4/15/18

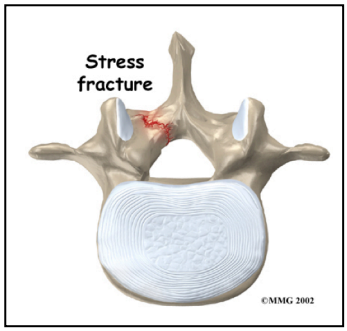
Lumbar Spondylolysis & Spondylolisthesis

Lumbar spondylo*lysis* is a unilateral or bilateral disruption (usually a stress fracture) of the narrow bridge between the upper and lower pars interarticularis. Spondylo*listhesis* occurs when one vertebra slips forward in relation to an adjacent vertebra, usually in the lowest lumbar vertebral segments (L4 or L5). Spondylolisthesis may or may not be due to a pars fracture. Although spondylolysis and spondylolisthesis are separate entities, they frequently do occur together and their management is very similar.

Symptomatic spondylolysis and spondylolisthesis are generally conditions of childhood and young adulthood.

Spondylolysis

Spondylolysis can range from a defect[1] in the pars interarticularis to a fracture[2] with separation and can be unilateral but is bilateral in 80% of symptomatic cases. (Bouras 2015) The most common location is L5 (85-95%) followed by L4 (5-15%) (Malanga 2016).



The pathological progression is a response usually to repetitive loads, which create a stress reaction in the pars, progressing to an *incomplete* stress fracture, and then a complete pars fracture. From that point, either normal healing and union will occur or there may a permanent inactive non-union filled in with fibrotic tissue. These early stages are apparent only with advanced imaging. (Leone 2011)

Spondylolysis is estimated to be present in 6-13% of the general population. Most, however, are asymptomatic. (Malanga 2016) In the young athlete, however, it has been estimated to cause as much as 47% of low back pain, compared to 5% in adult athletes (Micheli 1995). At the time of detection, it is associated with anterior translation of the vertebrae (spondylolisthesis) about 25% of the time (Malanga 2016). The slippage is usually minor with only about 11% of adolescents and 5% of adults progressing to more than 10mm of slippage. (Malanga 2016) A cross-sectional study of participants in the Framingham Heart Study (Kalichman 2009) followed an unselected group of adults aged 40 to 80 years with CT imaging and found a prevalence of lumbar spondylolysis of 11.5%. There was no significant association between spondylolysis, observed on CT and the occurrence of LBP. The authors concluded “the condition does not seem to represent a major cause of LBP in the general population.”

[1] Pars defect = occult fracture/stress reaction/stress fracture/incomplete fracture. A pars defect may progress to a true fracture of the pars interarticularis. A pars defect is not a congenital anomaly.
[2] True fracture = frank fracture/complete fracture. A fracture through both cortices of the pars interarticularis, usually due to repetitive overuse beginning as a fatigue stress fracture.

HISTORY

The provider should suspect acute spondylolysis in a teenager or young adult with low back pain, especially if he or she is active in sports that require repetitious flexion and extension hyperextension or twisting and axial load activities. (Bouras 2015) It is more common in males (2:1) and there is a positive association with older teenagers (athletes under 20 years old in 75% of cases), and in athletes who train for more than 15 hours per week. (Malanga 2016) Sports that have been implicated include gymnastics, dance, wrestling, figure skating, weight lifting (particularly standing overhead presses), swimming (especially the butterfly stroke), diving, rowing, tennis (especially serving), soccer, baseball (especially pitching), football (especially lineman) and volleyball. (Malanga 2016, Perrin 2016). Gymnastics and football are generally considered the highest risk sports. (Perrin 2016)

Like other stress fractures, the pain may come on abruptly or more insidiously over time and only related to certain activities. About half of the patients report an initiating event; symptoms in the rest come on gradually. (Shah 2011) The pain may be acute and lancinating in the initial phase and become dull and achy in the chronic presentation (Malanga 2016). Occasionally, even after the fracture has healed, it may remain "active" due to tissue changes in the healed defect that make it hypersensitive to certain loads. Severity ranges from mild to moderate. Patients often report difficulty falling to sleep due to pain (75%) and pain which is worse with sitting and with standing (75%). Unfortunately, these complaints are nonspecific and present in other competing diagnoses as well. (Grodahl 2016)
Pain associated with hyperextension in athletes is the most commonly reported history and physical finding. (Ledonio 2017)

PHYSICAL EXAMINATION

- AROM is variable. It may be completely normal, although pain is frequently aggravated by hyperextension, especially if it mimics the sporting movement that generally elicits pain. (Perrin 2015). In some patients, the pain may also be aggravated by extending from a flexed postured and rotation or lateral flexion to the side of lysis. In some cases, flexion may offer pain relief; in other cases, it may be limited by hamstring spasm. (Malanga 2016).
- Psoas may be short and tight bilaterally.
- The stork test (an orthopedic test in which the patient stands on one leg and leans back at an angle over one pars) is a classic test but one that several studies have demonstrated as having poor accuracy, failing to be very useful at ruling the condition in or out. It may have limited to use to increase suspicion of a bilateral break (when the test is positive bilaterally). (Shah 2011)
- In acute cases, focal tenderness can be elicited over the lumbar spine (Shah 2011). Otherwise, there may be no tenderness to palpation except for some discomfort with deep percussion. (Perrin 2015)
- The presence of skin dimpling over the spine suggests possible spina bifida occulta, which increases the risk for spondylolysis. (Malanga 2016)
- Neurological signs are very uncommon.

