



Spondylolysis-induced Multilevel Lumbar Spondylolisthesis; Challenges in Lumbar Spine Surgery

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Abstract

Lumbar spondylolysis and multilevel lumbar spondylolysis account for 4.4-5.8% and 0.3% of the general population, and multilevel lumbar spondylolysis resulting in spondylolisthesis is even rarer. Herein, we report two cases of three-level lumbar spondylolisthesis because of spondylolysis: A 49-year-old woman was admitted to the hospital for dull lower back pain over the past 8 months, with exacerbating symptoms when standing and walking. Spasticity at lumbar region and radiculopathy at S1 nerve root was found on examination and a 63-year-old man was admitted to the hospital because of numbness and perianal sensory disturbances with difficulty urinating 2 weeks ago, the symptoms gradually increased to the time of examination. Both patients were diagnosed with multilevel lumbar spondylolisthesis because of spondylolysis and were indicated for posterior lumbar interbody fusion (PLIF). After surgery, both patients recovered well without any significant complications. The improved treatment results suggest the application of PLIF technique to treat spondylolysis-induced multilevel lumbar spondylolisthesis.

Keywords: Multilevel lumbar spondylolisthesis; Low back pain; Nerve root pain; Spondylolysis; Posterior lumbar interbody fusion (PLIF).

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Introduction

Isthmic spondylolisthesis is a clinical scenario caused by lumbar spondylolysis, leading to posterior/anterior spondylolisthesis. The proportion of lumbar spondylolysis is approximately 4.4-5.8% of the general population and isthmic spondylolisthesis ranges from 2.6% to 4.4%.¹ Multilevel lumbar spondylolysis accounts for 0.3% and in which 90.3% of cases involving L5 vertebra.² Multilevel lumbar spondylolisthesis due to spondylolysis is found to be rarer.^{3,4} According to Wiltse et al, lumbar spondylolisthesis is divided into six subtypes: isthmic spondylolisthesis is the classified type II, following bilateral pars interarticularis defects. The defects can be considered as the result of fatigue fracture or elongation of the intact pars.⁵ Most of the patients with spondylolisthesis are treated conservatively. Especially in teenage patients, their supine position, brace, and limiting activities can improve symptoms of the disease. However, surgery must be considered in cases of progressive neurological deficit or cauda equina syndrome. Most patients with spondylolisthesis may require surgical treatment.⁴ Surgery to treat spondylolisthesis due to spondylolysis aims to: release nerve compression and stabilize the spine, including direct repair of the pars defect, posterior

lumbar interbody fusion (PLIF) and combination of both the aforementioned methods in different spinal segments.⁶ Direct surgical repair that preserves motion in the segment affected vertebrae has become more common in young patients with spondylolysis, which is suitable in cases without spondylolisthesis and lacks an accurate classification of spondylolisthesis.⁷ PLIF uses a system of pedicle screw and posterior lumbar interbody cages with bone grafts for fixation. This report presents 2 rare clinical cases of three-level lumbar spondylolisthesis because of spondylolysis.

Case Presentation

Case 1

A 49-year-old woman was admitted to the hospital because of low back pain for more than 8 months. Recently, the pain has gradually increased, especially when standing and walking, accompanied by spasticity in the lumbar region that limits movement of the spine. On physical examination: S1 radicular pain, visual analogue scale (VAS) score for low back pain 8/10, positive “step ladder sign”, Lasègue’s test was positive 30 degrees on right side, 50 degrees on left side, lumbosacral spine radiograph (Figure 1) with pelvic incidence, pelvic tilt,

sacral slope were 58.3, 30.1, and 28.2, respectively, and lumbar MRI imaging revealed a three-level lumbar spondylolysis at L3-L4-L5 with and low-grade anterior spondylolisthesis of L3, L4, L5 in combination with disc protrusions compressing bilateral S1 nerve root in the spinal canal (Figure 2) on the spine with transpedicular screws at L4-S1 and placing PEEK cage at L5-S1. The patient was placed prone, with L3-S1 under C-arm, and an incision was made in the midline at the L3-S1 site. Spinous processes, laminae and bilateral facets were exposed, with 8 poly-axial screws inserted in the pedicles of L3, L4, L5 and S1. The screws were located with C-arm. Then, the bilateral laminae was removed completely and the S1 nerve root was decompressed on the right side and lateral recess. Continuously, nucleus pulposus and cartilaginous endplates were also removed. A PEEK cage filled with bone chops was inserted into the intervertebral disc space. Two rods were placed and fixed with screws. Drainage and 3-layer closure were completed. There were no postoperative complications, so the patient was



Figure 1. Radiograph of the Lumbar Sacral Spine With Three-Level Anterior Spondylolisthesis at L3-L4-L5.

