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Retrospective Case Review

Four Complications Associated with Lateral and Oblique Fusion Treatable with Endoscopic Spine Surgery: Technical Note and Case Series

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Background: The lateral fusion procedure is a newer minimally invasive approach to indirectly decompressing and fusing a lumbar motion segment. As with many new procedures, new thoughtful approaches to recognizing and treating the complications of these procedures need to be developed.

Objectives: Here we describe our experience with transforaminal endoscopic decompression for complications of lateral and oblique lumbar fusion.

Study Design: Retrospective case review.

Setting: This was a multicenter study that took place in an academic hospital, community hospital, and ambulatory surgery center.

Methods: An endoscopic treatment technique for 4 types of complications associated with lateral and oblique fusion is presented. We retrospectively reviewed cases at 3 centers in 2 countries of patients who underwent transforaminal endoscopic surgery for the treatment of lateral fusion complications in a 4-year period with a minimum follow-up of 1 year.

Results: A preliminary series of 4 patients with an average age of 74.8 years (range, 69–82 years) who underwent transforaminal endoscopic procedures at the level of their lateral and oblique lumbar fusions between 2014 and 2018 is presented. Disc herniations, heterotopic bone formation, endplate fracture, and nerve root impingement by the interbody device were all treated endoscopically.

Limitations: Small case series evaluated retrospectively with 1-year follow-up.

Conclusions: Transforaminal endoscopic surgery is a useful minimally invasive surgical technique to treat several complications associated with lateral and oblique lumbar interbody fusion procedures.

Key words: Endoscopic spine surgery, minimally invasive, transforaminal, XLIF, OLIF, DLIF, LLIF, lateral fusion

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Lateral fusion approaches to the lumbar spine include the transpsoas approaches (extreme lateral interbody fusion [XLIF], direct lateral interbody fusion [DLIF], lateral lumbar interbody fusion [LLIF]) and the prepsoas approach (oblique lateral interbody fusion [OLIF]). These techniques are increasingly being employed for a wide range of indications, from deformity, degenerative stenosis, and even in the setting of revision surgery (1-4). Regardless of the route, all lateral techniques ultimately act by restoring disc height to (1) realign the spinal column in sagittal and coronal planes, (2) indirectly decompress the central canal and neural foramen, and (3) complement supplement posterolateral approaches when indicated. Although a powerful tool, there are a myriad of common and uncommon complications that can undermine the therapeutic benefit of these interventions. Reported complication rates vary by indication and extent of associated surgery but range anywhere from 10% to 30% (5-7). Although complications are known, little published data exists discussing optimal management of complications related to ongoing neurologic or new neurologic compression following these techniques.

Three high-volume endoscopic spine surgery centers share their experience here with novel complications seen secondary to lateral fusion surgery and how they can be successfully treated with an outpatient, awake endoscopic surgical approach. The lateral fusion complications treated included nerve root impingement by (1) contralateral disc herniation, (2) heterotopic bone formation in the foramen, (3) endplate fracture, and (4) compression secondary to placement of the interbody device in the foramen.

Methods

Patient Selection

We retrospectively reviewed cases at 3 centers in 2 countries of patients who underwent transforaminal endoscopic surgery for the treatment of lateral and oblique fusion complications in a 4-year period with a minimum follow-up of 1 year. Patients treated endoscopically for lateral fusion complications included 2 patients with contralateral disc herniations, 1 patient with contralateral heterotopic bone formation, 1 patient with an endplate fracture, and 1 patient with nerve compression secondary to placement of the interbody device.

Transforaminal Endoscopic Operative Technique

The procedures were performed under local analgesia and intravenous sedation; the level of anesthetic was titrated, so the patient was able to communicate with the surgeon throughout the procedure. Patients were positioned either prone on the Jackson table and Wilson frame or in the lateral decubitus position on a standard operating table. The Joimax (Karlsruhe, Germany) TESSYS endoscopic system was used for the procedure. Percutaneous entry was established entering through the skin 11 to 13 cm lateral to the midline. Using intermittent fluoroscopic guidance, alternating between lateral and anterior-posterior (AP) view, a 15-cm 18-gauge needle was advanced, and the tip placed on the superior endplate of the inferior vertebral body first by touching the superior articulating process (SAP) and being deflected ventrally. “Hugging” the SAP allowed for maximal removal of ventral SAP bone to open the foramen for visualization and avoid compression of the exiting nerve root with the final tubular retractor. Sequential reamers were used to remove the ventral aspect of the superior facet. A 7-mm beveled tubular retractor was then placed in the Kambin triangle (the triangle defined by the exiting and traversing nerve roots and the superior endplate of the inferior vertebra). Endoscopic grasping forceps were used to remove herniated disc material. The endoscopic Shrill drill (Joimax) was used to drill down compressive bone and polyetheretherketone (PEEK) interbody material. {AU: Confirm manufacturer for Shrill drill (Joimax)} Patients were able to communicate during the surgery when their pain had completely resolved. After the working channel and endoscope were removed, pressure was held on the 5-mm incision for 5 minutes, and the wound was closed with a single interrupted suture.

