseudo-articulation of TP and sacral ala, the dilator should touch the sacral ala or sacral notch initially where the interspace of superior articular process (SAP) of S1 and sacral ala (Fig. 11.7). After finishing the instrumental portal making, the endoscopic portal is made in the same manner. The first dilator inserted in endoscopic portal should also touch the sacral ala or sacra notch. The triangulation of two portals is a cornerstone of this technique (Fig. 11.8).

2. **Making initial working space**

To obtain good initial operative visualization, the meticulous dissection and detachment of muscular ending and soft tissue around the surface of sacral alar or sacral notch are essential. The initial working space of FOS decompression surgery is the interspace filled with irrigation saline between the surface of bony structure and soft tissue. This space is very narrow, but we can gradually obtain wider space by ablating or coagulating the soft tissue using RF device. The stage of initial working space is finished until clearly identifying the bony surface of SAP lateral aspect, sacral alar, and lower border of TP. The triangle zone of these three structures is a true working space. In addition, we can also easily identify the lateral aspect of isthmus and sacral notch (Fig. 11.9).

3. **Removal of bony structures and soft tissue**

After full exposure of these bony structures, we usually start the drilling to sacral alar, lateral aspect of SAP, and inferior border of TP. The exposure of cancellous bone sometimes induces severe bony bleeding and this can be controlled by bone wax or RF probe. When drilling out in the lateral direction of TP and alar, pseudo-articulation is observed. This lesion should be removed as laterally as possible, because the exiting nerve root runs under this pseudo-articulation (Fig. 11.10a). Drilling to the lower portion of L5 TP and lateral aspect of SAP and alar area, combined further removal of soft tissue using RF device allow identification of the ligamentum flavum covering the exiting nerve root (Fig. 11.10b).

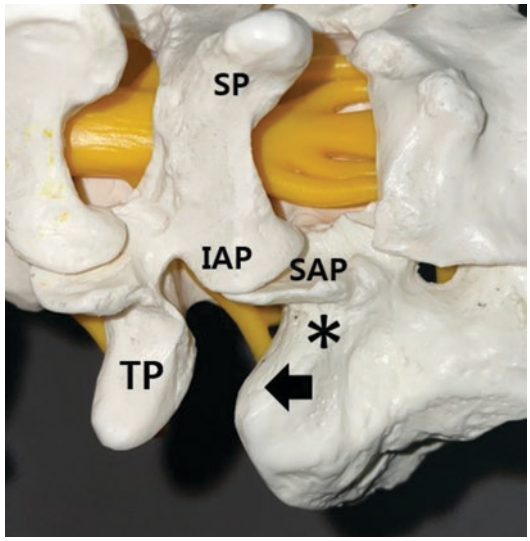

Fig. 11.7 The initial target point of FOS (*): sacral notch. Black arrow: sacral ala. TP: transverse process. IAP: inferior articular process. SAP: superior articular process. SP: spinous process

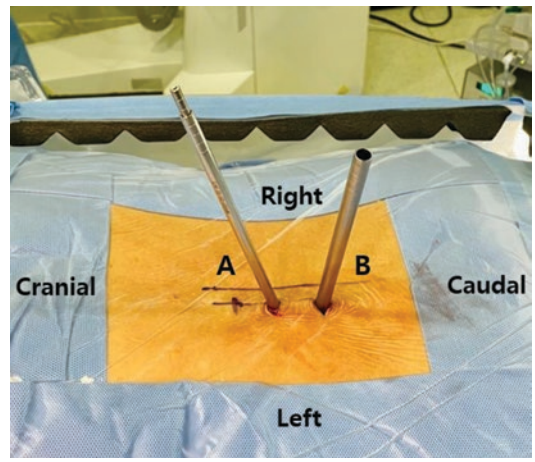

Fig. 11.8 Triangulation of endoscopic portal (**A**) and instrumental portal (**B**)

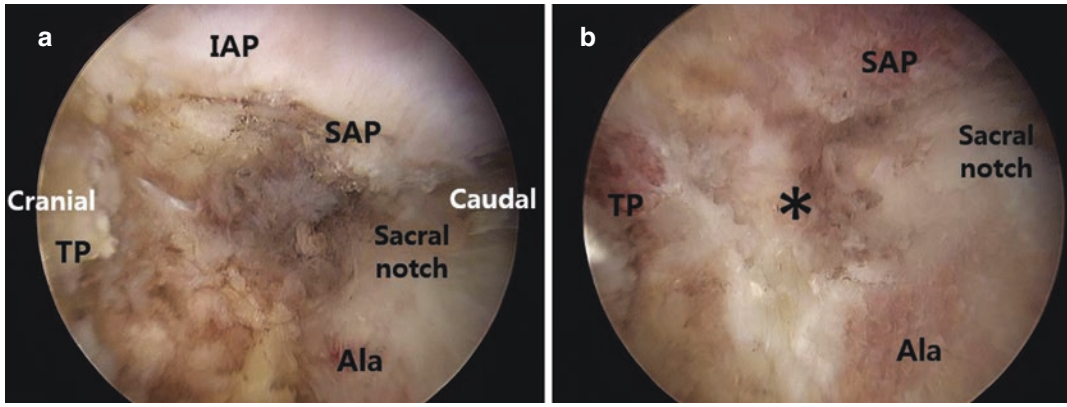

Fig. 11.9 (**a**): Initial endoscopic image. After removal of soft tissue around bony structures, initial working space is acquired. (**b**): Initial working space. The triangle zone (*) of TP, SAP, and Ala is a main field of FOS decompression surgery. TP: transverse process; SAP: superior articular process; IAP: inferior articular process