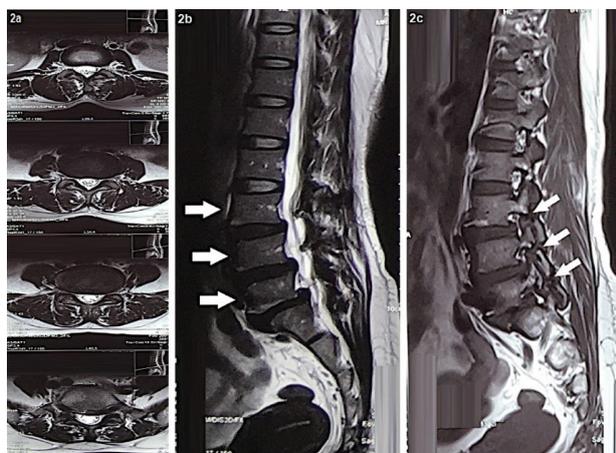


Figure 2. Magnetic Resonance of the Lumbar Spine: (a) Axial plane: disc protrusions at L5-S1 compressing bilateral S1 nerve root in the spinal canal, (b) sagittal plane: anterior spondylolisthesis grade I at L3, L4, L5 (white arrow), and (c) spondylolysis at L3, L4, L5 (white arrow).

discharged after 10 days. She had her follow-up after 1 month and the symptoms of lower back, as well as nerve root pain, were improved. Lumbar spine radiograph showed positioned instruments (Figure 3). Currently, during the 1-year follow-up period the VAS score reduced to 3/10 and the Oswestry Disability Index (ODI) score reduced to 18%, and she can do normal activities on her own.

Case 2

A 63-year-old man was admitted to the hospital because of pain and numbness in the perianal region with difficulty urinating for two weeks. His had chronic kidney disease being treated with corticosteroids (10-15 tablets/day), hypertension being treated for 1 year, and asthma for 4 years. Physical examination results were as follows: radicular pain in both legs, VAS score for low back pain (9/10), bowel disorders, difficulty urinating, muscle strength in right leg (4/5), left leg (4/5); radiographs (Figure 4) and pelvic incidence, pelvic tilt, and sacral slope were 43.9, 25.2, and 18.7, respectively, CT scan, MRI of lumbar spine showed bone spurs L3, L4, L5, decrease in height of vertebral body L4, L5, spondylolysis



Figure 3. Lumbar Sacral Spine Radiograph Showing Positioned Instruments One Month After Surgery.

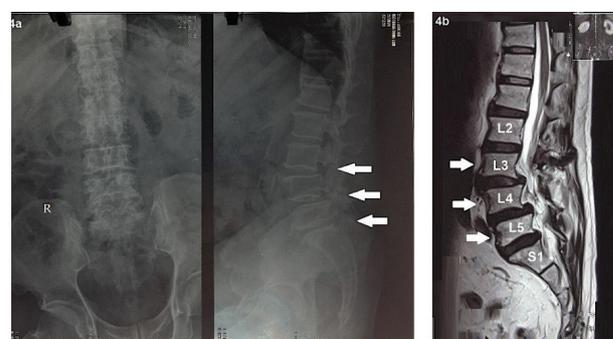


Figure 4. (a) Lumbar sacral spine radiograph, (b) MRI of the lumbar sacral spine showed bone spurs at L3, L4, L5, reduced height of vertebral bodies at L4, L5, the spondylolysis at L3, L4, L5 causing three-level lumbar spondylolisthesis grade I at L3-L4-L5.

at L3, L4, L5 causing anterior spondylolisthesis at L3, L4 grade I (Figure 5), L3-4 disc bulge compresses L3 nerve root on both sides, L4-5 disc bulge compresses L4 nerve root on left side. The patient had symptoms of sphincter dysfunction with worsening neurological deficits, so we decided to perform PLIF surgery: fix the spine with a pedicle screw at L3-S1 and place two PEEK cages at L3-4, L4-5. Before surgery, the patient was treated to stabilize blood pressure and blood sugar, and to control asthma. Radiographs 3 days after surgery (Figure 5) showed positioned instrument. After 1 week of surgery, neurological symptoms and muscle strength improved. There were no complications after surgery, and the patient was discharged 10 days after surgery. Currently, during the 1-year follow-up period, VAS reduced to 4/10 and ODI score to 19%, and he can do normal activities on his own.