Postoperative Course

The surgeries were performed under MAC (monitored anesthesia care) anesthesia, so the patients were examined in the operating room immediately and were found to be full strength and with no radicular pain at rest or with straight leg raise. Patients were seen at 2 weeks, 6 weeks, 3 months, and 1 year postoperatively.

Results

Contralateral Disc Herniations

Two patients were treated with contralateral disc herniations after lateral fusions. The first patient was a 65-year-old man who had a lumbar 2-3 lateral fusion from a left-sided approach and developed proximal right lower extremity weakness and intractable right thigh pain. Magnetic resonance imaging (MRI) revealed a large disc extrusion in the right L2-3 foramen, which was removed through an awake, transforaminal endoscopic spine surgery, with immediate symptomatic relief. The second patient was an 81-year-old man who underwent a lumbar 4-5 lateral fusion and immediately postoperatively experienced right-sided L4 and L5 radicular pain that did not improve with time. Figure 1 demonstrates the lumbar MRI showing the large right L4-5 foraminal disc herniation (the PEEK spacer is well

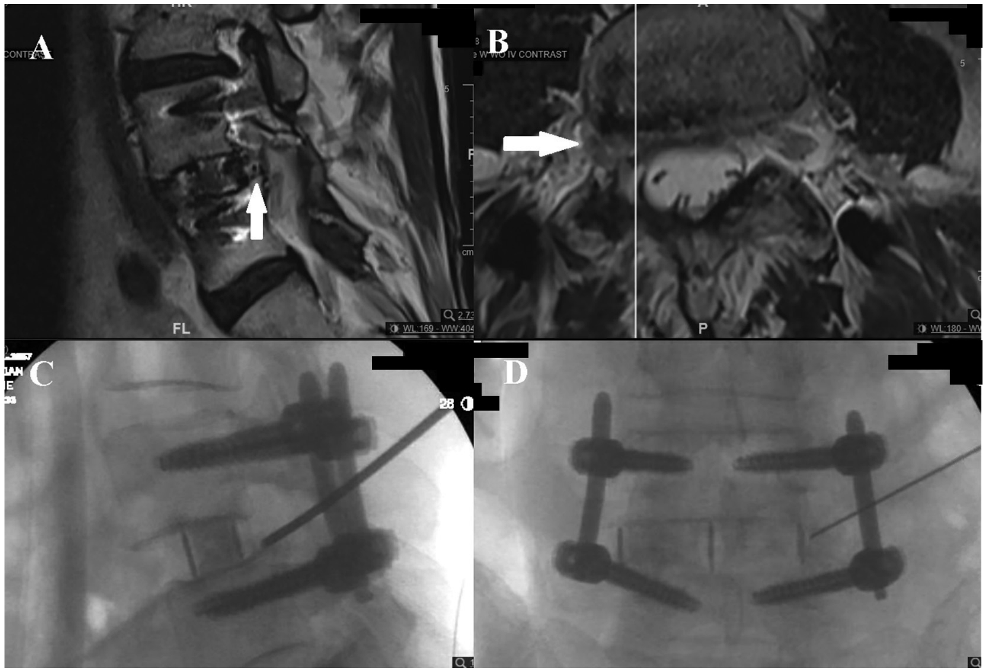

Fig. 1. *Contralateral disc herniations. (A) T2 sagittal MRI and (B) T2 axial MRI demonstrate disc material in the right L4-5 neural foramen after an L4-5 XLIF from a left-sided approach. (C) Lateral and (D) AP fluoroscopic images of the approach to the disc herniation; (C) shows initial dilator and (D) shows spinal needle.*

placed) and the fluoroscopic images depicting the needle access to the herniation. Transforaminal endoscopic resection of the fragment was successful in treating the patient's pain. A durotomy occurred in decompressing the nerve, and this was treated by placing a dural replacement sponge through the endoscopic cannula. The patient had no symptoms or clinical sequelae related to the durotomy.