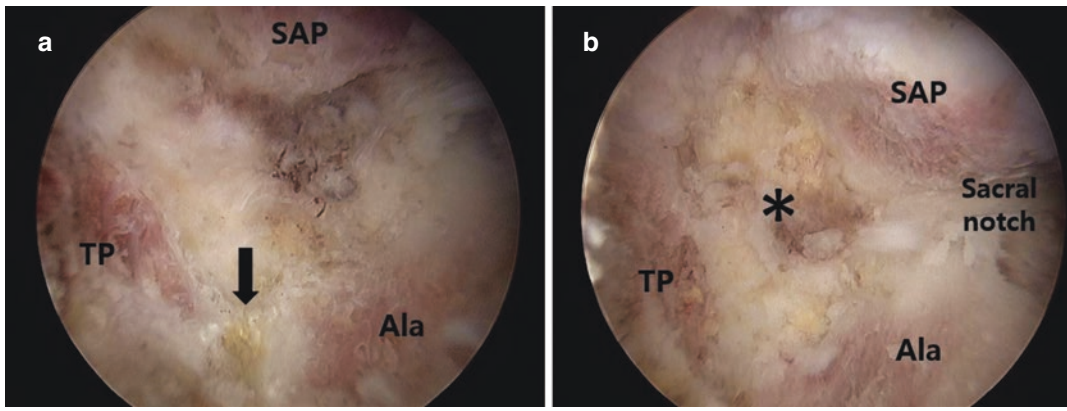

Fig. 11.10 (**a**): Pseudo-articulation (black arrow) is observed at the point of TP and ala encounter. (**b**): After more resection of bony structures and soft tissue, the ligamentum flavum (*) covering the exiting nerve root (L5 root) is identified. TP: transverse process; SAP: superior articular process

4. **Identify the exiting nerve root and alar resection**

   After dissecting the lower part of the TP and along the fissure of the ligament flavum, we can figure out the exiting nerve root immediately (Fig. 11.11a). Then, using a small Kerrison punch or angled curette, the ligamentum flavum can be removed easily and safely (Fig. 11.11b). Now, the foraminal portion of exiting nerve root is entirely exposed. We also identify the annulus of intervertebral disc located just below the nerve root (Fig. 11.12a). In order to completely decompress the extra-foraminal portion of exiting nerve root, the medial part of Alar as well as pseudo-articulation part must be further removed by drilling out or Kerrison punch (Fig. 11.12b).

5. **Finish the decompression and wound closure**

   In the case of severe bulging disc or disc herniation, the discectomy is also performed using pituitary forceps or Kerrison punch for fully ventral decompression of the nerve root. (Fig. 11.13a). It is also very important that clarify the ventral decompression of the nerve root to improve the prognosis after surgery. All decompression procedure is successfully completed when the root confirmed freely passes through alar and enters the abdominal cavity.

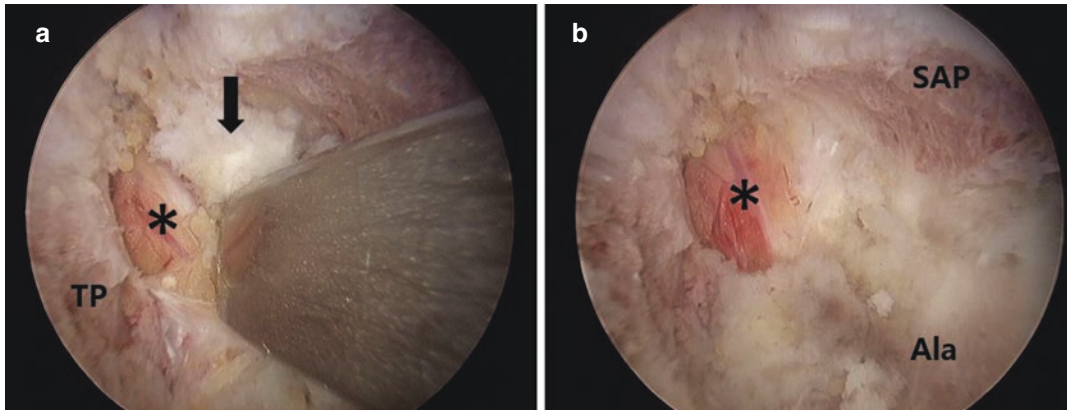

Fig. 11.11 (**a**): The ligamentum flavum (black arrow) covering the exiting nerve root (*). (**b**): After removal of ligamentum flavum, L5 nerve root is identified (*). TP: transverse process; SAP: superior articular process

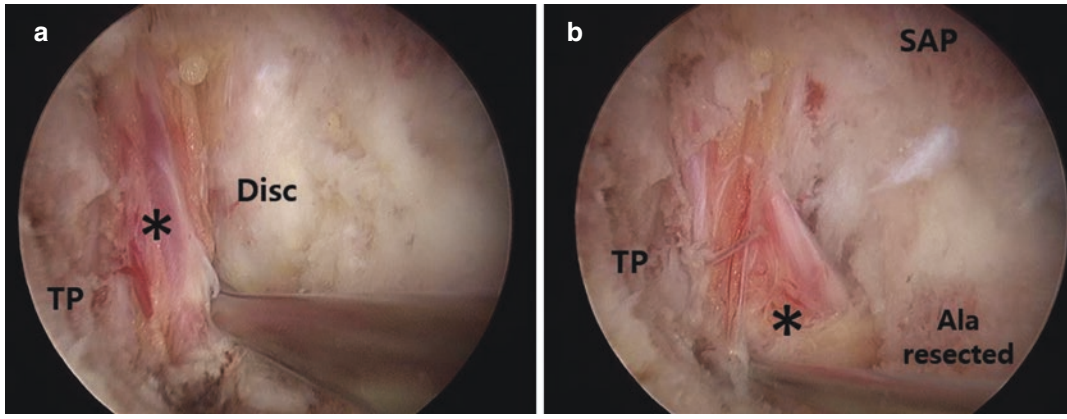

Fig. 11.12 (**a**): The intervertebral disc is located just below the exiting nerve root (*). (**b**): The extra-foraminal portion (*) of exiting nerve root is identified. TP: transverse process; SAP: superior articular process

