Biportal Endoscopic Approach for Lumbar Central Stenosis

Hee-Seok Yang, Dong Hwa Heo, and Jeong-Yoon Park

Introduction

Lumbar central stenosis is a degenerative process that is frequent in the aging population. Lumbar spinal stenosis is a pathologic process where vertebral bodies, ligaments, and facet joints of the lumbar spine degenerate and overgrow, progressively compressing the neural and vascular elements in the spinal canal [1].

Recently, endoscopic techniques also have shown encouraging clinical results in the treatment of lumbar spinal stenosis [2]. Based on many studies and reports of successful decompression of the stenosis through uniportal and biprotal endoscopic approach, endoscopic spine surgery have evolved with less damage on normal structures and have demonstrated effective stenosis decompressions under direct visualization [2–5]. Recently, biportal endoscopic decompression is introduced. Uniportal endoscope uses single and same axis for endoscope and working channel, and it should have a close view. In addition, the instrument must be seen under close view and visual field during uniportal endoscopic surgery is narrow. On the other hand, biportal endoscopic spine surgery has a long and wide field of view, and the axes of the endoscope and working channel are separated. Therefore, the instrument can be used under a relatively long distance and wide field of view, and this unique feature of biportal endoscope made it easy to understand the anatomical orientation and to handle the surgical instruments. In biportal endoscopic spine surgery, endoscope and instrument approach angles are independent, and there is the freedom of vision and instrument angle during endoscopic spine surgery.

During biportal endoscopic spine surgery, we can use conventional retractor and instrument (drill, punch et al.) through a working portal and also can use the endoscopic cannula through endoscopic portal like uniportal endoscopic spine surgery. One of the main differences between biportal and uniportal endoscopic spine surgeries is that various general surgical instruments can be used during biportal endoscopic spine surgery because of independent working portal. In addition, we have to understand fluid dynamics during biportal endoscopic spine surgery and make cavitary water space, and there

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-981-15-8253-0_5) contains supplementary material, which is available to authorized users.

H.-S. Yang
Department of Neurosurgery, Seoul Barunsesang Hospital, Seoul, South Korea

D. H. Heo
Department of Neurosurgery, Seoul Bumin Hospital, Seoul, South Korea

J.-Y. Park (✉)
Department of Neurosurgery, Spine and Spinal Cord Institute, Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, South Korea
e-mail: spinepjy@yuhs.ac

H. S. Kim et al. (eds.), *Advanced Techniques of Endoscopic Lumbar Spine Surgery*,
https://doi.org/10.1007/978-981-15-8253-0_5

could be continuous flow between input and output channels. There were several papers about the behaviors of arthroscopic irrigation, and the authors recommend using an output cannula for biportal endoscopic spine surgery [6, 7]. In the text below, the surgical procedure for lumbar central stenosis using biportal endoscopic spine surgery will be described in detail.

Anesthesia and Position

The procedure is performed under general or epidural anesthesia. The patient is placed in the prone position with the abdomen free over the radiolucent frame in a flexed position to open the interlaminar space and foramen. A surgical drape designed to drain water well from the output channel can prevent the water leak from surgical field (Fig. 1).

Special Surgical Instruments

During the procedures, we used 3.5-mm spherical bur and diamond drill, 0° 4-mm-diameter arthroscope, 3.5-mm radiofrequency (RF) device, serial dilators, a specially designed dissector, and standard laminectomy instruments, such as hook dissectors, Kerrison punches, and pituitary for-