Contralateral Heterotopic Bone Formation

A 49-year-old man had a lumbar 4-5 OLIF 2 years prior for a left paracentral disc herniation and positive discogram. The patient's preoperative right lumbar radicular symptoms resolved immediately after that surgery. Postoperatively, he had 3 months of right L4 radicular-type symptoms that resolved and were thought to be owing to the right side OLIF approach.Thirteen months after his surgery, he returned with right L4 radicular symptoms and a computed tomography (CT) myelogram revealing heterotopic bone in the foramen (Fig. 2) explaining the patient's right L4 radicular symptoms. Figure 3 demonstrates the pre- and postoperative CT images and the intraoperative fluoroscopic images. Navigation was used for the case (BrainLab AG, Munich, Germany) and a navigated endoscopic Shrill drill was used to drill down the PEEK implant. An intraoperative CT was performed to demonstrate the decompression (Fig. 3).

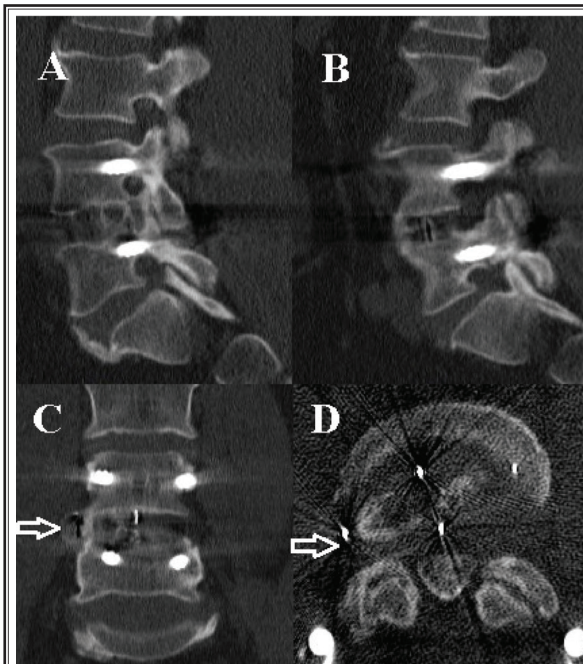

Fig. 2. *Contralateral heterotopic bone formation. (A) Sagittal CT reconstruction showing heterotopic bone formation in the right L4-L5 neural foramen. (B) Sagittal CT reconstruction showing the open left L4-L5 neural foramen. (C) Coronal reconstruction showing the right L4-L5 foraminal heterotopic bone formation (arrow). (D) Axial CT at L4-L5 showing the right L4-L5 heterotopic bone formation impinging the area of the exiting L4 nerve.*

