Chapter 11
A Girl with Low Back Pain due to Spondylolisthesis

John F. Sarwark, Kristine Santos Martin, and Ayesha Maqsood

Brief Case Presentation

Chief Complaint

Four-year history of chronic low back pain

History

This 18-year-old female has had chronic low back pain for the last 4 years. There was no trauma or an inciting incident. She has the pain when she wakes up, if she stands or sits for long periods of time and when she runs. She works at a cable factory for 40 hours a week, mostly sitting. She notices the mid to low back pain towards the end of her day, but with some relief with changing positions and stretching. She also occasionally has shooting pain on the lateral aspect of her right thigh and right foot plantar paresthesia when the back pain occurs. She has been managing her pain with physical therapy (PT), a lumbosacral orthosis (LSO) and nonsteroidal anti-inflammatory drugs (NSAIDs). She was taking the NSAID daily, until a few months ago when she started to have gastrointestinal (GI) symptoms. Her primary care physician (PCP) then prescribed acetaminophen 325 mg, which she

J. F. Sarwark (✉)
Division of Orthopaedic Surgery & Sports Medicine, Department of Surgery, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL, USA
e-mail: jsarwark@luriechildrens.org

K. Santos Martin · A. Maqsood
Department of Surgery, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, IL, USA

R. M. Schwend, W. L. Hennrikus (eds.), *Back Pain in the Young Child and Adolescent*, https://doi.org/10.1007/978-3-030-50758-9_11

can tolerate daily, with some pain relief. She now also takes diazepam at night, to ease the pain enough to sleep.

Physical Examination

Weight 103.8 kg, height 171.3 cm, BMI 35. She is healthy and well-nourished. Her stance and gait are normal. She has no pain with right left or forward bending. Her single leg hyperextension (stork) test was positive with the left foot raised and negative with the right foot raised. Neurologic, motor, sensory and reflex exams are normal. Bowel and bladder functions are normal as well. She had difficulty doing more than one push up and more than five sit ups.

Imaging and Radiographic Studies (Figs. 11.1 and 11.2)

Questions About the Case the Reader Should Consider

1. Was there increased physical activity or repetitive motions by the patient?
2. What is the appropriate referral?
3. What is the next diagnostic test that should be considered?
4. Why is a combination of PT, LSO and NSAIDs not alleviating her symptoms?
5. What are possible treatments in this case?

Discussion

In the paediatric population, the clinical manifestations of spondylolisthesis can vary greatly. Most cases are asymptomatic but symptoms, most commonly low back pain, can arise during pubertal growth. The pain can occasionally radiate in a sciatic distribution to the buttock or posterior thigh [1]. Patients who are athletes and compete in high-risk sports, such as gymnastics and football, can have injuries as their inciting incident or trauma. Other causes include minor overuse trauma, in particular repetitive hyperextension movements of the lumbar spine [2]. In adolescence and adulthood, the increased physical activity in addition to the wear-and-tear of daily life can result in spondylolisthesis, making it very common in this age range. In this case the young woman did not remember an inciting incident or trauma, but indicated that her job led to sitting 40 hours a week. The erect posture produces a constant downward and forward loading force on the lumbar vertebrae. This daily stress and repeated force being applied to the spine can wear out or degenerate it. Her obesity and weak core muscles may have contributed to the pain she had been experiencing.