ANCILLARY STUDIES: DIAGNOSTIC IMAGING

Radiographs are the initial imaging modality of choice, but more advanced imaging may be required in a variety of circumstances. Advanced imaging is reported to detect between 32-44% pars defects in patients suspected of having spondylolysis based on history and physical exam assessment. (Ledonio 2017)

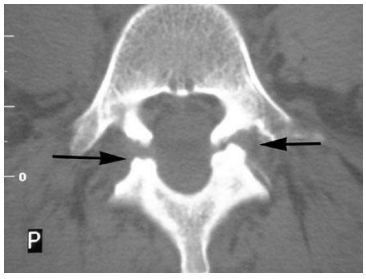
Radiography

Radiographs may reveal a fracture at the pars interarticularis, but they are often inconclusive in early cases. Sensitivity and specificity ratings for test accuracy are not readily available, although one study reported radiographs to have high specificity and poor sensitivity (Ledonio 2017) In pediatric patients, Tofte et al recommend starting with just the AP and lateral views to see if a diagnosis can be made. If these do not reveal a fracture, an AP axial lumbosacral spot view and/or oblique views should be done. If these radiographs are equivocal or appear normal but there remains a high index of suspicion, advanced imaging may be necessary to clarify the best treatment approach. The initial two view strategy exposes the patient to 7-9 times less radiation dose than bone scanning (e.g., SPECT) and approximately half of that associated with four-view plain radiography and CT) [reported in Malanga 2016].

The tests of choice if the radiograph is unclear is scanning (CT or SPECT) or an MRI. (Shah 2011, Bouras 2015). Each imaging choice has its own advantages and disadvantages.

CT

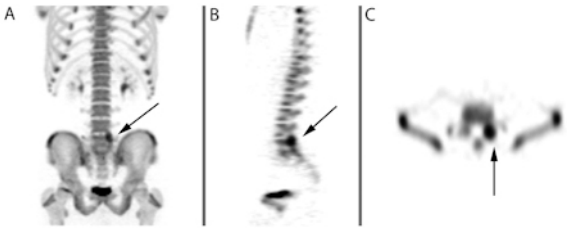
Some authorities suggest that CT is the best test for discovering an occult spondylolysis that is not readily apparent on plain film radiographs. (Dynamed 2017) Although, surprisingly, formal validation studies have not been performed (Ledonio 2017), CT scanning is generally regarded as being more sensitive for detecting defects than plain radiographs and more specific than single photon emission CT scans (SPECT). CTs provide an additional advantage of revealing other spinal pathologies (e.g., intervertebral disc pathology) that are not seen on the other radionuclide imaging studies. CT scanning may have a role in monitoring the stage of healing in a pars fracture.



One important disadvantage, especially in the pediatric population, is the high radiation exposure. Cancers induced by radiation are 3-5 times higher in children than in adults. (Ledonio 2017) CT scans cannot reliably distinguish between active (i.e., those that may be symptomatic) and inactive lesions. (Dynamed 2017)

SPECT

The single photon emission CT scan (SPECT scan) is thought to be much more sensitive for detecting the presence of a pars defect than are plain radiographs. It is currently unclear as to whether it is more sensitive than a regular CT in identifying that a defect is present. SPECT scans do carry substantial false positive and negative rates that may require further testing with CT or MRI. (Ledonio 2017) The SPECT scan is, however, reported to be the gold standard for detecting occult *active* (and therefore more likely symptomatic) spondylolysis. (ACR 2015, Ledonio 2017) The accumulation of radioactively tagged dye employed in this scan can identify an area of increased *physiological* activity in the bone, which correlates with the inflammation that occurs in the early stage of a fracture.



Therefore, SPECT can also be useful in clarifying if a fracture is actually the *cause* of the low back pain. In a study by Lowe et al., a positive bone scan correlated with the presence of LBP, whereas negative scans were not correlated with pain, thereby helping the provider differentiate a true pain generator from an otherwise incidental finding.

By assessing the results of both the plain film radiograph and the SPECT results, a practitioner can plot a course of action. See table below for examples.

Plain Radiograph	SPECT Scan	Interpretation	Management
Negative	**Negative (No dye uptake)**	Pars defect unlikely, seek other diagnosis	Further investigation of cause of back pain should be performed (e.g., MRI)
Negative	**Positive (Heavy dye uptake)**	Early pars interarticularis defect/fracture	Conservative management in form of rest, +/– bracing
Positive for fracture	**Healing (Light dye uptake)**	Spondylolysis	Conservative management in the form of rest and bracing
Positive for fracture	**Negative**	Pseudoarthrosis or old unhealed fracture	Consider surgical intervention for stabilization to prevent spondylo-listhesis and to relieve pain. Consider further investigation to rule out alternative pathology.

Modified from Malanga 2016

SPECT scans, like CT scans, also expose the patient to significant amounts of radiation. Limitations of a SPECT scan include an inability to detect fractures that have progressed to chronic nonunion. It also cannot differentiate spondylolysis from facet arthritis, infection, or neoplasm and so CT may need to follow a positive SPECT test. (Dynamed 2017)

MRI

A 2017 review of the literature reports that there is "fair" evidence that MRI may be as accurate as a CT scan and, because there is no exposure to ionizing radiation, it might be the preferred initial advanced imaging of choice (Ledonio 2017, Leone 2011, Kobayashi 2013). In addition, MRI should be considered for cases with neurological presentations (which, though uncommon, are actually more likely associated with spondylolisthesis). (Bouras 2015) MRI has been shown to be useful in detecting early edematous stress reactions of the pars articularis even when a fracture line is not visible on radiography or CT (Ledonio 2017).

