Progression of Diagnostic Imaging Findings of a Patient With Traumatic Spondylolisthesis Secondary to Unilateral Facet Fractures: A Case Report

Lauren J. Tollefson, DC, and John Chin-Suk Cho, DC, DACBR

ABSTRACT

Objective: The purpose of this case study is to describe the diagnostic imaging studies of a patient who had a traumatic spondylolisthesis at L5-S1 secondary to unilateral facet fractures.

Clinical Features: A 21-year-old man experienced a rollover motor vehicle crash that led to low back pain and progressive left-sided radiculopathy. Later, he sought treatment from a doctor of chiropractic because he continued to have low back pain with progressive pain down his left leg. A magnetic resonance imaging study demonstrated a left paracentral disc protrusion at L5-S1. Follow-up computed tomography demonstrated multiple transverse process fractures and left-sided L5-S1 facet fractures with spondylolisthesis that progressed over time.

Intervention and Outcome: The patient was referred for a neurosurgical consultation 10 months after the injury. At 12 months after the injury, he underwent transforaminal lumbar interbody fusion with a posterior approach. The patient's pain and radicular symptoms resolved after the surgery.

Conclusion: This patient exhibited posterior element fractures, had continued symptom progression, and was monitored for the development of a spondylolisthesis. Because of progression and exacerbation of symptoms, neurosurgical consultation for surgical stabilization was mandated. (J Chiropr Med 2019;18:139-143)

Key Indexing Terms: *Spondylolisthesis; Spinal Fractures; Low Back Pain*

INTRODUCTION

Spondylolisthesis has 5 etiologies: dysplastic, isthmic, degenerative, traumatic, and pathologic.¹ Although the isthmic type (those involving the pars interarticularis) is common in the lumbar spine, traumatic spondylolisthesis is rare. Approximately 100 cases of lumbosacral traumatic spondylolisthesis have been reported since 1940.² In this case study, we discuss a patient who had a traumatic spondylolisthesis secondary to left-sided unilateral facet fractures at L5 and S1 with a slowly progressive spondylolisthesis.

CASE REPORT

A 21-year-old male patient was thrown through a soft-top Jeep followed by the vehicle rolling over him. He was

transferred to a local emergency department, complaining of low back pain. Computed tomography (CT) scans of his abdomen, pelvis, chest, cervical spine, and head were taken. Left-sided facet fractures at L5 and S1 were present at this time (Fig 1), as were transverse process fractures throughout the lower lumbar region. However, these fractures were not mentioned in the initial CT report, and he was cleared by the emergency department physician and released the same day without a diagnosis. He continued to experience low back pain and sought treatment at a different trauma center 1 day later. A repeated CT examination was performed at the second trauma center, where the reading radiologist diagnosed left-sided fractures of the inferior facet at L5 and the superior facet at S1 and transverse process fractures on the right at L2-L4 and bilaterally at L5. Spondylolisthesis was not evident at that time. He was released with a lumbar brace and instructions to rest.

Three weeks after the injury, he sought treatment from a doctor of chiropractic when he continued to have low back pain and began experiencing progressive pain down his left leg. A magnetic resonance imaging study demonstrated a left paracentral disc protrusion L5-S1 (Figs 2 and 3). High signal intensity was noted in the regions of the pedicles, pars interarticularis, and transverse processes of L5 and in the anterior longitudinal ligament adjacent to L5-S1. There was

Clinical Sciences Department, Parker University, Dallas, Texas.
Corresponding author: Lauren J. Tollefson, DC, Clinical Sciences Department, Parker University, 2500 Walnut Hill Lane, Suite 220, Dallas, TX 75229. Tel.: +1 214 902-2459 ext 7342. (e-mail: LTollefson@parker.edu).

Paper submitted July 2, 2018; in revised form November 5, 2018; accepted December 19, 2018.
1556-3707

© 2019 National University of Health Sciences.
<https://doi.org/10.1016/j.jcm.2018.12.002>

Fig 1. Day of injury. Sagittal computed tomography in the bone window image showing left-sided inferior facet fracture at L5 and superior facet fracture at S1 without frank spondylolisthesis.