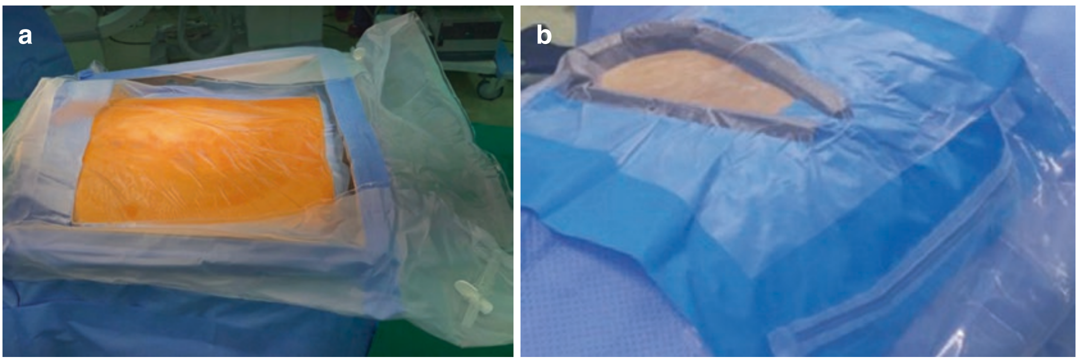

Fig. 1 Waterproof surgical drapes (A and B) for biportal endoscopic surgery

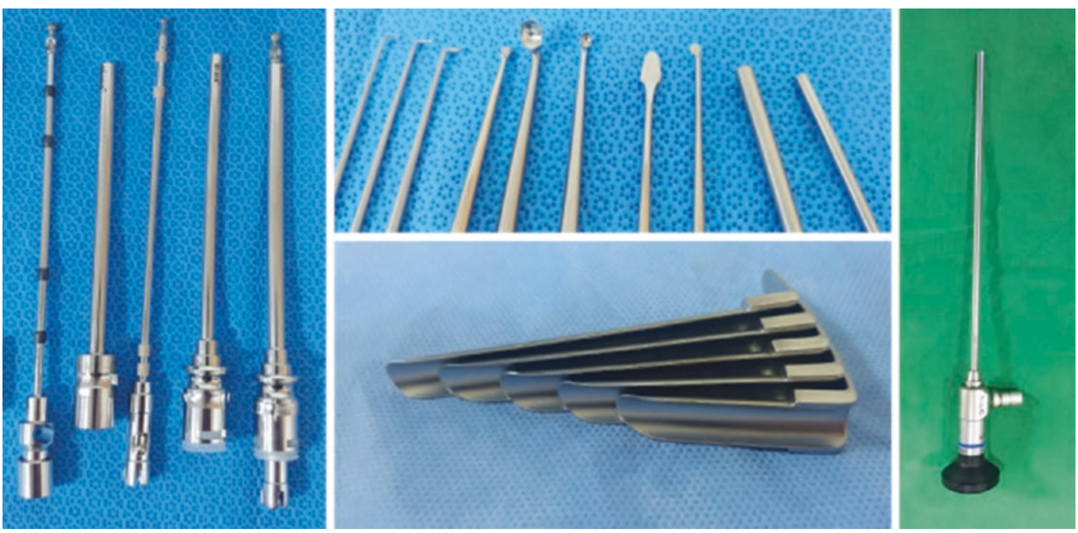

Fig. 2 Various kinds of surgical instruments of biportal endoscopic surgeries. 3.5-mm spherical bur and diamond drill (**a**), a specially designed dissector (**b**), 4-mm-diameter arthroscope (**c**), and semicircular cannula to keep proper outflow for working cannula (**d**). Clockwise from left. General spine surgical instruments were also available for biportal endoscopic surgeries

ceps (Fig. 2). The rest of the equipment uses the same endoscopy tower system. Instruments designed exclusively for biportal endoscopes are also available and could be more convenient. We use semicircular cannula to keep proper outflow through working cannula (Fig. 2d).

Surgical Steps (Illustration, Photos, and Video)

Skin Mark and Incision

Under image intensification, fluoroscopic confirmation of the level is made with a spinal needle inserted at the target area. Two portals are used: one portal was used for endoscope and the other working portal was used for instruments like drill, punch, and forceps. Skin entry points are determined according to the lesion site and the patient's anatomical variation. Because stenosis lesions differ from patient to patient and may combine central to lateral recess both side and foraminal lesions, portals should be created considering stenosis severity [8] and approach angles of instrument and scope to these combined lesions. Two standard entry points are made at 1 cm above and below the disc space for a posterior approach (Fig. 3). A 5-mm incision was given at the skin for the endoscope portal, and an 8-mm incision was given for the working portal along the skin crease. Docking point of two portals was over the lower portion of cranial laminae.

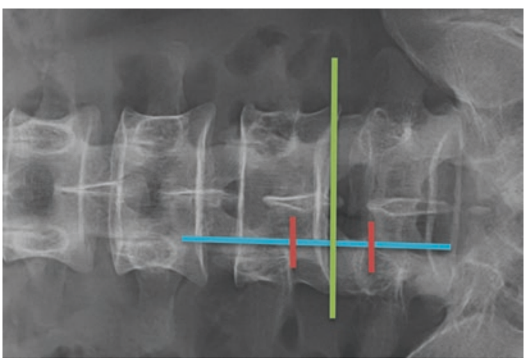

Fig. 3 Skin incision areas of biportal endoscopic lumbar surgery for L4–5 level. Anteroposterior X-ray view (**a**) and lateral X-ray view. From anteroposterior X-ray, draw line along the medical pedicle. From lateral X-ray, confirm the disc space. Two standard entry points are made at 1 cm above and below the disc space for a posterior approach. Upper portal was used for endoscope and the other working portal was used for instruments. Red lines are the skin incision