MANAGEMENT

The primary objectives are pain control, preventing a pars defect from progressing to a frank fracture, and preventing slippage. Conservative care outcomes are usually good-excellent and reported to be as high as 95%. (Kurd 2007)

The treatment approach requires avoiding sports or activities that require repetitive flexion and extension and may require bracing. Dynamed (2017) reports level 3 evidence that most patients can return to sports activity in about 5.4-5.5 months.

Acute Interventions

Apply ice to the injured area for 20 minutes 3-4 times a day along with pain free ROM exercises and stretching of the hip flexors and hamstring muscles. Activity modification is recommended.

Behavioral modification advice should be given to help patients avoid hyperextension postures and activities.

Physiological rest

The first phase of treatment is for the patient to stop the activity or sport that evokes the back pain for an average of 2-4 weeks. [23, 45, 53] In particular, any activities involving hyperextension must be avoided. If plain films do not detect a frank fracture, and a defect shows only on SPECT scan and symptoms are resolving, the patient may begin to return to activities. But in cases of true fracture or if symptoms do not resolve refraining from these sports activities may be required for 3-6 months. Dynamed (2017) reports that there is midlevel evidence that stopping sports activity for ≥ 3 months is associated with better pain improvement than stopping sports for < 3 months.

Orthosis (bracing)

Bracing is a commonly recommended intervention (Dynamed 2017, Kurd 2007), but high-level evidence is lacking. A 2009 meta-analysis of children and young adults treated conservatively for spondylolysis and spondylolisthesis found that 83.9% of patients had a successful clinical outcome after at least 1 year. In these pooled results from observational trials, bracing did not seem to affect patient outcomes. (Klein 2009). No RCTs have been done to clarify the effectiveness of bracing so the decision is left up to the practitioner and patients (or parents).

Patients with only SPECT signs of an occult fracture may not require external bracing, although it remains an option. Bracing can be considered in patients who continue to have symptoms despite an initial period of rest. Additional indications for the consideration of using an external brace are presence of a true fracture, the presence of spondylolisthesis, or lack of patient compliance to activity restrictions (Malanga 2016).

RIGID BRACE

A common approach is to prescribe a rigid Boston brace to immobilize the pelvis and prevent hyperextension. If a brace is used, some authorities suggest it is more effective if applied as soon as possible. (Shah 2011) It is generally prescribed to be worn in 0° lordosis for 20-23 hours a day for approximately 3-6 months. In a 2015 study of children (ages 5-14), treatment included wearing a brace all day except at bedtime. (Leonidou 2015). The patient is slowly weaned off it as symptoms resolve even if the fracture has healed in nonunion. (Shah 2011) One protocol for the weaning process after 3 months of wear was 30 minutes of brace free time three times a day for the first day and then an additional 30 minutes added each following day for about two weeks. Patients were allowed to sleep without the brace if symptoms were not exacerbated. (Kurd 2007) A repeat bone scan is usually performed at around 3 months. (Perrin 2016)

Wearing a rigid brace is not the only bracing option. In one study, Morita et. al. studied 185 adolescents with spondylolysis and classified the pars defects into early, progressive, and terminal stages. [60] A rigid, antilordotic, modified Boston brace was applied for 23 hours per day for 6 months, followed by 6 months of weaning. This was compared to conservative management, which included the use of a conventional soft lumbar corset for 3-6 months. Follow-up radiographs showed healing without the use of a rigid brace in 73% of the patients in the early stage, in 38.5% of those in the progressive stage, and in 0% of those in the terminal stage. [60] For most of these patients, non-rigid bracing was adequate. The Sairyo et. al. study (2012) suggests that patients younger than 18 years with early defects on CT scan may be good candidates for rigid hard bracing for 3 months, owing to the high rate of union in their study. Bouras (2015) suggests that the athlete's compliance with treatment and relative rest protocol may be more important than which particular type of brace is used.

Physical Rehabilitation

Dynamed (2017) reports that there is mid-level evidence that a low back physical rehabilitation focusing on stabilizing back exercises may decrease pain intensity and functional disability in symptomatic patients with isthmic spondylolysis. The rehabilitation program is initiated after symptoms begin to resolve and the bone has had some time to recover, but it should not be delayed too long. One retrospective study (Selhorst 2016) found that adolescent athletes with acute spondylolysis who were referred to physical therapy sooner than after 10 weeks of rest, the median period for full return to activity was almost 25 days shorter than for those who waited for more than 10 weeks. And there was no statistically significant difference in the risk of adverse reactions seen between the two groups.

The exercise program is essentially the same as for treatment for spondylolisthesis; see page 11.

Spondylolisthesis

Spondylolisthesis is generally classified as congenital (dysplastic with abnormally formed L5 facets but the pars intact); isthmic/lytic (defect in pars from stress fractures or bone remodeling after a traumatic fracture; 71-94% at L5); degenerative (due to facet arthritis and remodeling); post-traumatic (damage to posterior elements as opposed to the pars); and pathological (e.g., secondary to Paget's disease). (Bouras 2015) It can sometimes also be iatrogenic post spinal fusion surgery or laminectomies. Spondylolisthesis is almost never due to trauma (Malanga 2016) and most commonly is isthmic in young patients and degenerative in older patients.

