Iatrogenic contralateral foraminal stenosis following lumbar spine fusion surgery: illustrative cases

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BACKGROUND Lumbar spine fusion is the mainstay treatment for degenerative spine disease. Multiple potential complications of spinal fusion have been found. Acute contralateral radiculopathy postoperatively has been reported in previous literature, with unclear underlying pathology. Few articles reported the incidence of contralateral iatrogenic foraminal stenosis after lumbar fusion surgery. The aim of current article is to explore the possible causes and prevention of this complication.

OBSERVATIONS The authors present 4 cases in which patients developed acute postoperative contralateral radiculopathy requiring revision surgery. In addition, we present a fourth case in which preventive measures have been applied. The aim of this article was to explore the possible causes and prevention to this complication.

LESSONS Iatrogenic foraminal stenosis of the lumbar spine is a common complication; preoperative evaluation and middle intervertebral cage positioning are needed to prevent this complication.

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Lumbar spine surgery for degenerative conditions reduces pain and disability and improves function.1 Many degenerative pathologies require fusion to optimize surgical outcomes. There are several fusion methods, such as posterolateral fusion, transforaminal lumbar interbody fusion (TLIF), anterior lumbar interbody fusion, and lateral lumbar interbody fusion (LLIF).2 Previous studies have reported many possible complications after spinal fusion, including ipsilateral nerve injury, wound infections, recurrent pain, and cerebrospinal fluid leak.3 Acute contralateral radiculopathy postoperatively has been reported in previous literature, but the underlying factors that are involved in contralateral disc herniation were unclear in each situation.3 Lately, rich evidence has been published and adapted by spine surgeons, which discusses the importance of global spine alignment, particularly pelvic incidence (PI)–lumbar lordosis (LL) matching.4 PI-LL mismatch is associated with poor short- and long-term outcomes, including adjacent segment disease and acquired adult spine deformity.5 This has led many surgeons to aim to increase LL during fusion surgery to avoid PI-LL mismatch. However, few studies have highlighted the relationship between increased LL and iatrogenic foraminal stenosis.3,6–8 This complication has been recognized 3 times in our institution, where patients require revision surgery. We present these cases for illustration. In addition, we present a fourth case in which preventive measures were applied. This study aimed to explore the possible causes of postoperative contralateral radiculopathy and preventive measures for this possible complication.

Illustrative Cases

Case 1
A 63-year-old woman with hypertension complained of lower back pain with radiculopathy in the right lower limb and neurogenic
claudication. The patient had a history of L4–5 decompression and fusion 7 years prior. The patient had no neurological deficits. Lumbar spine radiography and magnetic resonance imaging (MRI) showed solid fusion at L4–5 with interbody fusion without loosening, an adjacent degenerative spinal stenosis and retrolisthesis of L3–4, and right lateral recess and foraminal stenosis at the L3–4 level. After failed conservative treatment, the patient underwent extension of the fusion to L3 with right-sided decompression of the lateral recess and complete foraminotomy. The right leg pain resolved completely postoperatively, but the patient complained of a new severe left leg pain and no right leg pain; however, she complained of severe left leg pain in the L3 distribution. Postoperative computed tomography (CT) showed no obvious malpositioning of the screws but demonstrated severe left L3–4 foraminal stenosis, as shown in Fig. 1, which required revision surgery. During the surgery, we found that the left L3 nerve root was flattened by an osteophyte from the superior articular process of L4. We performed a full left L3–4 foraminotomy. Postoperatively, the patient’s left lower limb radiculopathy was alleviated with no back symptoms.

**Case 2**

A 59-year-old woman with hypothyroidism and dyslipidemia complained of back pain, radiculopathy of the right lower limb, and neurogenic claudication. The patient had a history of L4–5 decompression and fusion 5 years prior. The patient had no neurological deficit. Radiography and MRI showed grade 2 degenerative spondylolisthesis with spinal stenosis of L3–4. After conservative treatment failed, the patient underwent L3–4 TLIF with right-sided decompression along with full L3–4 foraminotomy, and a TLIF cage was inserted from the right side. The patient reported no pain in the right leg postoperatively. However, she complained of lower back and severe left leg pain at the L3 level. Postoperative CT showed no obvious malpositioning of the implants, adequate right L3–4 foraminotomy, full reduction of the L3–4 spondylolisthesis, and severe left L3–4 foraminal stenosis due to a large osteophyte from the L4 superior articular process of the L3–4 facet joint (Fig. 2). The patient underwent revision surgery for a complete left L3–4 foraminotomy. A significant improvement in the left L3 radiculopathy was noted postoperatively.