Discussion

The incidence of lumbar spondylolysis is higher than that of spondylolisthesis. Approximately 20%-70% of spondylolysis leads to anterior spondylolisthesis.⁴ Although the pathophysiological mechanism of spondylolysis has not been elucidated, comprehensively, genetic and mechanistic factors could be considered. Some studies suggest that there were no hereditary defects, however genetic predisposition was suggested,⁸ with a reported incidence of spondylolisthesis in near relatives in the range of 25%-30%.¹ From a mechanical point of view, heavy repetitive work that flexion or extension could be a motivating factor, therefore, activities such as gymnastics, diving, weight lifting, and wrestling are associated with a higher incidence of spondylolisthesis.⁴ The cause of lumbar spondylolisthesis is likely a combination of several factors.

Regarding symptoms: spondylolisthesis because of spondylolysis includes two main syndromes, spinal syndrome and nerve root syndrome. First of all, lower

back pain increases when walking, standing for a long time and bending the spine. Changing position from sitting to standing is very difficult, in cases of high-grade spondylolisthesis, palpation of the lumbar region can reveal a hollow, known as the “step ladder sign”. Radicular pain is usually presented with pain radiating into buttocks, thighs, legs and feet due to the compression of the sciatic nerve, which is aggravated by coughing, sneezing, and Lasègue sign. Occasionally patients have reduced or lost sensation in the nerve root region. In some cases, paralysis, muscle atrophy, and restriction of movement of the legs and feet. It should be noted that high-grade spondylolisthesis can lead to cauda equina syndrome¹ including symptoms of severe low back pain, sciatica pain particularly at L5-S1, often bilateral but sometimes absent, saddle and/or genital sensation disturbances or bladder, bowel and sexual dysfunction.⁹ In spondylolisthesis grade III, lumbosacral kyphosis manifests as patient compensated in two maneuvers: the patient tries to lengthen the lumbar spine and rotate the pelvis (flexion) so that the sacrum is more vertical or flexion of the knees and hips to aid in maintaining balance with hamstrings tension^{1,4} maintaining lordosis lumbar spine. On imaging, Millard’s “Scotty dog” sign with bilateral pars defect on 3/4 plain radiograph is valuable in diagnosing spondylolisthesis. However, currently, CT and MRI are more commonly used for early diagnosis of spondylolisthesis as well as for making treatment decisions.¹⁰

Treatment of multilevel lumbar spondylolisthesis can be conservative or surgery. Conservative treatment includes nonsteroidal, anti-inflammatory drugs, selective nerve root injections, wearing a brace, limiting strenuous athletic activities, and bed rest.¹ Smith and Hu suggested that physical therapy should aim to reduce extension stresses in the lumbar spine, improving the flexibility of the hamstring, back and sacrospinalis muscles.¹¹ Conservative treatment is the standard treatment for lumbar spondylolisthesis in cases of grade III Meyerding or less.³ Surgical intervention is chosen after the failure of conservative measures. In general, pediatric cases respond well to conservative treatment. However, high-grade or progressive spondylolisthesis may require surgical intervention with better surgical outcomes in children compared with adults.¹¹ The main surgical methods performed for lumbar spondylolisthesis due to spondylolysis are direct repair of the pars defect, PLIF, and transforaminal lumbar interbody fusion. We suggest that the treatment methods of multilevel lumbar spondylolisthesis due to spondylolysis were similar to that for single level lumbar spondylolisthesis due to spondylolysis. Multilevel lumbar spondylolisthesis without spondylolysis can be repaired directly using wires and bone graft.¹² However, this method cannot achieve stability of the spine in multilevel lumbar spondylolisthesis

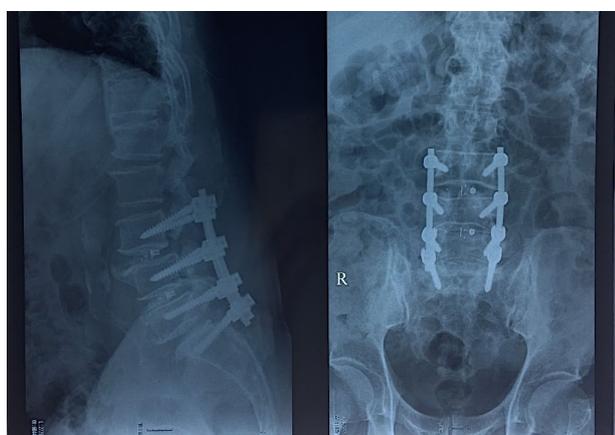


Figure 5. Lumbosacral spine radiograph showed positioned instruments three days after surgery.