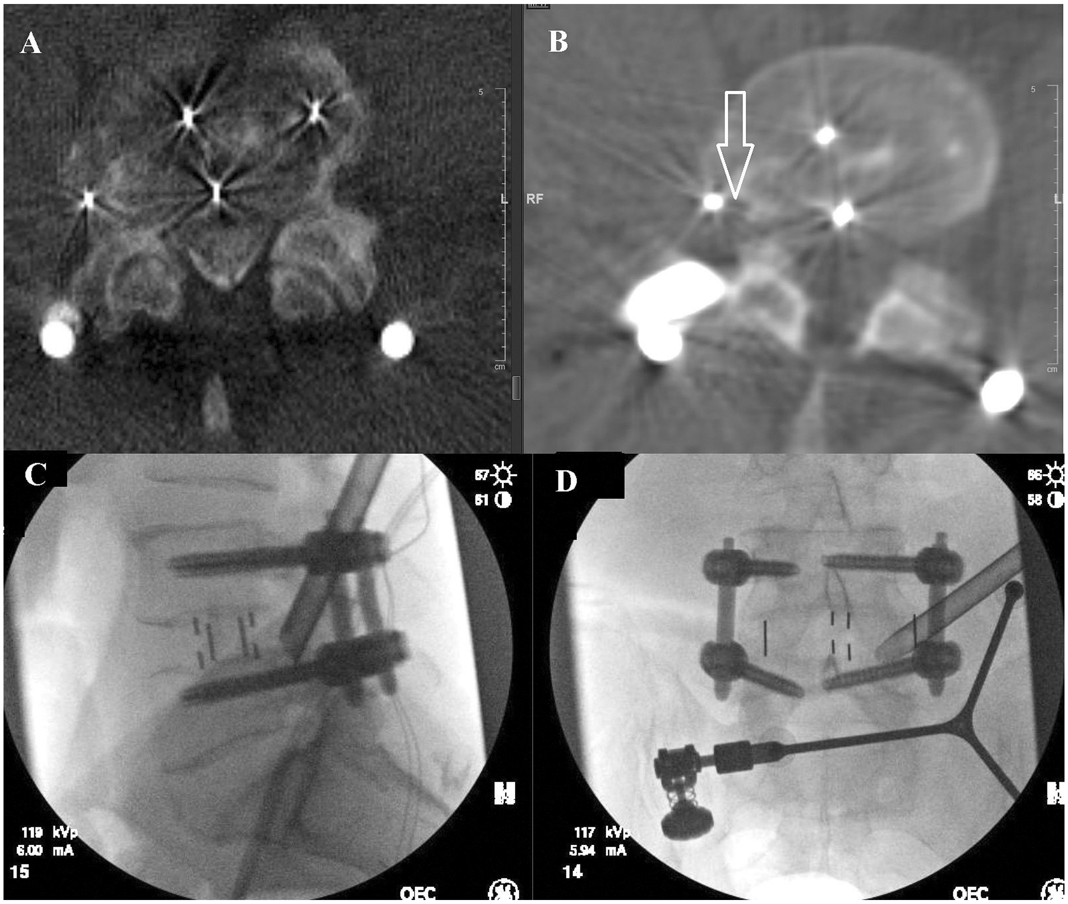

Fig. 3. *Contralateral heterotopic bone formation. (A) Preoperative and (B) intraoperative postprocedural CT. Preoperative axial CT at L4-L5 shows the amount of bone in the right L4-L5 area of the Kambin triangle, and postprocedure intraoperative axial CT shows the area of bony removal. (C) Lateral and (D) AP intraoperative fluoroscopy during the right L4-L5 transforaminal bony decompression. Lateral fluoroscopic image shows the L4-L5 pedicle screws and oblique lumbar interbody fusion cage with the 7-mm diameter beveled cannula placed at the inferior edge of the foramen in a transisthmus approach. Anteroposterior fluoroscopic view showing the surgical hardware at L4-L5, the fiducial "star" at L5-S1, and the beveled cannula place at the inferior edge of the right L4-L5 foramen.*

Endplate Fracture

A 69-year-old man presented with degenerative disc disease and spinal stenosis at lumbar 3-4 and lumbar 4-5. He had failed conservative nonoperative treatment and underwent a standalone lumbar 3-4 and 4-5 LLIF for treatment of his back pain and lumbar claudication symptoms. The surgical approach for his LLIF was from the left side, and immediately postoperatively he was noted to have some proximal left lower extremity weakness. On the second postoperative day, a lumbar CT scan was performed for progressive left proximal lower extremity weakness. The lumbar CT (Fig. 4A–C) demonstrated an L3-4 endplate fracture with a fragment of bone in the left L3-4 neural foramen likely compressing the patient's left L3 nerve, as well as a slightly left eccentric placement of his L3-4 implant. A transforaminal endoscopic surgical approach was used to remove the bone fragment and decompress the left L3 and L4 nerves. Figure 4 displays the pre- and postoperative CT and the intraoperative fluoroscopic images.

Contralateral Exiting Nerve Root Compression Secondary to Placement of the Interbody Device