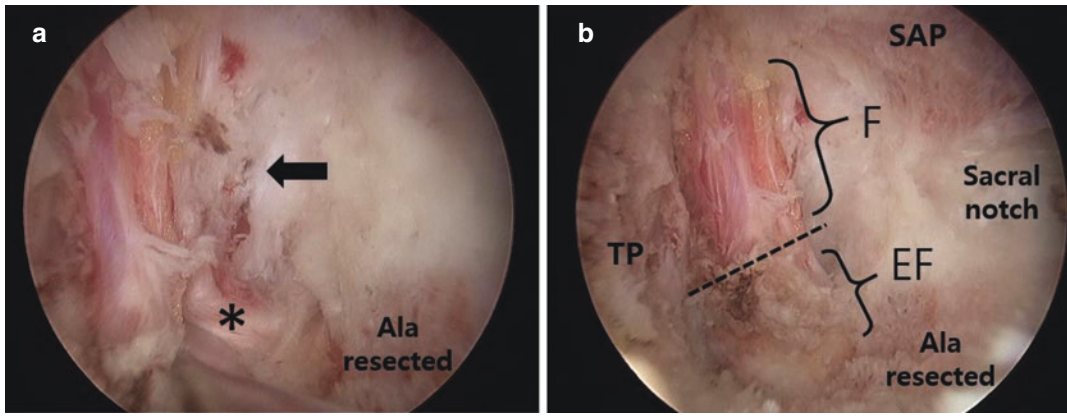

Fig. 11.13 (**a**): The ventral portion of nerve root (*) is exposed. Black arrow indicates the discectomy site. (**b**): Final image. Both foraminal portion and extra-foraminal portion of exiting nerve root is identified (F: foraminal portion, EF: extra-foraminal portion). TP: transverse process; SAP: superior articular process

In the final image, we can check the details including foraminal portion and extra-foraminal portion of exiting nerve root (Fig. 11.13b). A drain catheter is always inserted through the instrumental portal before skin closure (Fig. 11.14). After approximation of subcutaneous layer using absorbable suture material, skin stapler or a point of non-absorbable suture is applied to close the skin.

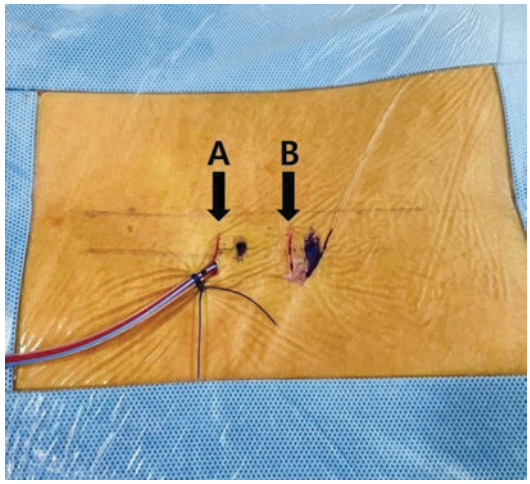

Fig. 11.14 (**a**): Scope portal. (**b**): Instrument portal. A drain catheter is fixed by suture

11.6 Illustrated Case

11.6.1 Case 1 (Left Side Approach, Video 11.1)

A female patient complained of severe radiating pain in the left lower extremities with L5 dermatome. This patient had undergone microscopic lumbar L4/5 decompression surgery 7 years ago at another hospital. Her symptoms have recently worsened and selective nerve block did not improve the symptoms, and she has been unable to lie down due to the pain. Preoperative MRI showed severe extra-foraminal stenosis on the left side of L5/S1, and UBE surgery was performed to relieve the pain (Fig. 11.15). The description of the surgical method is replaced by the main text of the surgical steps in this chapter. The sufficient decompression of the exiting nerve root is well observed in the postoperative MRI images and the final endoscopic image showed full decompression of nerve root from foraminal portion to extra-foraminal portion (Fig. 11.16). The patient was discharged on the fifth day after surgery without any complication.

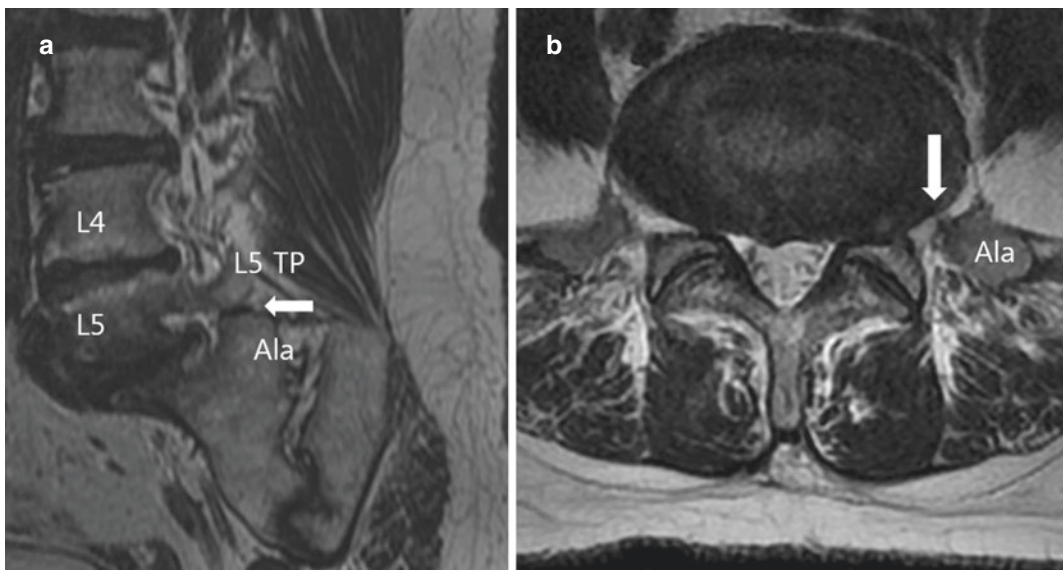

Fig. 11.15 Preoperative MRI T2WI (**a**): Left side oblique view. The pseudo-articulation between L5 TP and sacral ala is indicated with white arrow. (**b**): Axial view. The exiting L5 nerve root (white arrow) is entrapped in the extra-foraminal area surrounded with ala