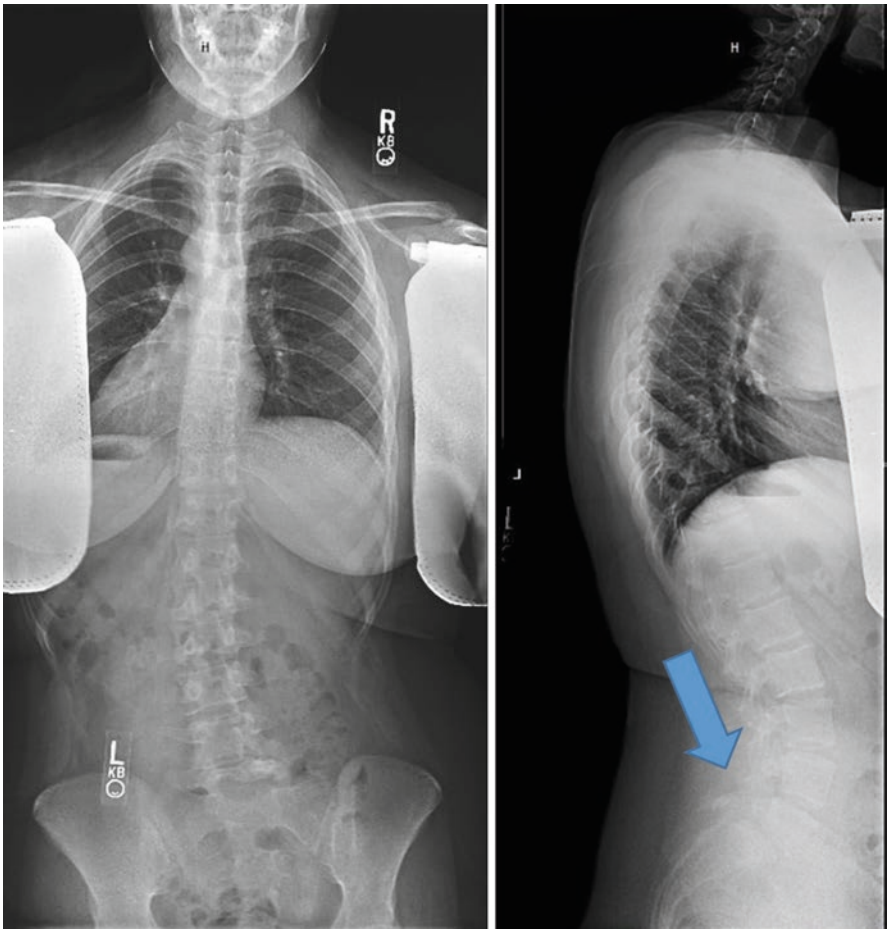

Fig. 11.1 PA and lateral radiograph; bilateral pars interarticularis defects at L5 with mild forward slip of L5 on S1. Note the secondary mild with apex left scoliosis which is frequently seen associated with painful spondylolisthesis. Apex of the secondary scoliosis may be to the left or to the right and is often a long neuromuscular appearing curvature

A spinal and lumbosacral AP and lateral radiographs are used to make a diagnosis of spondylolisthesis. If suspected, referral to an orthopaedic spine surgeon or sports medicine specialist if the patient is an athlete is appropriate. Neurologic findings such as weakness or decreased sensation especially need a referral to a spine surgeon. Advanced imaging such as MRI or CT are best ordered by the specialist. These radiological assessments give a better visualization of the bone morphology, making it check for the alignment of the facet joint and the degenerative changes that have occurred [3]. The need for advanced imaging arises when the patient is exhibiting significant and progressing neurologic claudication, bladder or bowel complaints, radiculopathies and the clinical suspicion that another condition such as space-occupying lesion such as disc, tumour or infection [4]. This patient had an

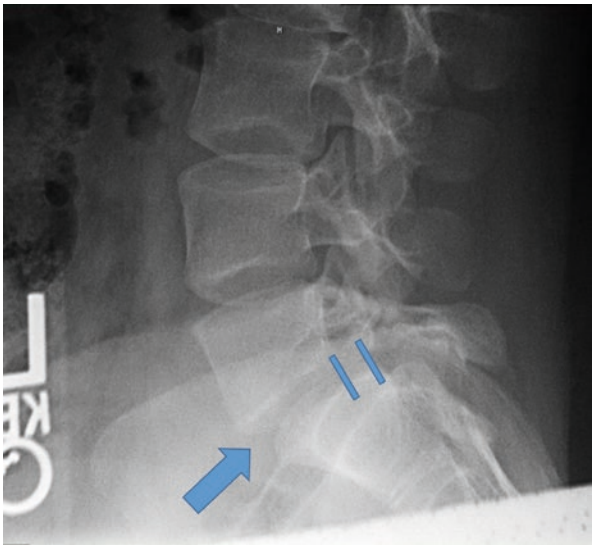

Fig. 11.2 Lateral lumbar radiograph; there is a loss of height observed between the vertebral bodies (*arrow*) and also a vertebral displacement observed at L5-S1 (*lines*); diagnosis is isthmic spondylolisthesis grade 1

Fig. 11.3 Lateral lumbar MRI; degenerative disc findings associated with L4-L5 and L5-S1 discs (*arrows*). No spinal canal or foraminal narrowing associated with this level. Notice the mild forward slip of L5 on S1, which on a supine film or supine MRI is often less noticable than seen on the standing radiograph

MRI of the lumbar spine ordered by the referred orthopaedic surgeon. It showed a progression of the grade 1 anterolisthesis of L5 upon S1, sclerosis in the bilateral L5 pars interarticularis with persistent bony change on the right L5-S1 facet and progressive degenerative disc findings at the L4-L5 level (Fig. 11.3).