Spondylolisthesis is likely asymptomatic in most adult patients (only about 10% of adult patients with spondylolisthesis reported to have symptoms that require treatment) (Dynamed) and so an incidental finding on a radiograph may be worth charting as a complicating factor (especially by a manual therapist) but may not be relevant to the patient's symptoms.

Clinical Tip: Spondylolisthesis is an unlikely cause of back pain in adults (especially after age 40) *with no history of symptoms before age 30 years*; usually, another diagnosis must be identified (e.g., disc, strain). (Perin 2016)

There are, however, several scenarios where the spondylolisthesis may be contributing to the pain generation: 1) When associated with acute (isthmic) spondylolysis, it is usually a teenager or young adult with an overuse pars fracture at L5 (Shah 2011), 2) when the spondylolisthesis is unstable (see CSPE protocol *Lumbar Functional Instability* for signs and symptoms), 3) when it is degenerative and may be associated with spinal canal stenosis (see CSPE protocol *Lumbar Spinal Canal Stenosis*), or 4) when it is associated with radiculopathy.

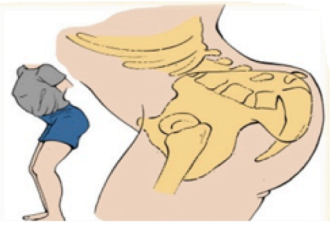
History

Slippage may present associated with acute spondylolysis or it may be chronic with pain onset occurring over months or longer.

Physical Examination

Findings are very similar to those found in spondylolysis.

- The patient may stand with increased flexion at the hips and knees (*Phalen Dickson* sign) (Shah 2011)
- Approximately 60% of patients have some degree of functional scoliosis that unusually resolves as the symptoms resolve. (Shah 2011)
- Hamstring muscle spasm is very common (estimates up to 80%) and can be significant (Perrin 2016). Spasm can cause hypolordosis and cause involuntary knee flexion during SLR (Shah 2011).



Phalen Dickson Sign

- Tenderness to deep palpation of the spinous process above the slip (typically L4) may be present. This palpation occasionally causes radicular pain. (Perrin 2016)
- Paraspinal muscle spasm and tenderness are usually present. (Perrin 2016)

- There may be a palpable step off defect (often at L4-L5 junction). In the case of dysplastic spondylolisthesis, the defect more often is at the L5-S1 junction. A step defect discovered during the physical has a reported test sensitivity ranging from 60-88% and a specificity of 87-100% in an athlete population. (Grodahl 2016) Another study reported a +LR of 4.6 in 30 patients with isthmic spondylolisthesis. (Collaer 2006)
- A supplementary physical examination finding in the elderly with instability is a positive passive leg extension test. (Peterson 2017) Both of the patient's legs are lifted to about 30 cm and gently tractioned, allowing the relaxed lumbar spine to settle into extension. A positive test is pain or feeling of heaviness in the low back that disappears when the leg is lowered. It has a reported +LR 8.8 and –LR of 0.17 in 38 patients with radiographic signs of instability. (Reiman)
- There may be segmental hypermobility detected by P-A motion palpation (Petersen 2017).

PASSIVE LEG EXTENSION TEST

Clinical Tip: In a 2017 review of the literature, Petersen suggests that the following combination of clues may be useful: intervertebral slip by inspection or palpation AND segmental hypermobility by use of manual passive physiological intervertebral motion test (especially if it is an unstable spondylolisthesis).

DEGENERATIVE SPONDYLOLISTHESIS WITH STENOSIS AND/OR INSTABILITY

Even though there is no pars fracture, the degenerative changes in this type of spondylolisthesis resulting in loss of disc height and degrading of the posterior elements result in slippage and may be unstable. It can even result in a dynamic form of stenosis.

Degenerative spondylolisthesis is more common in women than in men (5-6X) (Vibert 2006), although men demonstrate radiographic instability more frequently than women. (Simmonds 2015) (See appendix for measurements of instability.)

Degenerative spondylolisthesis seldom occurs before the 5th decade (Simmonds 2015). The most common level affected is L4 slipping over L5. Anterior translation up to 30% of the vertebral body is possible. Treatment begins with conservative care, but may need surgical stabilization.

SPONDYLOLISTHESIS AND RADICULOPATHY

Spondylolisthesis (either degenerative or with a pars break) can cause radiculopathy but is not a common cause. In most cases, patients do not complain of symptoms suggesting neurologic deficit with lower grades of spondylolisthesis. Radicular pain becomes more common with larger slips. Nerve roots can be affected by the local expansion of scar tissue in the healing defect or tractioned when there is slippage of the vertebral body. (Shah 2011)

The lower extremity presentation can be roughly divided into two scenarios. 1) pain that does not follow a precise dermatome, is position-dependent, has no motor signs and may actually more likely be

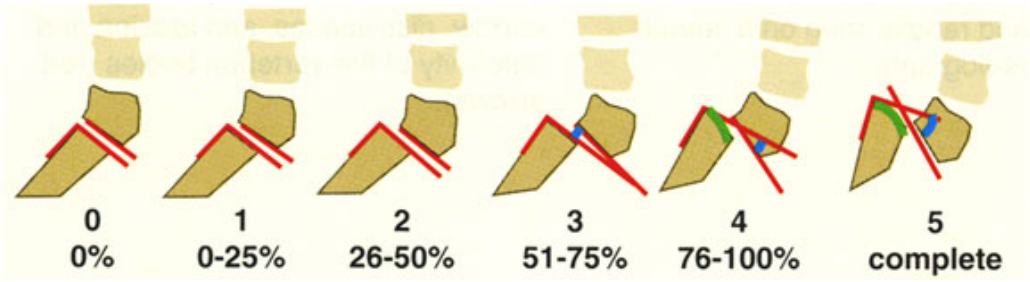
a deep referred pain phenomenon and 2) less common, classic radicular sciatic pain with neurological deficits. The nerve root compression in these cases may be due to hypertrophic fibrous or osseous tissue filling in the pars defect. (Leone 2011)