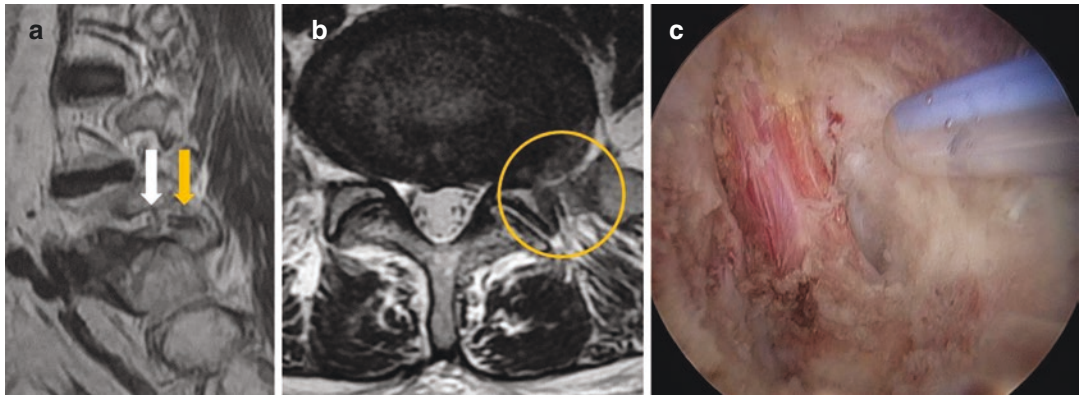

Fig. 11.16 Postoperative MRI T2WI sagittal view (**a**) and axial view (**b**). White arrow indicates decompressed exiting L5 nerve root and yellow arrow indicates the drain catheter. In the yellow circle, partially removed SAP and Ala are observed. (**c**): Final endoscopic image. The drain catheter is inserted

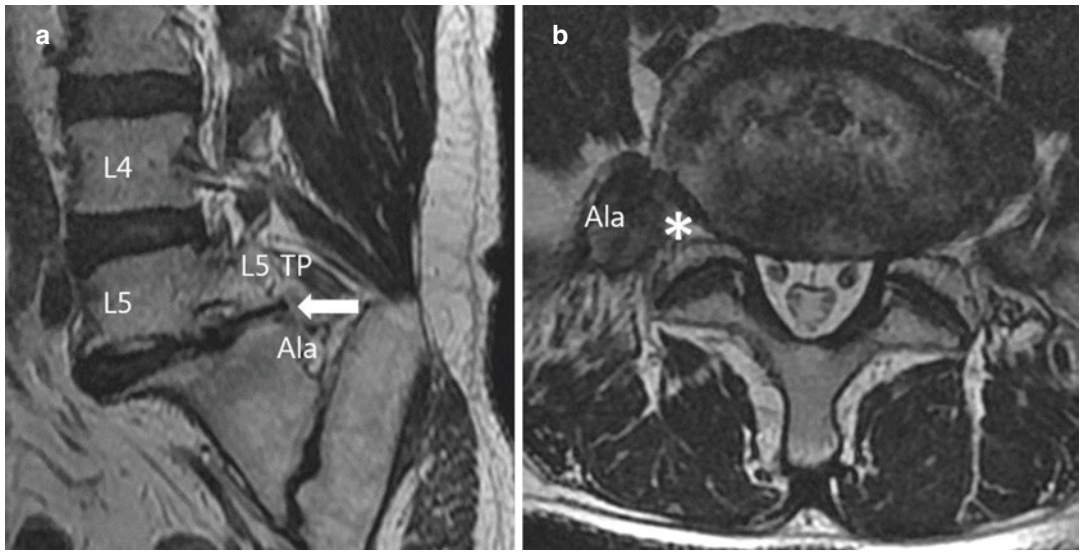

Fig. 11.17 Preoperative MRI T2WI (**a**): Right side oblique view. The pseudo-articulation between L5 TP and sacral ala is indicated with white arrow. (**b**): Axial view. The exiting L5 nerve root is compressed from forminal portion to extra-foraminal portion (*) due to hypertrophied bony structures

11.6.2 Case 2 (Right Side Approach, Video 11.2)

A male patient complained of radiating pain and tingling sensation in the right lower extremities with L5 dermatome. He also complained of neurogenic intermittent claudication (NIC) on left leg, so he could not walk for more than 5 min. There was no response to the selective nerve block and the gait was very uncomfortable, so the UBE decompression surgery was performed. Preoperative MRI showed severe foraminal and extra-foraminal stenosis on the right side of L5/S1 and the exiting L5 nerve root is severely compressed (Fig. 11.17). Under the epidural anesthesia, UBE far-out decompression with right side approach was performed. After identifying the triangle zone in the initial working