Fig 3. Axial T2 magnetic resonance imaging demonstrates left paracentral disc protrusion at L5-S1.

no evidence of ligamentous rupture. The reading radiologist requested a follow-up CT study that was performed 1 week later. This study demonstrated anterolisthesis of L5-S1 measuring 3.5 mm on the left. Faint left-sided heterotopic ossification was seen at the anterior aspect of L5-S1 (Fig 4).

The patient experienced persistent low back pain and began to experience increased left-sided radiculopathy. The patient had a neurosurgical consultation 10 months after the injury; the neurosurgeon ordered a CT myelogram study for preoperative planning. This study demonstrated progression of the spondylolisthesis to 7 mm on the left and 5 mm

Fig 2. Three weeks after the injury. Sagittal magnetic resonance image with short τ inversion recovery demonstrating broad disc protrusion at L5-S1 with increased signal of the soft tissues anterior to L5-S1.

Fig 4. One month after the injury. Sagittal computed tomographic imaging shows grade 1 spondylolisthesis of L5 on S1 with healing left-sided facet fracture at L5 and nonunion of the S1 facet. Faint heterotopic ossification is seen at the anterior portion of L5-S1.

Fig 5. Ten months after the injury. Sagittal computed tomography demonstrates increased spondylolisthesis of L5 on S1 with increased density of the heterotopic ossification at L5-S1.

on the right. Furthermore, there was increased organization of the heterotopic ossification anterior to L5-S1 (Fig 5). Marked facet remodeling was observed at L5-S1 on the left with nonunion of the S1 superior facet. There was also pseudoherniation of the L5-S1 disc secondary to the spondylolisthesis where a portion of the disc was exposed because of the vertebral body slippage.

The patient was surgically stabilized 12 months after the injury using a posterior approach and a transforaminal lumbar interbody fusion at L5-S1. Reduction of the spondylolisthesis was performed with the anterolisthesis measuring 4.2 mm. Postoperative rehabilitative therapy was initiated with resolution of pain and neurologic symptoms. The postoperative imaging studies, consisting of lumbar CT and radiographs, confirmed stability at L5-S1.

DISCUSSION

The traumatic type of spondylolisthesis in the lumbosacral spine is rare.² Typically, a traumatic lumbar spondylolisthesis is associated with a lumbosacral facet joint fracture–dislocation. To our knowledge, only 2 other cases of traumatic spondylolisthesis in the lumbosacral spine without facet dislocation have been seen in the past decade (2008–2018).^{3,4} Traumatic spondylolisthesis of the lumbar spine is the result of a high-energy trauma.² Most literature supports that hyper-

flexion accompanied by compression is the likely mechanism of facet dislocation in the lumbar spine.^{5–7} However, there is no consensus regarding the mechanism of injury for isolated facet fracture. Hyperextension with axial loading can result in facet or laminar fractures.⁶ In this case, we believe that the mechanism was likely extension with rotation owing to the unilateral nature of the facet fractures.

Because of the complex anatomy of the spine, there may be increased diagnostic difficulty in this region. Thirty-eight percent of patients with spinal fractures were misdiagnosed at the initial assessment in 1 study.⁸ However, this number might be outdated, and improvement is probable from advancements in advanced imaging.

Our patient underwent 11 CT scans and 4 radiographic series within the first 12 months after injury, of which 9 were performed within the first 36 hours. The number of studies may have been due to a combination of missed diagnosis and a lack of communication between providers. The dose incurred during CT is much higher than that of conventional radiography⁹; this could have detrimental effects, particularly when the radiosensitive thyroid gland is exposed.⁹ When possible, previous imaging should be obtained from the initial trauma center rather than reimaging of the patient, unless warranted by a change in symptoms. A judicious implementation of radiation safety should always be considered. Improved interdisciplinary communication could have also reduced the amount of radiation the patient was exposed to.