Neurological presentations, unsurprisingly, are more common in patients going to surgery. In one cohort of 111 patients with symptomatic spondylolisthesis awaiting surgery, 62% had sciatica (Möller 2000). If significant listhesis is present, radicular syndromes, though uncommon, do occur; cauda equina syndrome is even a rarer complication. (Shah 2011) Unlike in a lumbar disc herniation, the SLR is rarely positive even when the patient reports sciatica (sensitivity of 12% compared to 80-100% in disc herniations). (Möller 2000) Nerve root deficits are not common (12% in one study). The L5 nerve root is the most commonly involved, followed by the L4 nerve root in more severe cases (with weakness in the tibialis anterior muscle). (Möller 2000)

Clinical tip: When patients present with lumbar radicular signs and symptoms, spondylolisthesis does not lead the list of differentials but should be considered.

Ancillary Studies: Diagnostic Imaging

Plain film radiographs should include AP, lateral (to measure slippage), and AP axial L/S spot view and/or oblique views (to detect pars fracture). Slippage is usually measured using the Meyerding Grading System: Grade I (0% to 25% displacement), Grade II (25% to 50% displacement), Grade III (50% to 75% displacement), and Grade IV (> 75% displacement). Complete or 100% spondylolisthesis is termed spondyloptosis. Low-grade isthmic spondylolisthesis corresponds to grades I and II, or less than 50% listhesis. (Cochrane 2012)



Although MRI is not usually necessary, it should be ordered if there is evidence of a true radicular or cauda equina syndrome.

General Conservative Treatment Recommendations

Key Management Options

Physiological rest/limit offending activities
Bracing
Hamstring stretches
Spinal manipulation/flexion-distraction therapy
Lumbar stabilization program

Most patients with symptomatic spondylolisthesis and chronic LBP can be treated conservatively. (Dixit 2017) Treatment focuses on bracing, initially limiting the offending activity, pain control, and then core strengthening and restoration of ROM. (Shah 2011) Similarly to managing spondylolysis, refraining from these sports activities may be required for 3-6 months.

Oral medications such NSAIDS are commonly prescribed, but due to adverse effects should be used judiciously and avoided if possible. In some cases of chronic spondylolisthesis, weight loss may be recommended to decrease ventral load on lumbar spine (Dynamed 2017).

Orthosis (bracing)

Dynamed (2017) reports that there is level 3 evidence that back bracing leads to cessation in back pain in patients with grade 1-2 spondylolisthesis. Braces are usually worn for 3-6 months. (For more information on bracing, see p. 5.)

Manual therapy

Patients should be treated based on the totality of their findings, not the imaging. Indications of spinal joint dysfunction and myofascial pain generators should be assessed and treated accordingly, aside from acknowledging the presence the spondylolisthesis which may or may not be the pain generator. Beware of over-emphasizing the importance of the imaging to the patient.

High velocity, low amplitude manipulation can offer pain relief (Cassidy 1978). Patients with spondylolisthesis respond at a rate similar to other forms of mechanical low back pain, with an 80% success rate compared to a 77% success rate for general non-specific low back cases. (Mireau 1978) Providers, however, should be cautious of P-A thrust adjustments over the spondylolisthesis, especially if there is evidence of instability. In office stretching (e.g., CRAC) or relaxation techniques (e.g., PIR) should be performed for the hamstrings muscles and psoas muscles, as indicated.

The practitioner may find that the patient generally tolerates manipulation and patient positioning that favor flexion over extension. Examples include manipulation in side posture promoting lumbosacral flexion (e.g., sacral apex S-to-I), knee-chest stretches/mobilization, drop table adjustments, and prone treatment utilizing a flexion-biased table (e.g. Leader table).

Flexion distraction therapy can also be employed. A small flexion roll is placed under the segment that has slipped. The spinous process of the vertebra above is lifted cephalad as the table is flexed causing local distraction. Three 20-second distraction sessions are applied, each session consisting of 5-6 cycles of distraction. A typical treatment schedule for this therapy would be about 8 weeks, 3 times a week. Outcomes are more favorable in patients with stable spondylolisthesis. (Cox 2011)

Rehabilitation Program

An initial program of hamstring stretching while wearing the brace can be started. (Shah 2011, Cox 2011) Stretching hip flexors can also be incorporated as needed.

As a general rule, physical rehabilitation program should not be started until after an adequate rest period and once pain with daily activities has subsided (Perin 2016). Symptom resolution occurs in the majority of patients with low-grade slips, even if the pars defect does not heal. Exercise therapy is one of the mainstays of conservative treatment. Exercises include flexion exercises, core stabilization exercises (including pelvic tilts and abdominal trunk curls), hamstring stretching, and general aerobic exercise such as swimming and walking (Hu 2008, O'Sullivan 1997, Cochrane 2012). In a 2015 study of children, for example, exercises to strengthen the abdominal and back muscles were initiated after symptoms resolved. (Leonido 2015)

As the symptoms continue to decrease, exercises can be done without wearing a brace. Cross-training in non-extension activities can be performed, such as the stationary bike and hydrotherapy.