A 55-year-old man underwent an L4-5 lateral fu-

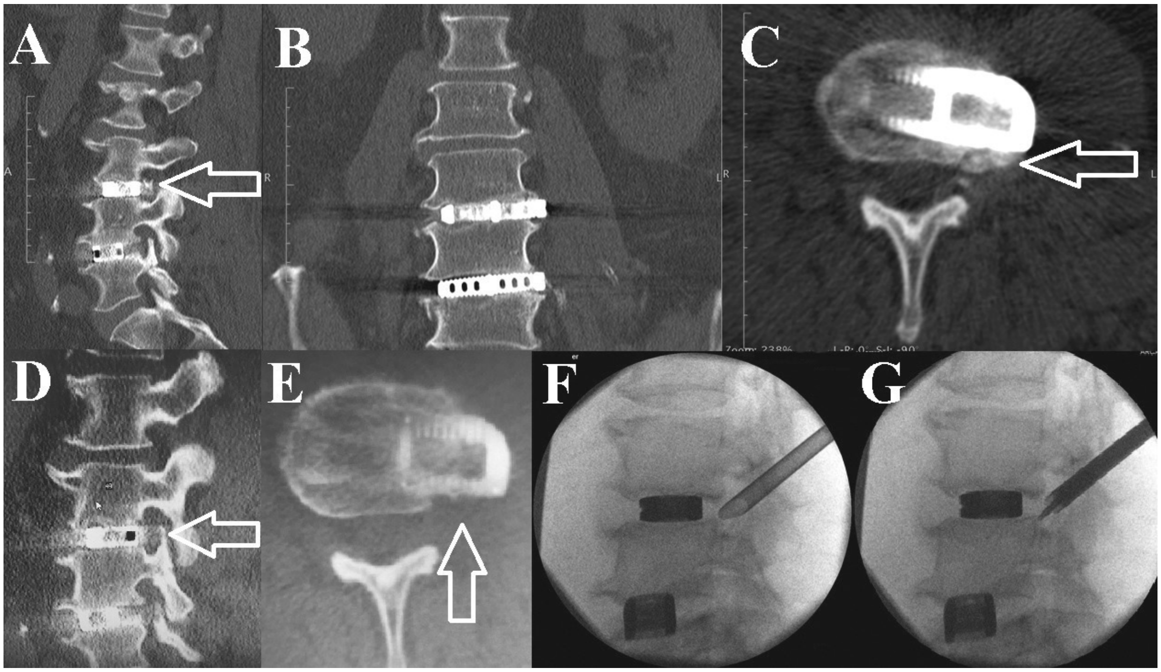

Fig. 4. *Endplate fracture. (A) Sagittal CT reconstruction demonstrating the bone fragment (open arrow) in the left L3-4 foramen after the L3-4 and L4-5 standalone LLIF. (B) Coronal CT reconstruction demonstrating the L3-4 (cage slightly eccentric to the left) and L4-5 LLIFs. (C) Axial CT image through the L3-4 disc space after the L3-4 LLIF (open arrow indicates the endplate fracture). (D) Sagittal CT reconstruction demonstrating the patent left L3-4 foramen (open arrow) after endoscopic decompression. (E) Axial CT image through the L3-4 disc space after endoscopic decompression (open arrow indicates the removal of the endplate fracture). (F) Lateral fluoroscopic view of the beveled 7-mm tubular retractor positioned in the L3-4 foramen. (G) Lateral fluoroscopic view of the endoscopic grasper positioned in the L3-4 foramen.*

sion from a right-sided approach for adjacent segment disease above his L5-S1 fusion. After that surgery, he developed left leg weakness and numbness in an L4 distribution. MRI demonstrated compression of the left L4 nerve by the PEEK cage (electromyography confirmed the radiculopathy). A transforaminal endoscopic approach was used to drill down the PEEK implant. Figure 5 demonstrates the preoperative MRI and CT lumbar and an intraoperative image of the initial placement of the tubular retractor. The patient improved immediately after his decompression.

Discussion

Lateral fusion surgery is a truly minimally invasive surgical approach that allows for indirect spinal canal and foraminal decompression and restoration of the alignment of spinopelvic parameters. First reported by Ozgur et al (8), the use of lateral procedures has become a major instrument in the realm of lumbar spinal fusion surgery. For treating spinal deformity, several studies have shown improvement in patient-reported outcomes and deformity parameters with the use of these techniques (9-10). Within the realm of nondeformity spine, lateral procedures are seeing increasing applications. Lateral interventions appear to be effective treatment options for both central and neuroforaminal stenosis in which concomitant fusion is desired (11-13). Recent work by Louie et al (14) suggests that LLIF might provide a less invasive and comparably effective technique in cases of adjacent segment disease after prior fusion.