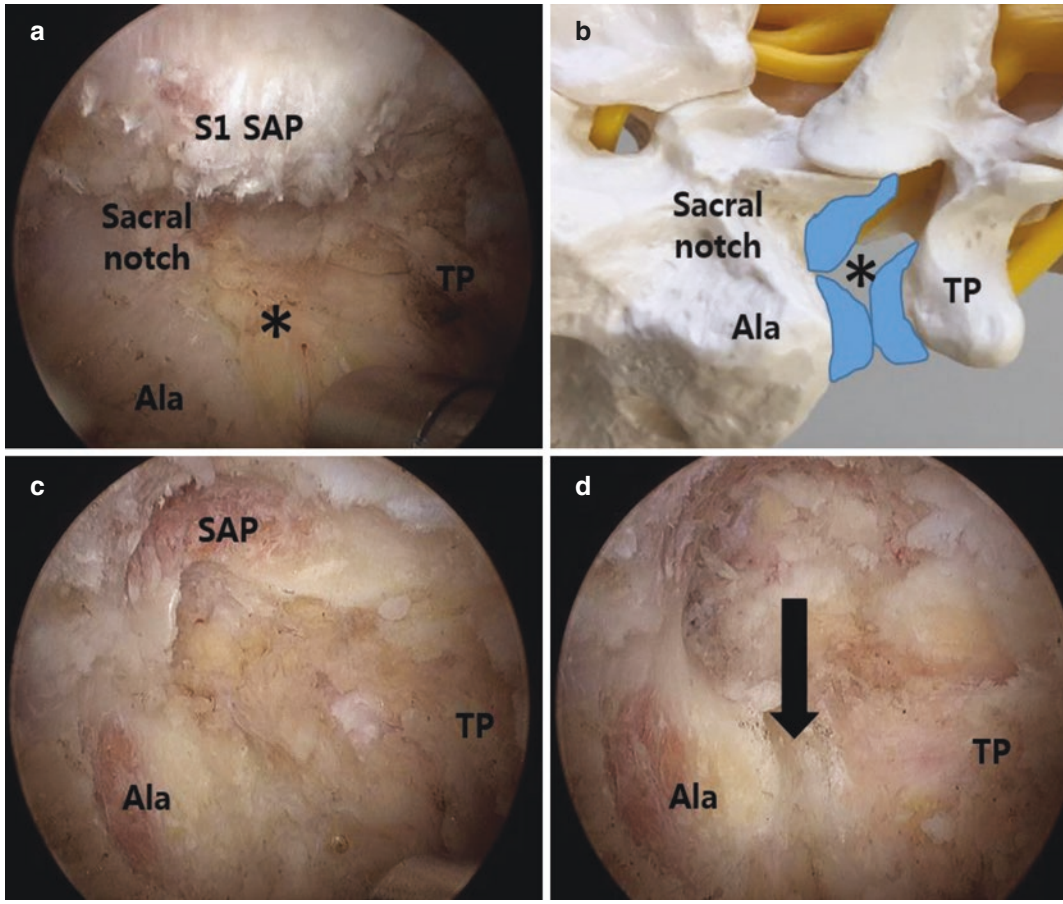

Fig. 11.18 Endoscopic image. Right side approach. (**a, b**): The triangle zone (*) is surrounded with hypertrophied bony structures. (**c, d**): After drilling out the hypertrophied bony structure, the pseudo-articulation is exposed (black arrow)

space, drilling out the bony structures is performed and the pseudo-articulation is well exposed (Fig. 11.18). The exiting nerve root can be identified by uncovering the yellow ligament, and the pseudo-arthosis is sufficiently removed to decompress the extra-foraminal lesion (Fig. 11.19). To decompress the ventral portion of nerve root and foraminal portion, a discectomy could be added. After full decompression along the nerve root from foraminal portion to extra-foraminal portion, the operator confirms that there are no remaining lesions, inserts a drain catheter, and can finish the surgery (Fig. 11.20). Postoperative MRI showed a completely decompression state of far-out lesion and did not show paraspinal muscle edema or hematoma (Fig. 11.21).

11.7 Complications and Their Management

1. Intraoperative bleeding

   The radicular artery around the facet joint is a common cause of intraoperative bleeding [8]. In far-out syndrome, this artery usually runs over the sacral notch. Gentle dissection and approach to sacral notch are very important to prevent

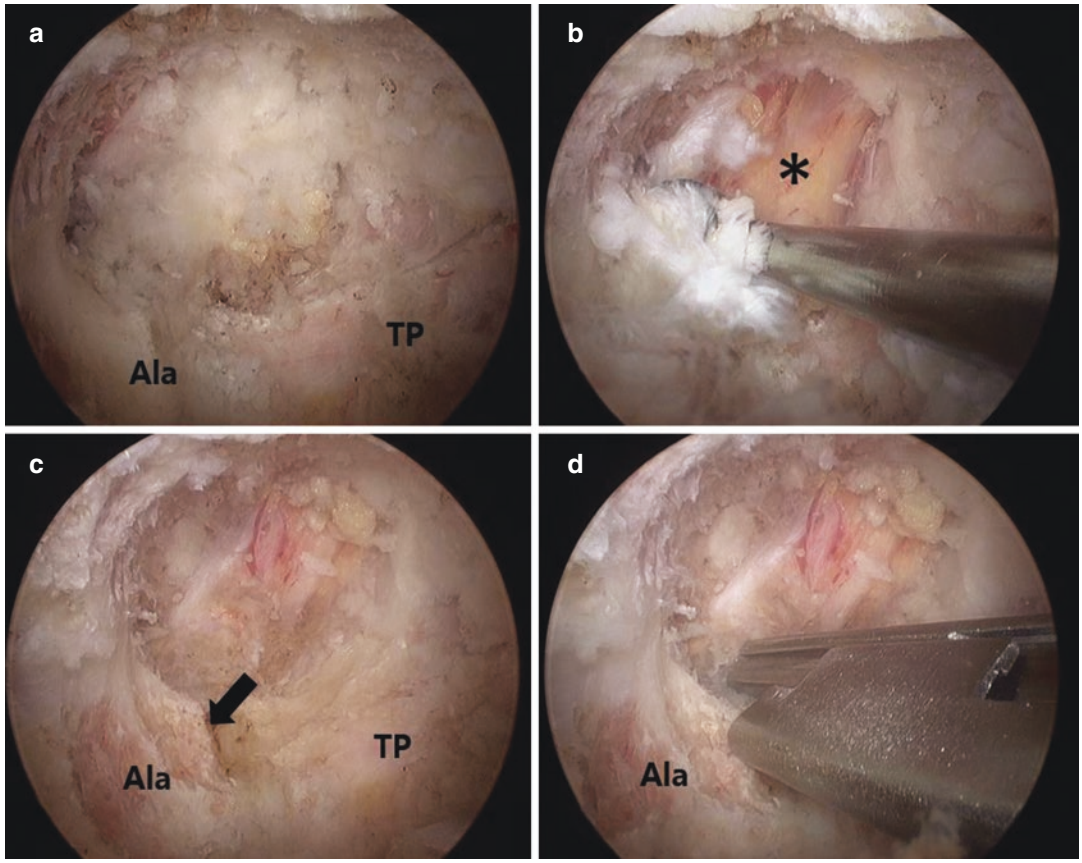

Fig. 11.19 (**a, b**): The yellow ligament covering the nerve root. After removal of ligament, exiting nerve root is exposed (*). (**c, d**): To decompress the far-out lesion, ala and pseudo-articulation should be removed more

arterial bleeding. If arterial vessels are not recognized, severe bleeding may occur. In this case, the endoscope must be closely attached to identify the bleeding site. Thereafter, RF device can be used to control the bleeding (Fig. 11.22).