The facet and transverse process fractures were undetected at the time of initial imaging. There is a high correlation with transverse process fractures and lumbosacral spondylolisthesis.^{2,6,7} In the presence of transverse process fractures, a search for traumatic spondylolisthesis is warranted. Furthermore, a diligent search for any transverse process or posterior element fractures must be done in the presence of trauma.^{6,7}

Initially, this patient demonstrated normal vertebral alignment. Over time, a spondylolisthesis developed; this might have been secondary to ligamentous instability, callous formation from the facet fracture leading to capsular laxity, secondary disc herniation, coronal orientation of the facets at L5-S1, sacral base angle, or a combination of factors. The main structure that opposes anteriorly directed shear forces is the intervertebral disc.¹⁰ This patient had a large disc protrusion, which might have contributed to the progressive nature of the slip. The combination of the coronal orientation of the facet joints at L5-S1 and the lumbosacral angle explains why traumatic spondylolisthesis occurs mostly at L5-S1⁶ and might have hastened the progression in this case. Studies on manual manipulation of a spondylolisthesis are limited and focus mainly on the isthmic and degenerative types.^{11–14} There is no literature about using manipulation for the treatment of traumatic spondylolisthesis in the lumbar spine.

The goal of surgical treatment is to restore normal alignment, decompress the nerves, and stabilize the lumbar spine.¹⁵ In the case of a high-risk mechanism of injury to

the lumbar spine (eg, falls >3 m, ejection from a motor vehicle, and motor vehicle crashes >50 mph [80 kph]), timely referral to the specialist and advanced imaging is recommended under the guideline when there is absence of clinical improvement after 4 to 6 weeks of therapy, function does not improve or deteriorates, or persistent signs or symptoms are present.¹⁶ In our case, the neurosurgical consultation was delayed to 10 months after trauma, and the standard patient management was relegated from the lack of communication between providers.

The most commonly used surgical method is the posterior approach.^{3-7,17,18} A posterior approach is beneficial for retrieving fracture fragments, increased safety and ease, and reduced complications.¹⁹ Other surgical procedures include the anterior approach²⁰ or combined anterior and posterior approach^{7,18,21}; however, these approaches are typically used when there is a concurrent dislocation. Our patient had complete resolution of his symptoms after surgical fixation. The patient gave consent for publication of this report.

Limitations

This is a report of only 1 patient. Therefore, the findings and outcome of this study cannot be generalized to other patients with similar injuries or diagnoses.

CONCLUSION

We present a case of a traumatic spondylolisthesis of the lumbosacral spine. This patient exhibited posterior element fractures, had continued symptom progression, and was monitored for the development of a spondylolisthesis. Because of progression and exacerbation of symptoms, neurosurgical consultation for surgical stabilization was mandated.

FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interest were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): J.C.-S.C.

Design (planned the methods to generate the results): L.J.T., J.C.-S.C.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): J.C.-S.C.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): L.J.T.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): L.J.T.

Literature search (performed the literature search): L.J.T.
Writing (responsible for writing a substantive part of the manuscript): L.J.T.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): L.J.T., J.C.-S.C.

Practical Applications

- Patients who have posterior element fractures with continued pain or symptom progression should be monitored for the development of a spondylolisthesis.
- Neurosurgical consultation for surgical fixation was sought 10 months after the injury, after which complete resolution of symptoms was achieved.