Two Portals (Biportal) Making

Serial dilators were then introduced to working portal and split the paraspinal muscles touching the spinous-laminar junction with minimal trauma. A 4-mm endoscope with trocar was then inserted into the endoscope portal, and a working sheath was inserted at the working portal (Fig. 4). RF device (for hemostasis and soft tissue dissection) was inserted into the working portal. A saline irrigation pump or just saline from 2 m height was connected to the endoscope and set to a pressure of 25–40 mm Hg during the procedure. Proper triangulation of the endoscope with the working instruments is vital for adequate visualization of the anatomical structures under keeping proper outflow with continuous irrigation of normal saline from endoscope to working portal. After exposing the lamina and the ligamentum flavum (LF), the levels are confirmed again with fluoroscopy.

Soft Tissue Dissection and Laminectomy

Muscle detachment using a dilator in the interlaminar space before inserting the endoscope helped secure sufficient visualization during the procedure. After triangulation with the endoscope and instrument, RF device and dissectors were used for bleeding control and detachment of the soft tissue remnants overlying the lamina and the ligamentum flavum.

Following complete exposure of the lamina and the ligamentum flavum in the targeted interlaminar space, an ipsilateral partial laminotomy was performed under magnified endoscopic vision. A laminotomy is performed using various burs initially to drill off the lower lamina of the cranial vertebra at the interlaminar space, similar to the decompression procedure with micro-

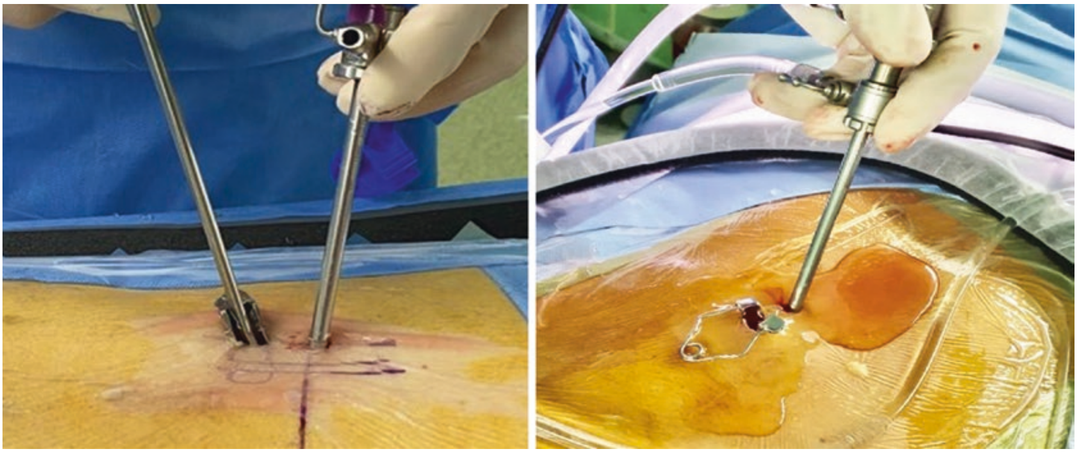

Fig. 4 Overview of biportal endoscopic surgeries. Endoscopic portal was used for only endoscopy and its trocar, and the other working portal was used for surgical instruments. Various kinds and sizes of working sheath were used for well drainage of irrigation fluid and smooth insertion of surgical instruments

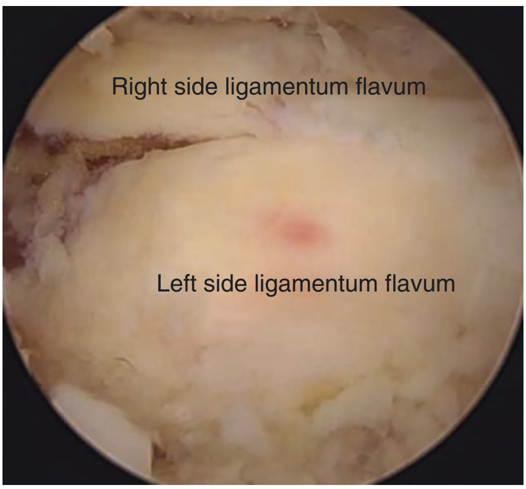

Fig. 5 Endoscopic view of unilateral laminectomy (left side approach). Ipsilateral ligamentum flavum as well as contralateral ligamentum flavum should be exposed after ipsilateral laminotomy