Low Back Stabilization Program

A comprehensive rehabilitation program would incorporate spinal stabilization exercises that help the patient in finding the neutral position of the spine (i.e., the position that produces the least amount of pain). This position is dependent on the specific individual and is determined by the pelvic and spine posture that places the least stress on the elements of the spine and supporting structures. Dynamic lumbar stabilization exercises may be used to help provide dynamic muscular control and to protect the spine from biomechanical stresses, such as tension, compression, torsion, and shear. [71]

Dynamed (2017) reports that there is mid-level evidence suggesting that stabilizing back exercises may decrease pain intensity and functional disability in symptomatic spondylolisthesis. This is based on a small RCT (N=44) where patients were enrolled in a supervised 10-week core stability program which emphasized isolated training of the deep abdominal muscles and lumbar multifidi proximal to their pars defect. It was compared to a control group managed by regular a medical practitioner, most patients performing general exercises and some getting other supervised therapy. (O'Sullivan 1997) Improvement favoring the stabilization group was clinically significant in terms of pain reduction (VAS

scores dropped to 19 vs. 48) and improved Oswestry disability scores (15 vs. 25). Differences remained significant at 30 months.

In a small case series (N=20) comprised of patients over 50 years old with degenerative spondylolisthesis a 6-month, home-based training program decreased pain from a VAS baseline of 63.5 at to 43.4 and sciatic pain from 53.7 at to 36.7 at 6-month follow-up. The program consisted of the usual basic stabilization tracks (e.g., bridge, side bride, quadruped) with an emphasis on neutral pelvis and motor control of the deep stabilizers and the diaphragm. Patients were to do the exercises daily, twice a day, 10 repetitions of each exercise. (Nava-Bringas 2014)

A small RCT reported that a rehabilitation program may also be initiated after fusion surgery and that the results appear to be better after a 12-week delay as opposed to waiting only 6-weeks. (Dynamed 2017).

(For more specific information on exercises, see CSPE protocol Low Back Rehabilitation.

Flexion exercises

Flexion-based exercise regimens (e.g., knee to chest exercises) are generally considered to be superior to extension-based exercises for pain relief for this condition (Jones 2009; Sinaki 1989)—although the evidence is actually mixed. (Samuel 2012)

Two studies (N=47 each) from the Mayo Clinic compared flexion only exercises to extension only exercises for adults with chronic spondylolisthesis The trend for improvement favored flexion only over extension only exercises at 3 months (27% still with moderate to severe pain vs. 67%) and 3 years (19% vs. 67%). There was no control group. (Gramse 1980, Sinaki 1989)

Knee to chest exercise: Performed twice daily; 6 repetitions, 4 second holds. (Cox 2011)

On the other hand, another small RCT (N=56) found that for adults bracing to maintain lordotic posture plus extension exercises had better pain scores after 1 month compared to bracing to avoid lumbar extension and flexion exercises. (Dynamed 2017)

Return to Sports

Athletes should not return to sport until pain free. Dynamed (2017) reports that "some clinicians recommend removal from athletic participation for ≥ 3 months, particularly for junior level or recreational athletes. But high-level athletes can typically return to sports once symptoms become tolerable and unlikely to affect performance."

Patients with grade 2 slippage are generally instructed to avoid hyperextension loading of the spine even after symptoms resolve with conservative treatment. (Perrin 2016)

Prognosis

The long term natural history and prognosis for spondylolisthesis and spondylolysis are favorable, and most people with these conditions are asymptomatic.

A prospective study of 500 first grade children (Beutler 2003) identified 30 subjects with pars defects. Significant progression of spondylolisthesis appears to be uncommon and rarely occurs after adolescence. During a 45 year follow up, progression of spondylolisthesis slowed with each decade, and there was no association between slip progression and low back pain. In fact, there was no statistically significant clinical difference between the study population and those of the general population of the same age.

The outcomes for conservative care appear to be favorable for both spondylolysis and low grade isthmic spondylolisthesis (grade 0-2). Good to excellent results vary but generally range from 80-90% for grades 0-1 and 66% for grade 2 (Bouras 2015, Shah 2011).

Athletes in this category usually return to full activity in 6 months even when there is non-union. (Bouras 2016) In fact, in Klein's meta-analysis of observational studies (2009) despite the high rate of clinical success, *most pars defects did not show radiographic improvement*, prompting the authors too conclude that "a successful clinical outcome does not depend on healing of the (radiographic) lesion."

The patient can return to full activity when symptoms have resolved and follow up radiographs document no further progression of the listhesis. Patients with grade 2 spondylolisthesis should continue to limit activities that require a hyperlordotic posture. Even with successful resolution of symptoms, monitoring for slippage should be continued to be monitored for slippage annually. (Shah 2011)

Surgical Interventions

A 2013 systematic review reported that four RCTs found surgical intervention to be more successful than nonoperative treatment for managing pain and functional limitation, while one RCT found no difference in future low back pain outcomes. However, the reviewers concluded that no firm conclusions could be made because of limited investigation, heterogeneity of studies, lack of control groups, and biases such as lack of blinding of assessors. (Garet 2013)

Surgery is usually reserved for patients with serious or progressive neurological deficits or neurogenic claudication secondary to instability causing a dynamic stenosis associated with high grade slippage. (Firestein 2017, Shah 2011) It can also be considered if symptoms continue for > 6-9 months despite activity restriction and bracing.