2. Dural tear or root injury

   Because FOS is an extra-foraminal lesion, the dural tear or damage in spinal canal rarely occurs. However, the exiting nerve root injury can occur. Most of the time, it happens when the Kerrison punch or pituitary forceps are used deeply without the exiting nerve fully identified. In this case, the dura mater surrounding the exiting nerve may be damaged and the nerve rootlets can be exposed (Fig. 11.23a–b). To repair dural defect, the injured area was packed and covered with Tachocomb® (Fig. 11.23c–d).

11.8 Surgical Tips, and Pitfall

1. Postoperative nerve root swelling and dysesthesia

   After UBE decompression surgery, residual symptoms such as radiating pain and paresthesia in the index lower extremities sometimes remain. Young male patient underwent UBE FOS decompression surgery to treat the severe radiating pain in the

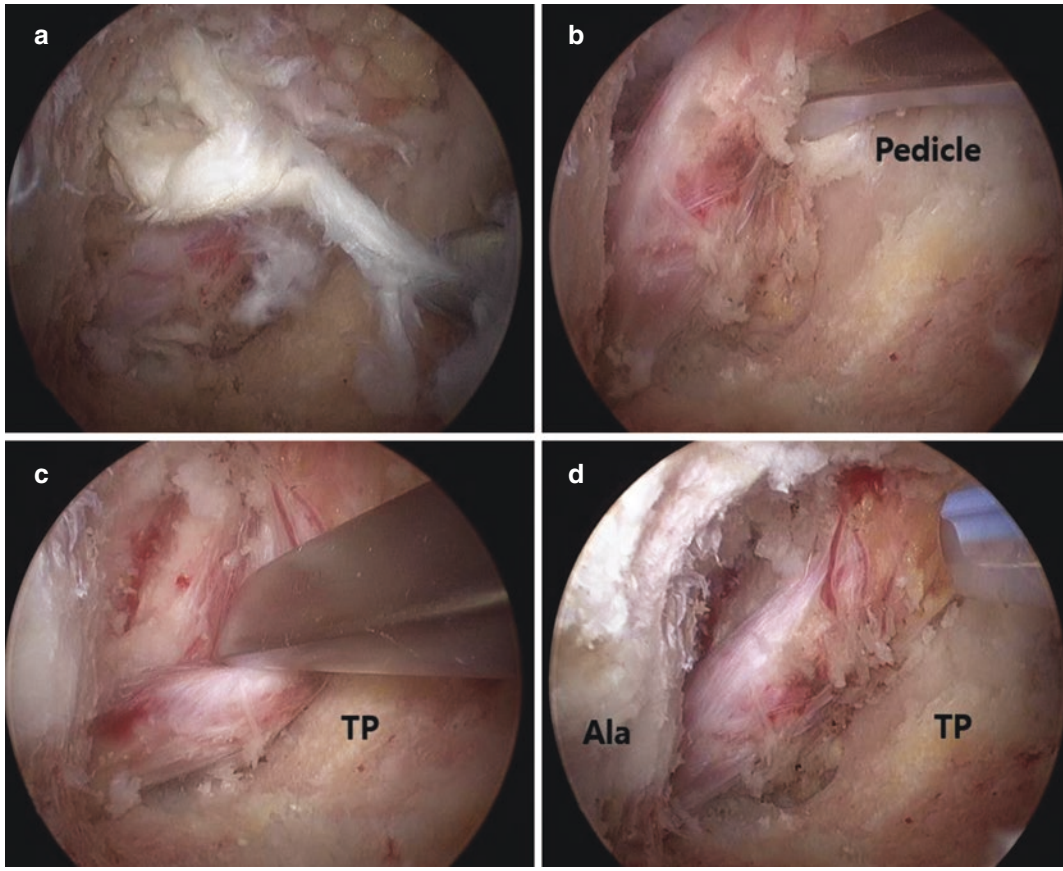

Fig. 11.20 (**a**): Discectomy for ventral decompression of nerve root. (**b, c**): L5 pedicle and vertebral body can be identified after full decompression. (**d**): Final endoscopic image. A drain catheter is inserted

left lower extremities. The lower extremity symptoms improved for a few days after surgery, but the pain worsened again after 1 month, and the MRI study was retaken. It showed significant swelling of nerve root ganglion (Fig. 11.24). Porchet et al reported that in 27% of patients who underwent far-lateral approach for extra-foraminal lumbar disc herniation showed fair or poor outcomes after surgery [9]. In order to reduce these complications, the gentle manipulation of nerve root is very important.

2. Retroperitoneal fluid collection

Continuous saline irrigation is essential to UBE surgery. To treat the far-out syndrome, removal of pseudo-articulation around the ala is most important and this may cause damage to the boundary between the paraspinal muscle and retroperitoneum [10]. Retroperitoneal fluid collection can cause abdominal discomfort and pain and can be diagnosed by abdominal computed tomography (CT) scan. In most cases, it can be resolved with conservative treatment, but sometimes lead to serious complications.