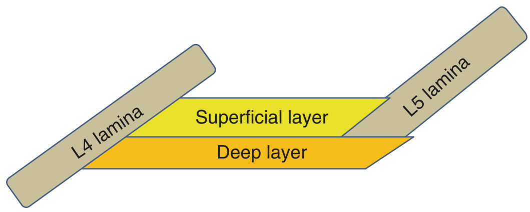

Fig. 6 Schematic illustration of the ligamentum flavum at lumbar area. Superficial layer was inserted over the caudal lamina. In contrast, deep layer was inserted below the caudal lamina

scopic approach with tubular retractor systems. Laminotomy of the upper laminar should be performed until exposure of proximal end of the ligamentum flavum. The upper lamina of the caudal vertebrae is partially removed using diamond drill and punches, continuing along the margins of the lateral recess and exposure of distal end of the ligamentum flavum. The thinned-off lateral recess and caudal laminar margin are then resected with the punch. In addition, midline spinous base area should be partially removed for exposure of contralateral ligamentum flavum (Fig. 5).

Ligamentum Flavum Removal and Decompression of Ipsilateral Traversing Nerve Root (Video 1)

Once adequate bony resection is achieved to the proximal and distal attachment of the ligamentum flavum, the superficial and deep layers of the ligamentum flavum are detached and removed. It may be removed with en bloc, but if adhesion is suspected due to severe stenosis, it may be necessary to separate and remove the superficial and deep layer (Fig. 6 and Video 1). In some cases, it is essential to check the lateral extent of the deep layer of the ligamentum flavum and remove to the lateral margin by using an angled curette [9]. A blunt hook dissector is used to identify the plane between the ligamentum flavum and the dura with saline irrigation, ensuring that it is free from adhesions. The ipsilateral ligamentum flavum was removed until full mobilization of the lateral border of the nerve root was achieved. The upper border of the lower lamina is removed for the ipsilateral foraminotomy as needed (Fig. 7).

Decompression of Contralateral Traversing Nerve Root (Video 2)

If bilateral decompression is required, the midline of the spinal canal must first be confirmed by resecting the base of the spinous process with a high-speed drill. The scope can then be adjusted medially. Usually, the base of the spinous process obstructs the placement of the scope; therefore, it may need to be partially resected to secure sufficient working space. Once exposed, the ligamen-