It may be appropriate to advise patients (or their parents) to seek out second opinions when surgery is being considered. One prospective observational study of 544 patients found a large discordance between first and second opinions regarding the exact diagnosis and need for spinal surgery. (Lenza 2017)

In the case of athletes, return to play following surgery varies from 6-12 months depending on the sport. (Bouras 2015)

Management of degenerative spondylolisthesis

- Only about 10-15% of patients with degenerative spondylolisthesis and stenosis ultimately undergo surgery. (Postacchini 1991)

- Absolute indications for surgical consultation are progressive neurological deficit (especially motor) and cauda equina syndrome. Relative indications for surgery include persistent radiculopathy despite conservative treatment, persistent and unremitting lower back pain for more than 6 months, loss of quality of life because of neurogenic claudication. (Vibert 2006)

- Surgery may be necessary for patients with structural instability; options include decompression only or decompression with fusion.
    - Direct surgical decompression is considered if symptoms have not responded to a trial of conservative therapy for patients with symptomatic spinal stenosis associated with low-grade (< 20% slippage) degenerative lumbar spondylolisthesis (weak recommendation). (Dynamed 2017)
    - Decompression alone with preservation of midline structures is suggested for patients with low-grade spondylolisthesis (< 20% slippage) without foraminal stenosis as this may be equivalent to decompression with fusion (Weak recommendation). (Dynamed 2017) One set of proposed (unvalidated) criteria for decompression alone are patients with dominant leg symptoms and stable motion units (based on less than 3 mm of translation on dynamic films and "restabilization" signs on radiograph such as grossly narrowed disc and no facet joint effusion on MRI).
    - Decompression with fusion is suggested over decompression alone for other patients with symptomatic spinal stenosis and degenerative lumbar spondylolisthesis (Weak recommendation). One proposed (unvalidated) criteria for decompression with fusion: translation > 3mm (especially if greater than 5 mm), few to no signs of restabilization, and the presence of facet effusion on MRI.

Primary Author: Ron LeFebvre DC

Contributors:

Owen Lynch DC
Tim Stecher DC DACBR

Reviewed by:

Stan Ewald DC, MPH, M.Ed.
Dave Panzer DC DABCO
Joseph Pfeifer DC

Edited by: Ron LeFebvre, DC

Reviewed by the Clinical Standards Protocols & Education (CSPE) Working Group (2017)

- Amanda Armington, DC
- Lorraine Ginter, DC
- Shawn Hatch, DC
- Craig Kawaoka, DC
- Ronald LeFebvre, DC
- Ryan Ondick, DC
- James Strange, DC

References

ACR Appropriateness Criteria 2015 p 8.

Beutler WJ, Fredrickson BE, Murtland A, Sweeney CA, Grant WD, Baker D. The natural history of spondylolysis and spondylolisthesis: 45-year follow-up evaluation. Spine (Phila Pa 1976). 2003 May 15;28(10):1027-35.

Bouras T, Korovessis P. Management of spondylolysis and low-grade spondylolisthesis in fine athletes. A comprehensive review. Eur. J Surg Traumatol. 2015 Jul;25 Suppl 1:S167-75. Epub 2014 Nov 14.

Cassidy JD, Porter GE. Kirkaldy-Willis WH. Manipulative management of back pain patients with spondylolisthesis. J Can Chiro Assoc 1978;22:15.

Collaer JW, McKeough DM et al. Lumbar isthmic spondylolisthesis detection with palpation: interrater reliability and concurrent criterion-related validity. J Man Manip Ther. 2006;14(1)22-29.

Cox JM. Spondylolisthesis in Cox JM Low Back Pain: Mechanisms, Diagnosis and Treatment 7th ed Lippincott Williams and Williams Philadelphia 2011

Dixit R. Low back pain in Firestein GS, Budd RC et al. Kelley & Firestein's Textbook of Rheumatology 10th edition 2017 Elsevier Philadelphia PA, pp 696-716

Garet M, Reiman MP, Mathers J, Sylvain J. Nonoperative treatment in lumbar spondylolysis and spondylolisthesis: a systematic review. Sports Health. 2013 May;5(3):225-32. doi: 10.1177/1941738113480936.

Gramse RR, Sinaki M, Istrup M. Lumbar spondylolisthesis: A rational approach to conservative treatment. Mayo Clin Proc 1980;55:681-6.

Grodahl LH, Fawcett L, Nazareth M et. al. Diagnostic utility of patient history and physical examination data to detect spondylolysis and spondylolisthesis in athletes in low back pain: a systematic review. Man Ther 2016; 24(70:7-17.

Kalichman L, Kim DH, Li L, et al. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. Spine 2009;34:199–205

Klein G, Mehlman CT, McCarty M. Nonoperative treatment of spondylolysis and grade I spondylolisthesis in children and young adults: a meta-analysis of observational studies. J Pediatr Orthop. 2009 Mar;29(2):146-56. doi: 10.1097/BPO.0b013e3181977fc5.

Kobayasshi A, Kobayashi T, Kato K et al. Diagnosis of radiographically occult lumbar spondylolysis in young athletes by magnetic resonance imaging. Am J Sports Med 2013;41(1):169-176.

Kurd MF, Patel D, Morton R et al. Nonoperative treatment of symptomatic spondylolistheses. J Spinal Disord Tech 2007;20(8):560-564.