due to spondylolysis. Therefore, in our case, the patient underwent PLIF surgery with transpedicular screw fixation and placement of an intervertebral graft (PEEK). At follow-up examination after 1 month, the patient's low back pain and nerve root pain had almost completely disappeared. Anterior and posterior radiographs showed correctly positioned instruments (Figures 3 and 4).

Conclusion

Two cases of multilevel lumbar spondylolisthesis due to spondylolysis were reported which is an uncommon clinical scenario. The diagnosis is based on clinical symptoms of low back pain and radicular pain, with the support of MRI to clarify the diagnosis. PLIF surgery consisting of pedicle screw fixation and intervertebral graft placement (PEEK) has shown satisfactory outcomes, suggesting the application of PLIF surgery to treat spondylolysis-induced multilevel lumbar spondylolisthesis.

Author' Contribution

Authors equally contributed to the work.

Conflict of Interest Disclosures

The authors declare that they have no conflict of interests.

Ethical Statement

This study was approved by the ethical approval committee/ Institutional Review Board of Hue University of Medicine and Pharmacy, No. 2395 / QD-DHYD, December 19, 2020.

References

- Ganju A. Isthmic spondylolisthesis. *Neurosurg Focus*. 2002;13(1):E1. doi: 10.3171/foc.2002.13.1.2.
- Sakai T, Sairyo K, Suzue N, Kosaka H, Yasui N. Incidence and etiology of lumbar spondylolysis: review of the literature. *J Orthop Sci*. 2010;15(3):281-8. doi: 10.1007/s00776-010-1454-4.
- Dunn AS, Baylis S, Ryan D. Chiropractic management of mechanical low back pain secondary to multiple-level lumbar spondylolysis with spondylolisthesis in a United States Marine Corps veteran: a case report. *J Chiropr Med*. 2009;8(3):125-30. doi: 10.1016/j.jcm.2009.04.003.
- Wong LC. Rehabilitation of a patient with a rare multi-level isthmic spondylolisthesis: a case report. *J Can Chiropr Assoc*. 2004;48(2):142-51.
- Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. *Clin Orthop Relat Res*. 1976(117):23-9.
- Higashino K, Sairyo K, Katoh S, Sakai T, Kosaka H, Yasui N. Minimally invasive technique for direct repair of the pars defects in young adults using a spinal endoscope: a technical note. *Minim Invasive Neurosurg*. 2007;50(3):182-6. doi: 10.1055/s-2007-982511.
- Zhang Y, Liu Y, Chen J, Li X, Wang H, Wang G, et al. Combining posterolateral lumbar fusion and posterior lumbar interbody fusion surgery for treating three-level lumbar spondylolysis and single-level spondylolisthesis: case report. *J Biosci Med*. 2019;7(8):77-83. doi: 10.4236/jbm.2019.78006.
- Wiltse LL. The etiology of spondylolisthesis. *J Bone Joint Surg Am*. 1962; 44(3):539-60.
- Gardner A, Gardner E, Morley T. Cauda equina syndrome: a review of the current clinical and medico-legal position. *Eur Spine J*. 2011;20(5):690-7. doi: 10.1007/s00586-010-1668-3.
- Morimoto M, Sakai T, Goto T, Sugiura K, Manabe H, Tezuka F, et al. Is the scotty dog sign adequate for diagnosis of fractures in pediatric patients with lumbar spondylolysis? *Spine Surg Relat Res*. 2019;3(1):49-53. doi: 10.22603/ssrr.2017-0099.
- Smith JA, Hu SS. Management of spondylolysis and spondylolisthesis in the pediatric and adolescent population. *Orthop Clin North Am*. 1999;30(3):487-99. doi: 10.1016/s0030-5898(05)70101-2.
- Al-Khawashki H, Wasef Al-Sebai M. Combined dysplastic and isthmic spondylolisthesis: possible etiology. *Spine (Phila Pa 1976)*. 2001;26(23):E542-6. doi: 10.1097/00007632-200112010-00021.