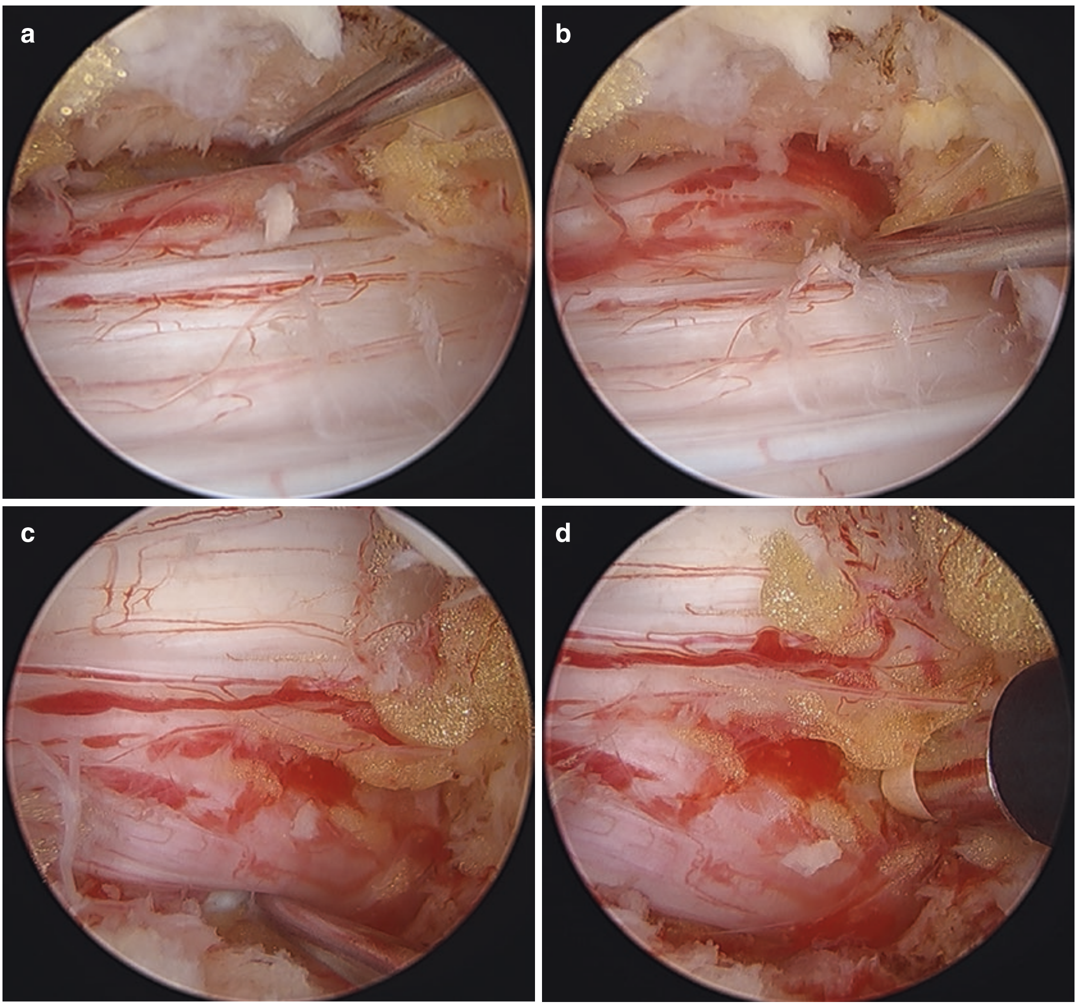

Fig. 7 Intraoperative endoscopic images showed complete decompression of bilateral traversing nerve roots. Medial margin of contralateral pedicle was checked for complete contralateral nerve root decompression of shoulder area (**a**). Also, axillar area of contralateral traversing nerve root was also checked (**b**). In addition, medical margin of ipsilateral pedicle (**c**) and ipsilateral axillar area (**d**) were carefully checked for complete decompression of ipsilateral nerve root

tum flavum can be detached from the contralateral lamina with angled curette and then undercut with a bur. After bony decompression, the thickened ligamentum flavum is resected with a curette and Kerrison punch to relieve the neural structures adequately. Contralateral decompression was performed until the contralateral traversing nerve root was identified and decompressed (Fig. 7).

Discectomy and Closure

If a patient is symptomatic and has ipsilateral disc herniation, it is possible to perform a discectomy under endoscopic view. The degree of neural decompression was assessed by normal respiratory-induced dural pulsation and confirmed with endoscopic viewing and use of a blunt probe. Bleeding is effectively controlled by the radiofrequency bipolar system under continuous irrigation. The skin incisions are closed after removal of the instruments and endoscope (Fig. 8). A surgical drain is inserted and kept for 24 h after surgery until spontaneous bleeding is controlled.

Illustrated Case or Cases

Case 1: A 79-year-old woman presented with a 1-year history of LBP and bilateral leg pain and numbness over the calf and dorsum of the foot.

Fig. 8 Wound image of biportal endoscopic approach for lumbar stenosis. Hemovac drainage catheter was inserted for prevention of postoperative epidural hematoma

No benefit was obtained from the use of analgesic or nonsteroidal anti-inflammatory medications. She could not walk for over 5 min due to the pain and weakness. Neurologic examination revealed weakness of the right great toe dorsiflexion (Grade III). Magnetic resonance imaging (MRI) documented bilateral lateral recess stenosis at L3–4–5 level (Fig. 9a–c). The patient underwent biportal endoscopic decompression surgery with left side approach under general anesthesia. Postoperative back and leg pain VAS scores were decreased from 7 and 8 preoperatively to 3 and 2 after the operation, respectively. Weakness of the right great toe dorsiflexion was also recovered gradually to Grade IV in 3 weeks after operation, and neurogenic intermittent claudication also improved more 30 min. Postoperative MRI revealed satisfactory decompression of bilateral lateral recesses at L3–4–5 (Fig. 9d–f).

Case 2 (Video 2): A 71-year-old male patient presented with severe radicular pain of both legs and neurological intermittent claudication. Preoperative MR images reveal severe central and lateral recess stenosis of L4–5 (Fig. 10). This patient was received left sided unilateral laminotomy with bilateral decompression by biportal endoscopic approach (Video 2). Intraoperative endoscopic image and postoperative MR images demonstrated complete decompression of central canal and lateral recess of L4–5 (Fig. 10). Postoperatively, his symptoms were significantly improved.

Complications and its Management

Bleeding

To reduce the occurrence of the technical complications, the most important factor is to keep the surgical field clear by blocking epidural bleeding. Fluent water flow and bleeding control from edge bone or epidural small vessels were ensured before processing with flavectomy or laminectomy especially on the contralateral side. A bleeding from the laminectomy bone edge was compressed by squashing a piece of bone wax on