**Case 3**

A 50-year-old woman with no prior medical illnesses presented to the clinic complaining of progressive left leg radiculopathy and...
Sciatica. She had no neurological deficit, but the pain was so severe that she was unable to walk for long distances and nonoperative treatment measures had been ineffective. Preoperative radiography and lumbar spine MRI showed degenerative L4–5 spondylolisthesis with local kyphosis at the segment. She underwent L3–5 fusion with L4–5 decompression, left L4–5 foraminotomy with TLIF insertion from the left side, as well as spondylolisthesis reduction and correction of local segmental kyphosis. She reported complete alleviation of the left leg radiculopathy postoperatively; however, she developed severe right leg radiculopathy. Postoperative CT scan of the lumbar spine showed proper implant position and reduction in the L4–5 spondylolisthesis with complete left L4–5 foramen decompression with an iatrogenic right L4–5 foraminal stenosis. The patient underwent revision surgery to achieve right L4–5 foraminotomy.

Case 4

A 69-year-old male patient with a known history of diabetes mellitus and hypertension, along with a history of L4–5 decompression and TLIF 2 years prior, presented with worsening back pain and neurogenic claudication, and had no neurological deficits. Preoperative radiological investigations showed solid fusion of the L4–5 with loss of lordosis at that segment. Additionally, there were degenerative changes with lysis of the adjacent levels L2–3 and L3–4 with severe L3–4 lumbar spinal stenosis (Fig. 4). After conservative management had failed, surgery was performed. Surgical intervention with extension of fusion to L2, decompression, and TLIF at the L3–4 levels were performed. However, the surgeon anticipated the need for increasing lordosis to compensate for the loss of segmental lordosis at the L4–5 level, and bilateral prophylactic L3–4 foraminotomy was performed to prevent iatrogenic foraminal stenosis at the adjacent level, as shown in Fig. 5. The patient did well, and the index symptoms resolved completely.

Discussion

Observations

Acute postoperative contralateral radiculopathy has been reported as a complication following lumbar spine fusion surgery for degenerative conditions, with an estimated incidence of 2.5–5.3%. Its causes are variable, including screw malposition and iatrogenic foraminal stenosis with facet subluxation, acute disc herniation, and epidural hematoma. Surgeons must attend to patients’ concerns and investigate according to these differentials. Postoperative MRI of the lumbar spine would be helpful in assessing the possibility of acute disc herniation or epidural hematomas. However, MRI has limitations in viewing the screw position and foraminal stenosis due to the presence of metal artifacts, and early postoperative changes may result in another limitation. A CT scan of the lumbar spine would ensure appropriate implant position without any medial or inferior breach, along with proper assessment of the foramina, which is best viewed in the sagittal views (Fig. 1), and facilitates the identification of osteophytes from the superior articular process or facet subluxation, which led to foraminal stenosis. Insufficient disc removal and decompression would result in a contralateral acute hemiated disc. Additionally, unilateral cage insertion may push the disc material to the contralateral side, leading to contralateral disc herniation. A crucial goal of lumbar spine fusion surgery is to restore adequate lordosis to prevent PI-LL mismatch, which could lead surgeons to try and create a lordotic segment using lordotic cages, contouring the rods into a hyperlordotic shape, or using compression between the pedicle screws. However, this has been reported to be a cause of iatrogenic foraminal stenosis. Two of our cases...
presented were revision surgeries to treat adjacent segment disease (ASD), and complete foraminotomies were performed on the side of the index radiculopathy. The pitfall was creating segmental lordosis at the fused segment to restore regional balance and prevent further ASD, missing the fact that the contralateral foramen was at risk of iatrogenic foraminal stenosis, eventually requiring reoperation and contralateral complete foraminotomy. Another proposed mechanism of iatrogenic foraminal stenosis is the use of a unilateral TLIF cage, resulting in an increase in foraminal height at the ipsilateral side and compression of the contralateral foramen. Such a mechanism has been observed, especially in cases of ipsilaterally placed cages. Therefore, it is advised to position the cage in the middle or contralateral side of the intervertebral space to increase contralateral foraminal height and create local scoliosis at the segment. One possible advantage of transverse cages (LLIF) compared with TLIF cages is the achievement of indirect foraminal decompression rather than risking iatrogenic foraminal stenosis. Theoretically, prophylactic foraminotomy on the asymptomatic side is the most effective way to prevent such complications. Our protocol is to perform prophylactic foraminotomy in revision for ASD (Fig. 5) in cases where we anticipate significant changes in the LL and in cases with spondylolisthesis that require reduction.

Lessons
Iatrogenic foraminal stenosis of the lumbar spine is not uncommon; careful planning and middle intervertebral space cage positioning are needed to prevent such a complication postoperatively.

References

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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