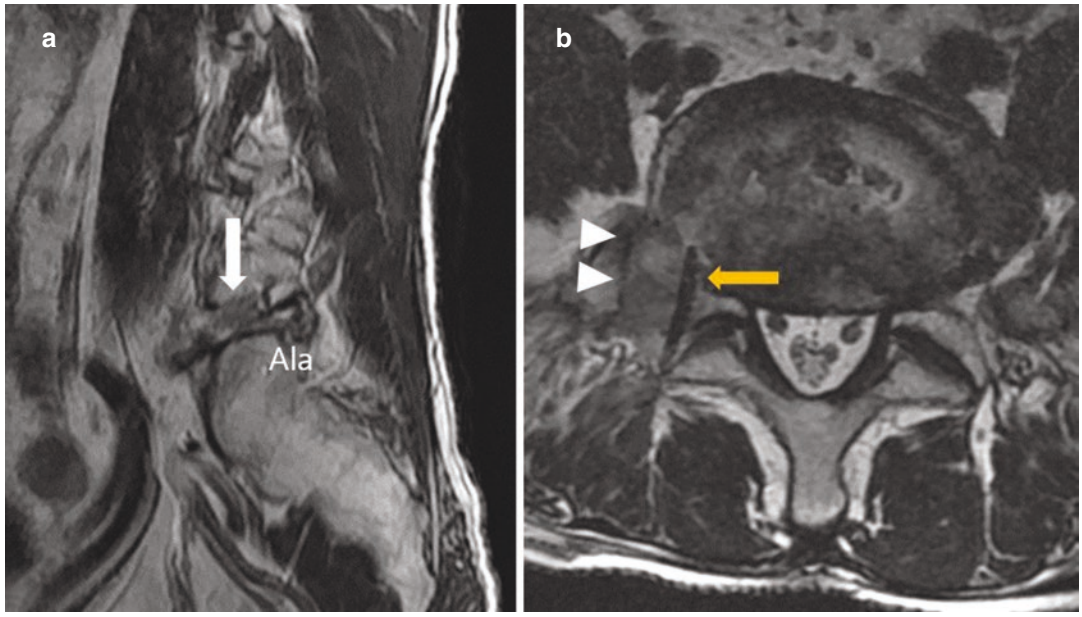

Fig. 11.21 Postoperative T2WI sagittal view (**a**) and axial view (**b**). White arrow indicates decompressed exiting L5 nerve root. In the axial view, ala bone has been sufficiently removed (arrowheads). The drain catheter is inserted (yellow arrow)

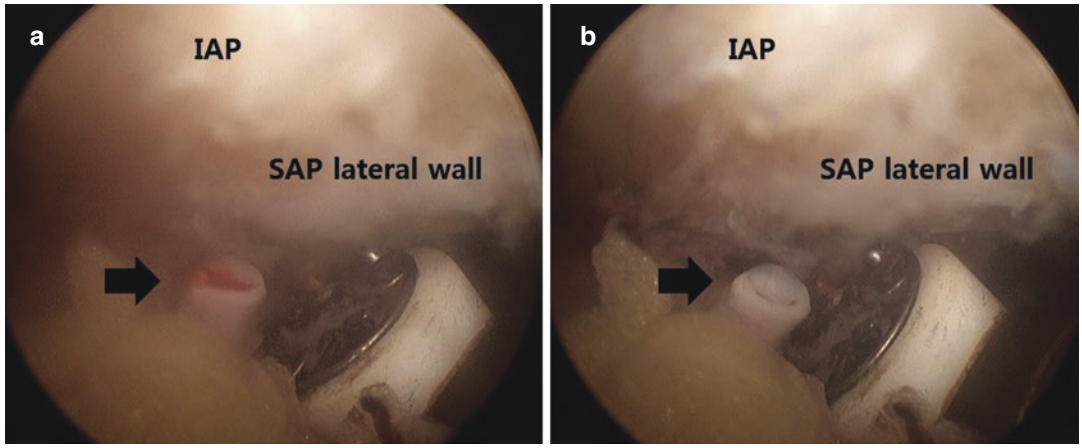

Fig. 11.22 (**a**): The radicular artery (black arrow) is identified at lateral of SAP. (**b**): Coagulated state of radicular artery (black arrow) by RF probe