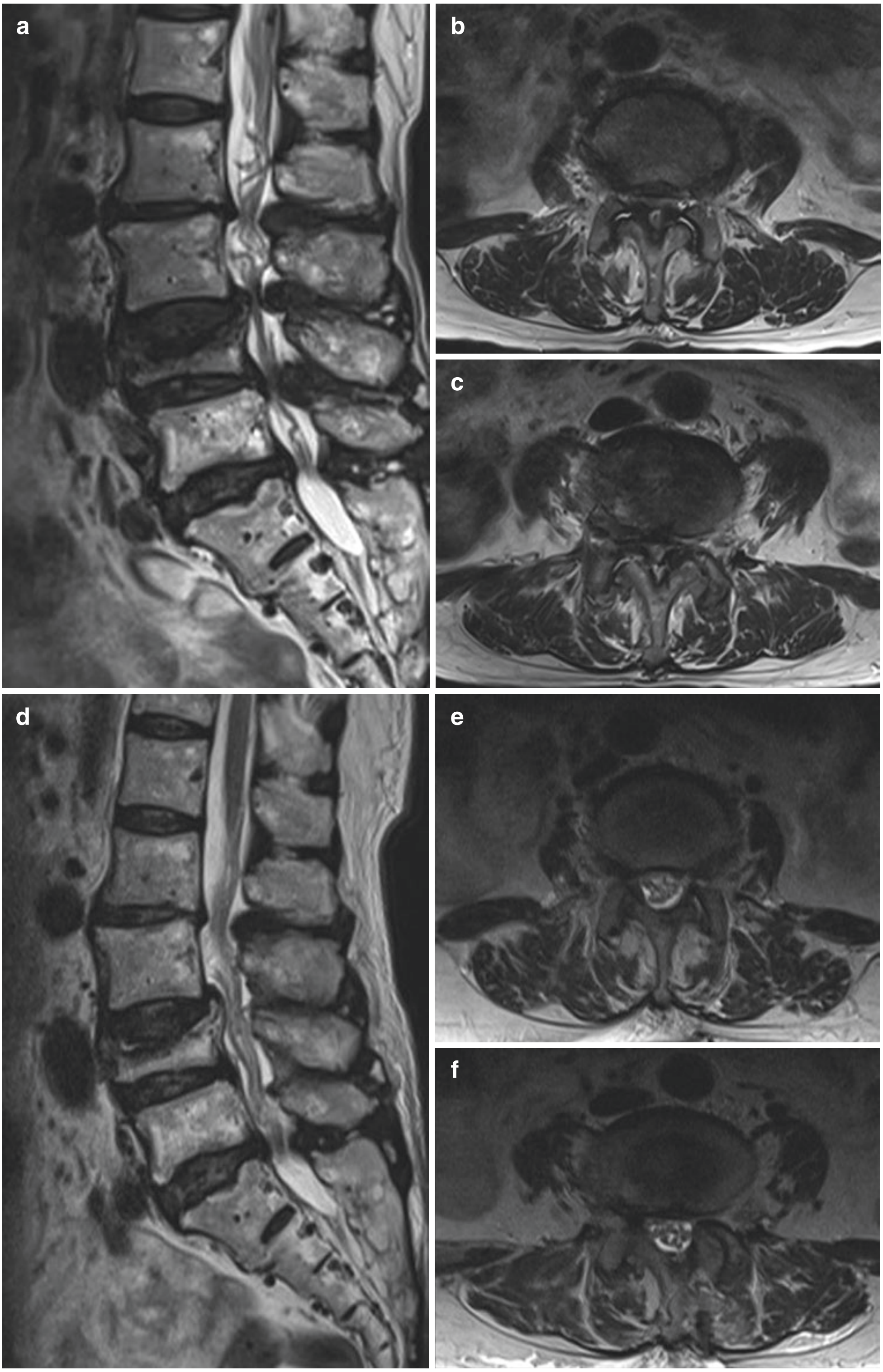

Fig. 9 Preoperative MRI showed severe central and lateral stenosis at L3–4–5 ((**a**) sagittal image; (**b**) axial image of L3–4; (**c**) axial image of L4–5). Postoperative MRI showed full decompression of lateral recess stenosis at L3–4–5 ((**d**) sagittal image; (**e**) axial image of L3–4; (**f**) axial image of L4-5). Clockwise from left