Much of the attractiveness of lateral techniques comes from the complication profile associated with the minimally invasive lateral techniques compared with posterior or even anterior approaches (15). However, lateral and oblique fusion surgeries have their own unique complication profiles; most frequently noted complications are the result of nerve retraction and,

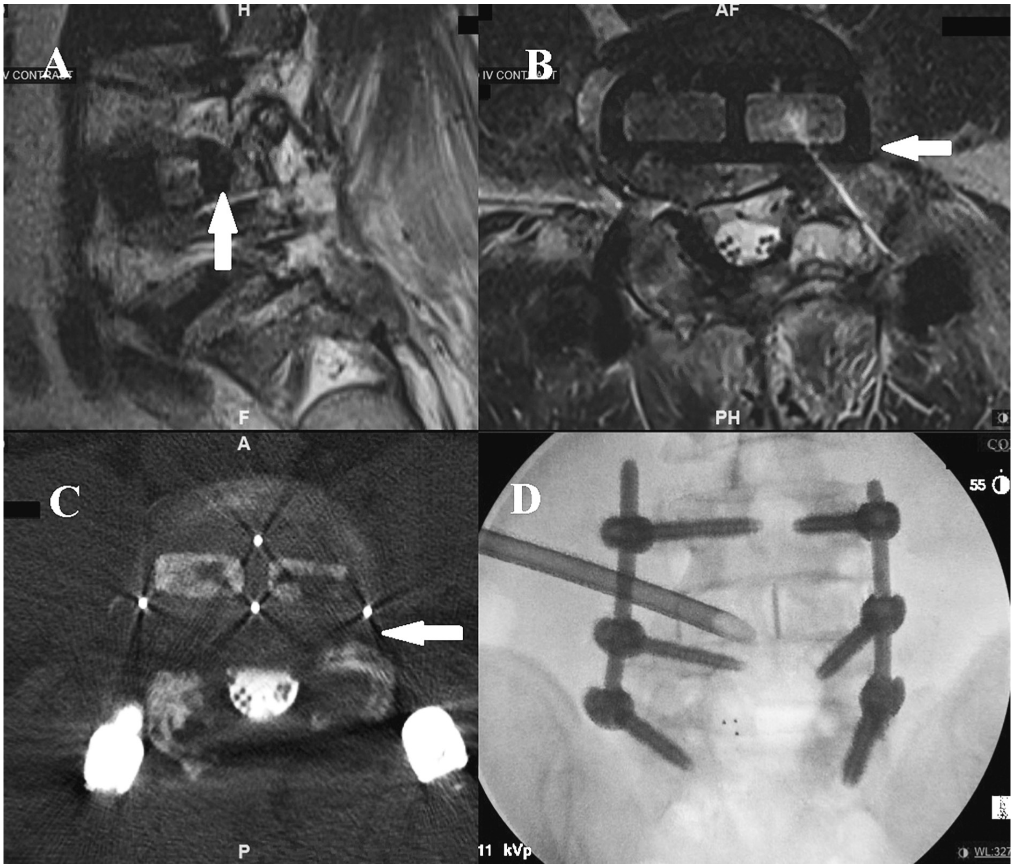

Fig. 5. *Contralateral exiting nerve root compression secondary to placement of the interbody. (A) Sagittal T2-weighted MRI demonstrates the PEEK XLIF implant occluding the foramen (arrow). (B) Axial T2-weighted MRI at L4-5 demonstrates the PEEK implant placed past the vertebral body ring. (C) Axial CT at the L4-5 disc space demonstrates the slightly oblique trajectory of the PEEK implant narrowing the foramen (arrow). (D) Intraoperative AP fluoroscopic image demonstrates the initial placement of the beveled tubular retractor for the endoscope.*

more rarely, vascular injury (2,5,15). Neurologic sequalae are particularly common given the proximity not only to exiting nerve roots but the lumbosacral plexus itself at the lower lumbar spine. The most common manifestations are dysesthesias and transient motor plexopathy or from psoas dissection-related weakness (5).

With regard to persistent nerve compression after lateral and oblique fusions, it is unclearly how commonly this occurs. Based on our literature review there is no obvious reporting of this subset of treatment failure in the lateral lumbar interbody literature, as such articles addressing this issue are scarce. Endoscopic approaches as a method of postfusion decompression, however, has been defined for a variety of indications (16-19). Without the availability of these techniques, the revision process for treating complications of these fusion surgeries requires a much more invasive posterior approach, which has a higher incidence of complication, length of stay, and estimated blood loss when compared with an endoscopic approach (20-21).

Conclusions

We believe that endoscopic spine surgery is a powerful primary and adjunctive technique for treating spine pathology. The centers participating in this review typically perform between 100 and 300 endoscopic spine surgeries a year and are referral centers for treating fusion complications with endoscopic techniques. As newer techniques such as the lateral approach proliferate, there likely will be new and challenging complications that require a variety of approaches to address them. The endoscopic approach is one such technique.

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