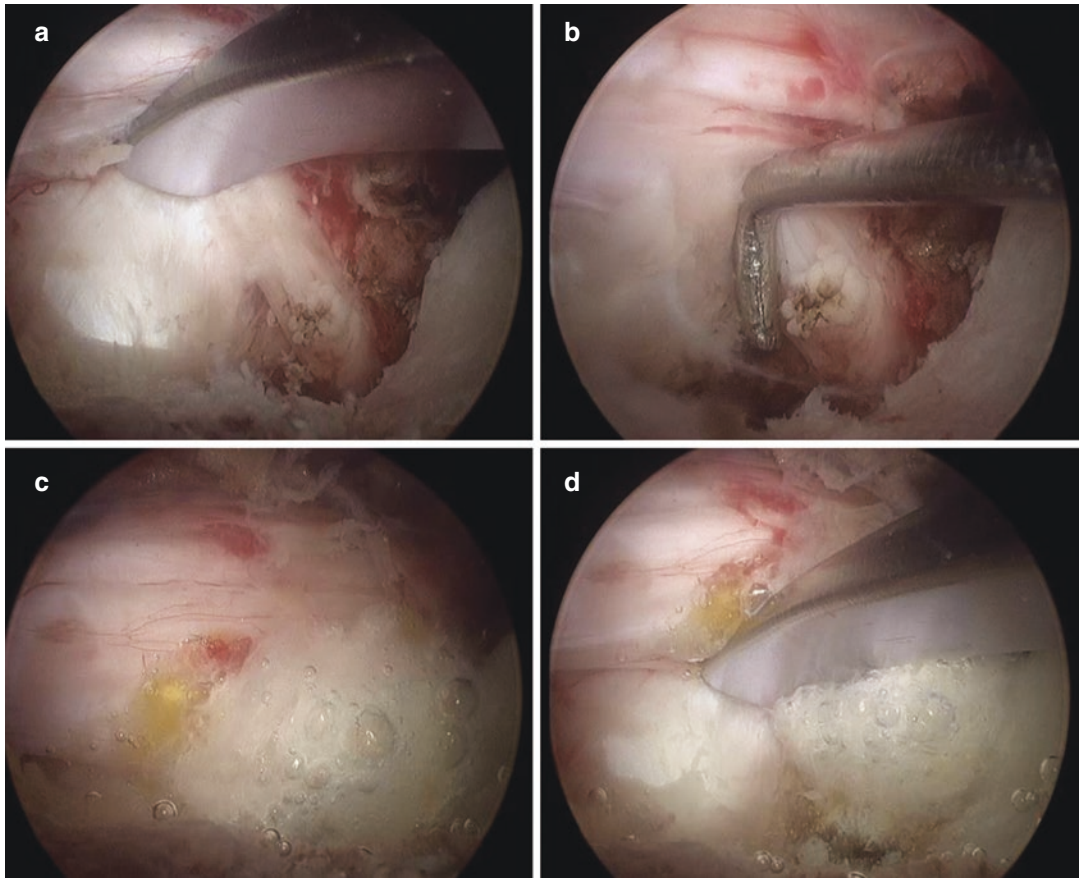

Fig. 11.23 Example case of L5 nerve root injury. (**a, b**): The shoulder portion of L5 nerve root was damaged and the rootlets were exposed. (**c, d**): The damaged area was packed and covered using a Tachocomb®

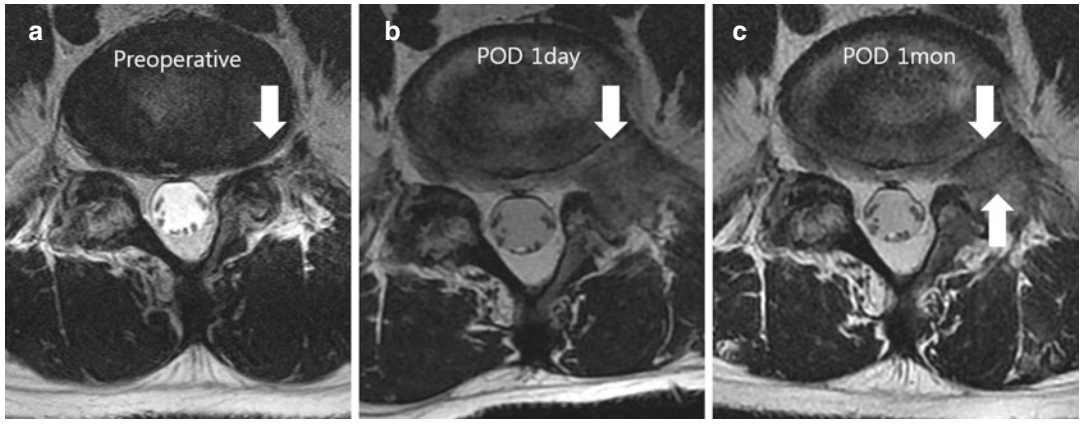

Fig. 11.24 The serial MRI T2WI axial view. (**a**): The extra-foraminal lesion is indicated (white arrow) in preoperative image. (**b**): Well-decompressed state is observed in POD 1 day image. (**c**): A month after surgery, significant swelling of nerve root ganglion is observed

References

1. Jancuska JM, Spivak JM, Bendo JA. A review of symptomatic lumbosacral transitional vertebrae: Bertolotti's syndrome. Int J Spine Surg. 2015;9:42.
2. Holm EK, Bünger C, Foldager CB. Symptomatic lumbosacral transitional vertebra: a review of the current literature and clinical outcomes following steroid injection or surgical intervention. Sicot-J. 2017;3:71.
3. Watanabe K, Yamazaki A, Morita O, Sano A, Katsumi K, Ohashi M. Clinical outcomes of posterior lumbar interbody fusion for lumbar foraminal stenosis: preoperative diagnosis and surgical strategy. Clin Spine Surg. 2011;24(3):137–41.
4. Li Y, Lubelski D, Abdullah KG, Mroz TE, Steinmetz MP. Minimally invasive tubular resection of the anomalous transverse process in patients with Bertolotti's syndrome: presented at the 2013 joint spine section meeting. J Neurosurg Spine. 2014;20(3):283–90.
5. Sasaki M, Aoki M, Matsumoto K, Tsuruzono K, Akiyama C, Yoshimine T. Middle-term surgical outcomes of microscopic posterior decompression for far-out syndrome. J Neurol Surg A Cent Eur Neurosurg. 2014;75(02):079–83.
6. Iwasaki M, Akiyama M, Koyanagi I, Niiya Y, Ihara T, Houkin K. Double crush of L5 spinal nerve root due to L4/5 lateral recess stenosis and bony spur formation of lumbosacral transitional vertebra pseudoarticulation: a case report and review. NMC Case Rep J. 2017;4(4):121–5.
7. Wiltse L, Guyer R, Spencer C, Glenn W, Porter I. Alar transverse process impingement of the L5 spinal nerve: the far-out syndrome. Spine. 1984;9(1):31–41.
8. Yang H-S, Lee N, Park J-Y. Current status of biportal endoscopic decompression for lumbar foraminal stenosis: endoscopic partial facetectomy and outcome factors. J Minim Invasive Spine Surg Tech. 2021;6:157–63.
9. Porchet F, Chollet-Bornand A, de Tribolet N. Long-term follow up of patients surgically treated by the far-lateral approach for foraminal and extraforaminal lumbar disc herniations. J Neurosurg Spine. 1999;90(1):59–66.
10. Heo DH, Sharma S, Park CK. Endoscopic treatment of extraforaminal entrapment of L5 nerve root (far out syndrome) by unilateral biportal endoscopic approach: technical report and preliminary clinical results. Neurospine. 2019;16(1):130.