Normally in cases of low-grade spondylolisthesis, patients will respond to conservative, nonsurgical treatment. This includes activity restriction and physical therapy to strengthen the core muscles. If they get little relieve with these measures, nerve blocks, intralesional injection of Marcaine or steroid injection can be used [5]. In this case she was able to achieve some pain relief with physical therapy, a brace and NSAIDs (later switching to acetaminophen due to GI issues she encountered). However, her pain has not fully resolved, and she now needed to take diazepam nightly to achieve some pain relief.

Although the majority of patients will improve with conservative treatments, surgical options are warranted after 6 months of failed conservative treatments for patients who have radiculopathy. Patients with neurogenic claudication, progressive neurological deficits, high-grade slips or bladder and bowel symptoms may require more immediate surgery [6]. A posterolateral fusion with instrumentation is the typical operative treatment for low-grade isthmic spondylolisthesis. It involves a single-level L5-S1 fusion of the transverse processes; this can extend upward to L4 for more severe slippages [7]. In this case the patient has persistent pain with degenerative disc changes of two discs at L4-S1, and for this reason stabilization surgery was recommended. She received posterior spinal fusion with instrumentation from L4 to the sacrum with allograft bone graft, removal of the two degenerated discs and replacement with anterior structural bone graft. Often children have a degree of dysplastic spondylolisthesis with deficient posterior bony anatomy, requiring the addition of disc surgery to provide anterior structural support in addition to posterior rods and bone graft. The posterior operation has a fusion rate of up to 90% and good long-term clinical outcomes [7], although more recently anterior structural support between the vertebral bodies is being used.

How to Approach the Case

Start with a detailed history. Ask the patient specific questions about their pain, including trauma or inciting event, location, severity, duration, quality, exacerbating and alleviating factors and how it is in the morning compared to the night. Next perform a physical examination focusing on the spinal alignment and range of motion of the lumbosacral spine as well as a neurologic examination assessing the distal strength, sensation and reflexes [1]. A radiographic evaluation can provide diagnostic information and determine the grade of slippage. Start with a standing lumbosacral AP and lateral radiograph. If these views are not diagnostic and you still suspect a spondylolysis, oblique views can be obtained, but these may not be diagnostic [6]. Advanced imaging techniques, such as CT and MRI, can be used obtained by the spine specialist on a case-by-case basis, especially when neurological symptoms are present.

Red Flags for Back Pain due to Spondylolisthesis

- Late childhood, early adolescence
- Lumbosacral region of spine
- Repetitive hyperextension
- Numbness or tingling in the feet
- Pain radiates to thighs or legs

Short Differential Diagnosis

- Lumbosacral Spondylolysis – typically occurs in young people (teens), low back pain aggravated by activity, particularly hyperextension.
- Lumbosacral Discogenic Pain Syndrome – found in athletes and non-athletes; typically pain increases with sitting and other activities that increase intradiscal pressure.
- Lumbosacral Radiculopathy – onset of symptoms is sudden, sitting can exacerbate the pain, and it can refer to the anterior aspect of the thigh.

Final Diagnosis

Grade 1 L5/S1 spondylolisthesis; stable

Natural History and Treatment Considerations

The increased growth rate during the adolescent period is associated with the greatest slip progression in those patients who had spondylolisthesis [8]. If a slip angle (angle between the top of L5 and the top of the sacrum) is greater than 25°–30° [9], there is severe spinal instability or chronic disabling pain, and then surgical intervention may be required. In this young woman, the pain started in her adolescent years and progressed to chronic pain, which eventually underwent correction via spinal fusion and instrumentation.

Referral – Emergency, Urgent, or Routine: And to Whom?

If the inciting incident was a new sports-related injury, urgent referral to a sports medicine specialist would be warranted. If there is a high-grade vertebral slippage or symptoms are refractory to conservative treatment and surgical intervention is

being considered, referral to an orthopaedic surgeon, spine surgeon or neurosurgeon would be appropriate.

Brief Summary

Most low-grade cases of spondylolisthesis tend to be asymptomatic or can be resolved with conservative treatment. However, in some cases, the condition may cause chronic low back pain, neurologic symptoms and pain resistant to conservative treatment and require surgical intervention. In order to assess a child with low back pain, form a diagnosis and treatment plan, a detailed history, physical examination and review of radiographs is important. A referral to an orthopaedic surgeon or a neurosurgeon is recommended if spondylolisthesis does not respond to conservative care.