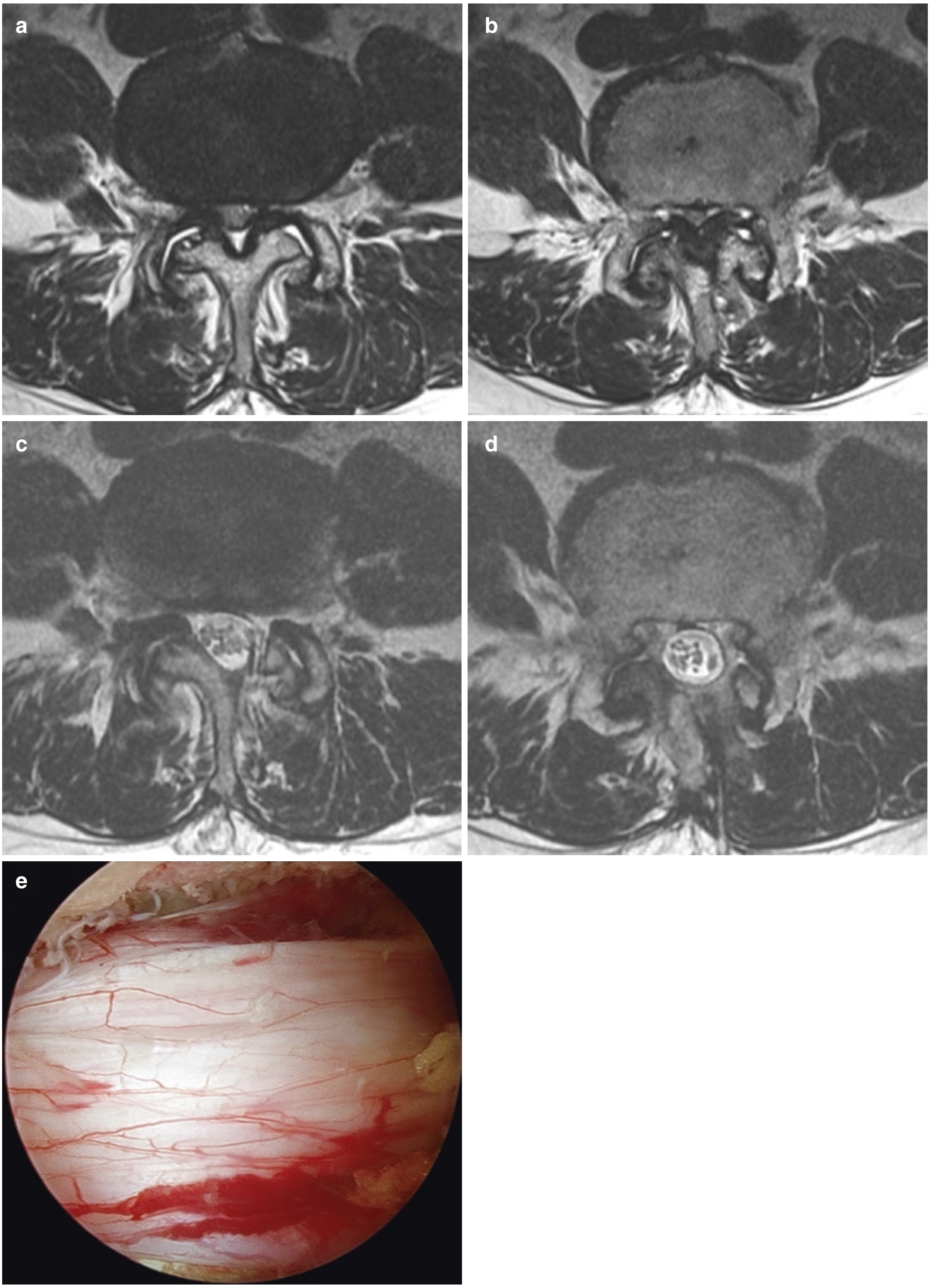

Fig. 10 Preoperative MR images show central and lateral recess stenosis of L4–5 (**a**, **b**). Postoperative MR images reveal complete decompression of central and lateral recess stenosis of L4–5 (**c**, **d**). Intraoperative endoscopic view image also demonstrated well decompression of central canal and bilateral traversing nerve roots (**e**)

the bleeding sites. A bleeding from the epidural edge just after flavectomy from the small epidural vessels could be coagulated using a small-sized RF device. If the bleeding cannot be controlled with these efforts, lowering the blood pressure to around 100 mm Hg can be helpful in some cases.

Dural tear

Several papers were reporting no differences in the incidence of complications between biportal endoscopic and microscopic groups [10]. The most common complication reported with a systematic review was a dural tear [11]. Biportal endoscopic spine surgery allows the surgical field to be viewed at high magnification, and the fluid from continuous pressure irrigation enables slight compression of the dura and widening of the contralateral epidural space during procedures. The risk of dural tear is reported to be increased in bilateral decompression procedures via a unilateral approach. Irrigation is continuous during biportal endoscopic surgery, which can make it difficult to confirm CSF leakage during the procedure. A significant dural defect should be repaired directly under the operative microscope, and small intraoperative durotomy can be resolved with the application of sealant materials and placing the patient on bed rest. The best treatment of dural tear is prevention with the exercise of several precautions. Aggressive surgical action to expose neural tissues through decompression may be harmful to the dural membrane. Instrumental manipulation of the narrow, invisible epidural space should be avoided. Keeping the cutting surface of the instruments (Kerrison punches and forceps) visible while removing structures identified by the endoscope also helps prevent dural tear.