REFERENCES

1. Wiltse LL, Newman PH, Macnab I. Classification of spondylolysis and spondylolisthesis. *Clin Orthop*. 1976; 117:23-29.
2. Robbins M, Mallon Z, Roberto R, Patel R, Gupta M, Klineberg E. Traumatic spondylolysis: a report of two cases of spondylolisthesis at L5-S1 and review of literature. *Glob Spine J*. 2015;5(3):225-230.
3. Lim CT, Hee HT, Liu G. Traumatic spondylolisthesis of the lumbar spine: a report of three cases. *J Orthop Surg*. 2009;17(3):361-365.
4. Yang X, Kong Q, Dou Q, Song Y. Traumatic high-grade L5-S1 spondylolisthesis with vertebral physal injury. *Spine J*. 2015;15(9):2097-2098.
5. N'Dri-Oka D, Sarki SI, Konan L, Haro Y. Traumatic lumbar spondylolisthesis without facet fracture at L4/L5. A case report and literature review. *Chin Neurosurg J*. 2016. Available at: <http://cnjournal.biomedcentral.com/articles/10.1186/s41016-016-0027-6>. Accessed March 18, 2018.
6. Deniz FE, Zileli M, Çağlı S, Kanyılmaz H. Traumatic L4-L5 spondylolisthesis: case report. *Eur Spine J*. 2008;17(suppl 2): S232-S235.
7. Tsirikos AI, Saifuddin A, Noordeen MH, Tucker SK. Traumatic lumbosacral dislocation: report of two cases. *Spine*. 2004;29(8): E164-E168.
8. Reid DC, Henderson R, Saboe L, Miller JD. Etiology and clinical course of missed spine fractures. *J Trauma*. 1987;27(9):980-986.
9. Tins BJ. Imaging investigations in spine trauma: the value of commonly used imaging modalities and emerging imaging modalities. *J Clin Orthop Trauma*. 2017;8(2):107-115.
10. Floman Y. Progression of lumbosacral isthmic spondylolisthesis in adults. *Spine*. 2000;25(3):342-347.
11. Mierau D, Cassidy JD, McGregor M, Kirkaldy-Willis WH. A comparison of the effectiveness of spinal manipulative

- therapy for low back pain patients with and without spondylolisthesis. *J Manipulative Physiol Ther.* 1987;10(2):49-55.
12. Wong LC. Rehabilitation of a patient with a rare multi-level isthmic spondylolisthesis: a case report. *J Can Chiropr Assoc.* 2004;48(2):142-151.
 13. Dunn AS. Chiropractic management of mechanical low back pain secondary to multiple-level spondylolysis with spondylolisthesis in a United States Marine Corps veteran: a case report. *J Chiropr Med.* 2009;8(3):125-130.
 14. Weinstein JN, Lurie JD, Tosteson TD, et al. Surgical versus nonsurgical treatment for lumbar degenerative spondylolisthesis. 2007;356(22):2257-2270.
 15. Bussieres AE, Taylor JA, Peterson C. Diagnostic imaging practice guidelines for musculoskeletal complaints in adults-an evidence-based approach-part 3: spinal disorders. *J Manipulative Physiol Ther.* 2008;31(1):33-88.
 16. Tang S, Rebholz BJ. Single-stage treatment of lumbar fracture-dislocation using a combined anterior and posterior approach. *J Orthop Sci.* 2012;17(5):659-662.
 17. Saiki K, Hirabayashi S, Sakai H, Inokuchi K. Traumatic anterior lumbosacral dislocation caused by hyperextension mechanism in preexisting L5 spondylolysis: a case report and a review of literature. *J Spinal Disord Tech.* 2006;19(6):455-462.
 18. Tang S. Traumatic lumbar spondylolisthesis. *Pak J Med Sci.* 2013;29(1):239-241.
 19. Tang S. Treating traumatic lumbosacral spondylolisthesis using posterior lumbar interbody fusion with three years follow up. *Pak J Med Sci.* 2014;30(5):1137-1140.
 20. Gräbe RP. Fracture-dislocation of the lumbosacral spine during a grand mal epileptic seizure. a case report. *S Afr Med J.* 1988;74(3):129-131.
 21. Kaplan SS, Wright NM, Yundt KD, Lauryssen C. Adjacent fracture-dislocations of the lumbosacral spine: case report. *Neurosurgery.* 1999;44(5):1134-1137.