Key Features and Pearls

- Repetitive hyperextension causes stress on the pars interarticularis, which can eventually lead to a stress fracture. A bilateral pars defect allows for forward slippage of the vertebra (usually L5, S1), resulting in spondylolisthesis.
- Associated pain radiating from the low back to the thigh, buttocks and leg may present in the L5 or S1 distribution as a result of nerve root compression.

  An erect posture produces a constant downward and forward loading force on the lumbar vertebrae. The daily stresses that are put on a spine or the repeated forces being applied to the spine can wear out or degenerate it.

Editor Discussion

Spondylolysis usually refers to a stress or fatigue fracture of the pars interarticularis caused by hyperextension of the lumbar spine. Certain sports such as gymnastics or weight lifting stress the spine and have a higher incidence of this lesion. Unilateral spondylolysis is stable and is more likely to heal with conservative treatment. Bilateral spondylolysis disengages the neural arch from the body and allows the body to slip relative to the adjacent neural arch resulting in spondylolisthesis. Hyperlordosis and a horizontal sacrum increase the likelihood of slippage. Hamstring tightness is a common secondary finding. The majority of patients can be treated conservatively. Fusion and instrumentation is indicated for unstable lesions. Decompression is indicated for neural signs and symptoms. Reduction of deformity is controversial but is occasionally indicated to achieve better spine and pelvic balance. Sagittal balance of the spine is the most sensitive measure related to quality of life.

W.L. Hennrikus

Spondylolisthesis in children with normal posterior spine anatomy can occur from repetitive stress. This is what typically happens to a girl in gymnastics who repeatedly does back bends or back flips. The normal L5 pars interarticularis gets overstressed until it fractures (termed isthmic spondylolisthesis since the pars is the narrowest part of this anatomy). With loss of the posterior "tether", the L5 vertebra can slip forward. Typically, the L5 disc is healthy and so the slippage is only slight (typically called grade 1). However, some children are born with deficient bony anatomy in both the posterior pars interarticularis and surrounding tissues. Early in life there can be slippage of L5 on S1, even without the stress of athletics. These children have "dysplastic" spondylolisthesis and can present early in childhood with more severe grades of spondylolisthesis that involves changes in the disc. Low-grade dysplastic spondylolisthesis is less than 50% slippage of L5 on S1. These require continued follow-up to make sure progression of deformity is not happening. High-grade spondylolisthesis is greater than 50% forward slippage, is usually dysplastic in nature, has a high risk of deformity progression and generally requires preventive spine fusion and at least partial reduction, to prevent further slippage.

R.M. Schwend

References

1. Attiah MA, Macyszyn L, Cahill PJ. Management of spondylolysis and spondylolisthesis in the pediatric population: a review. Semin Spine Surg. 2014;26(4):230–7.
2. Mac-Thiong JM, Duong L, Parent S, Hresko MT, Dimar JR, Weidenbaum M, et al. Reliability of the spinal deformity study groups classification of lumbosacral spondylolisthesis. Spine. 2012;37(2):95–102.
3. Tsirikos AI, Garrido EG. Spondylolysis and spondylolisthesis in children and adolescents. J Bone Joint Surg Br. 2010;92(6):751–9.
4. Pizzutillo PD, Hummer CD. Nonoperative treatment for painful adolescent spondylolysis or spondylolisthesis. J Pediatr Orthop. 1989;9(5):538–40.
5. Kalichman L, Hunter DJ. Diagnosis and conservative management of degenerative lumbar spondylolisthesis. Eur Spine J. 2008;17:327–35.
6. Metzger R, Chaney S. Spondylolysis and spondylolisthesis: what the primary care provider should know. J Am Assoc Nurse Pract. 2014;26(1):5–12.
7. Frennered AK, Danielson BI, Nachemson AL, Nordwall AB. Midterm follow-up of young patients fused in situ for spondylolisthesis. Spine. 1991;16(4):409–16.
8. Fredrickson BE, Baker D, McHolick WJ, Yuan HA, Lubicky JP. The natural history of spondylolysis and spondylolisthesis. J Bone Joint Surg Am. 1984;66(5):699–707.
9. Lundine KM, Lewis SJ, Al-Aubaidi Z, Alman B, Howard AW. Patient outcomes in the operative and nonoperative management of high-grade spondylolisthesis in children. J Pediatr Orthop. 2014;34(5):483–9.