Brief Discussion: Surgical Tip and Pitfall

For biportal endoscopic spine surgery, the axes of the endoscope and working channel are separated, making it easier for anatomical orientation and handling of instruments. The freedom of instrument angle is elevated and has made many technical advances, especially in the use of drills. Since biportal endoscopic spine surgery has a continuous water flow from the endoscopic portal to working portal, it is possible to maintain a clear view during bleeding.

From an anatomical perspective, the contralateral approach gives the most facile access to the lateral recess and intra-foraminal space. Using advantages of more freedom to manipulate instruments with biportal endoscopic spine sugery, endoscopic surgery for lumbar degenerative pathologies has been making rapid strides. Along with this, the efforts continue to find a useful and reliable classification system of lumbar spinal stenosis, which could be an index for preoperative evaluation and in determining the proper technique [12].

It was difficult to find the proper definition or criteria for the adequate decompression of spinal stenosis. The surgeon should perform surgery to keep the patient safe and to maximize the clinical results, and the spine surgeon must evaluate and take responsibility for the appropriate decompression, based on their experience and knowledge. The authors think the biportal endoscopic spine surgery has many advantages over the safety and stable outcome for the decompression of spinal stenosis.

The biportal endoscopic decompression method represents a viable option for lumbar spinal stenosis with good results. It was evolving with understanding other techniques and specialized in the benefits of the endoscopy. This biportal endoscopic technique is worth further developing and application.

References

1. Yong-Hing K, Kirkaldy-Willis WH. The pathophysiology of degenerative disease of the lumbar spine. Orthop Clin North Am. 1983;14(3):491–504.
2. Komp M, Hahn P, Oezdemir S, Giannakopoulos A, Heikenfeld R, Kasch R, et al. Bilateral spinal decompression of lumbar central stenosis with the full-endoscopic interlaminar versus microsurgical laminotomy technique: a prospective, randomized, controlled study. Pain Physician. 2015;18(1):61–70.
3. Hwa Eum J, Hwa Heo D, Son SK, Park CK. Percutaneous biportal endoscopic decompres-

sion for lumbar spinal stenosis: a technical note and preliminary clinical results. J Neurosurg Spine. 2016;24(4):602–7.
4. Kim HS, Paudel B, Jang JS, Oh SH, Lee S, Park JE, et al. Percutaneous full endoscopic bilateral lumbar decompression of spinal stenosis through Uniportal-contralateral approach: techniques and preliminary results. World Neurosurg. 2017;103:201–9.
5. Choi CM, Chung JT, Lee SJ, Choi DJ. How I do it? Biportal endoscopic spinal surgery (BESS) for treatment of lumbar spinal stenosis. Acta Neurochir. 2016;158(3):459–63.
6. Tuijthof GJ, Dusee L, Herder JL, van Dijk CN, Pistecky PV. Behavior of arthroscopic irrigation systems. Knee Surg Sports Traumatol Arthrosc. 2005;13(3):238–46.
7. Tuijthof GJ, de Vaal MM, Sierevelt IN, Blankevoort L, van der List MP. Performance of arthroscopic irrigation systems assessed with automatic blood detection. Knee Surg Sports Traumatol Arthrosc. 2011;19(11):1948–54.
8. Lee CK, Rauschning W, Glenn W. Lateral lumbar spinal canal stenosis: classification, pathologic anatomy and surgical decompression. Spine (Phila Pa 1976). 1988;13(3):313–20.
9. Chau AM, Pelzer NR, Hampton J, Smith A, Seex KA, Stewart F, et al. Lateral extent and ventral laminar attachments of the lumbar ligamentum flavum: cadaveric study. Spine J. 2014;14(10):2467–71.
10. Heo DH, Quillo-Olvera J, Park CK. Can percutaneous Biportal endoscopic surgery achieve Enough Canal decompression for degenerative lumbar stenosis? Prospective case-control study. World Neurosurg. 2018;120:e684–e9.
11. Lin GX, Huang P, Kotheeranurak V, Park CW, Heo DH, Park CK, et al. A systematic review of unilateral Biportal endoscopic spinal surgery: preliminary clinical results and complications. World Neurosurg. 2019;125:425–32.
12. Wang Y, Dou Q, Yang J, Zhang L, Yan Y, Peng Z, et al. Percutaneous endoscopic lumbar decompression for lumbar lateral Spinal Canal stenosis: classification of lateral region of lumbar Spinal Canal and surgical approaches. World Neurosurg. 2018;119:e276–e83.