Ledonio CGT, Burton DC, Crawford CH, et. al. Current evidence regarding diagnostic imaging methods for pediatric lumbar spondylolysis: A report from the scoliosis research society evidence-based medicine committee. Spine Deformity, 2017 9:97-101.

Lenza M, Buchbinder R, Staples MP, Dos Santos OFP, Brandt RA, Lottenberg CL, Cendoroglo M, Ferretti M. Second opinion for degenerative spinal conditions: an option or a necessity? A prospective observational study. BMC Musculoskelet Disord. 2017 Aug 17;18(1):354. doi: 10.1186/s12891-017-1712-0.

Litao A. Lumbosacral Spondylolysis. MEDSCAPE Updated: Nov 17, 2015

Lowe J, Schachner E, Hirschberg E, et al. Significance of bone scintigraphy in symptomatic spondylolysis. Spine 1984 Sep 9(6):653-5

Malanga G, Young CC et al. Pars interarticularis injury. *Medscape*, Nov 6, 2016.

Micheli LJ, Wood R. Back pain in young athletes. Significant differences from adults in causes and patterns. Arch Pediatr Adolesc Med. 1995 Jan;149(1):15-8.

Mireau D, Cassidy J, et al. A comparison of the effectiveness of spinal manipulative therapy for low back pain patients with and without spondylolisthesis. J Manipulative Physiol Ther 1987;10:49-55.

Möller H, Sundin A, Hedlund R. Symptoms, signs, and functional disability in adult spondylolisthesis. Spine 2000;25(6):683-9.

Nava-Bringas TI, Hernández-López M, Ramírez-Mora I, Coronado-Zarco R, Israel Macías-Hernández S, Cruz-Medina E, Arellano-Hernández A, León-Hernández SR. Effects of a stabilization exercise program in functionality and pain in patients with degenerative spondylolisthesis. J Back Musculoskelet Rehabil. 2014;27(1):41-6. doi: 10.3233/BMR-130417.

O'Sullivan PB, Phyty GD, Twomey LT, Allison GT. Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiologic diagnosis of spondylolysis or spondylolisthesis. Spine 1997;22:2959-67.

Perrin AE. Lumbosacral Spondylolisthesis. MEDSCAPE Updated: Feb 01, 2016

Peterson T, Laslett M, Juhl C. Clinical classification in low back pain: best-evidence diagnostic rules based on systematic reviews. BMC Musculoskeletal Disorders (2017) 18:188

Reimen MP Lumbar Spine in Orthopedic Clinical Examination. Duke University Medical Center. 2016

Postacchini F, Cinotti G, Perugia D. Degenerative lumbar spondylolisthesis II: Surgical treatment. Ital J Orthop Traumatol 1991;17:467-7.

Sairyo K, Sakai T, Yasui N, Dezawa A. Conservative treatment for pediatric lumbar spondylolysis to achieve bone healing using a hard brace: what type and how long?: Clinical article. J Neurosurg Spine. 2012 Jun. 16(6):610-4.

Samuel S, David K, et al. Fusion versus conservative management for low-grade isthmic spondylolisthesis. (Protocol) Cochrane Database of Systematic Reviews 2012, Issue 10. Art. No.: CD010150. DOI: 10.1002/14651858.CD010150.

Selhorst M, Fischer A, Graft K, et al. Timing of Physical Therapy Referral in Adolescent Athletes with Acute Spondylolysis: A Retrospective Chart Review. Clin J Sport Med. 2016 Jun 22.

Shah SA, Mahmood F, Nagraju KD, Milby AH, Spondylolysis and Spondylolistheses in Rothman-Simeone The Spine, 6th edition Elsevier Saunders Philadelphia PA 2011, pp 469-485

Simmonds AM, Rampersaud YR, et al. Defining the inherent stability of degenerative spondylolisthesis: a systematic review. J Neurosurg Spine, May 15, 2015

Sinaki M, Lutness MP, Ilstrup DM, et al. Lumbar spondylolisthesis: A retrospective comparison and three year follow up of two conservative treatment programs. Arch Phys Med Rehabili 1989;70:594-8.

Vibert BT, Sliva CD, Herkowitz HN. Treatment of instability and spondylolisthesis. Clinical Orthopedics and Related Research 2006; 44:222-7. [expert opinion]

APPENDIX I: Radiographic Instability

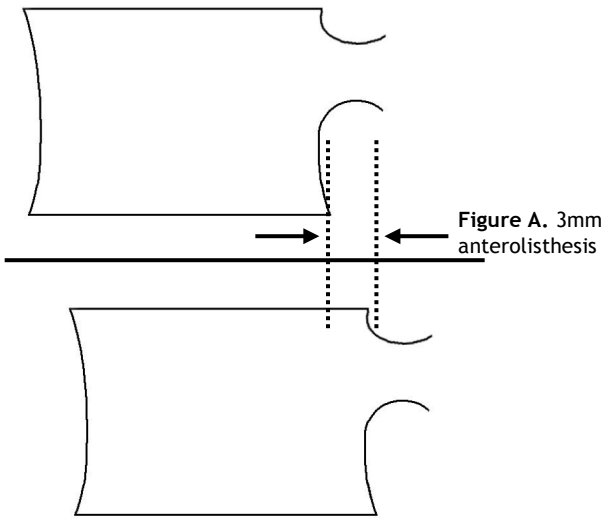


Figure A. 3mm anterolisthesis

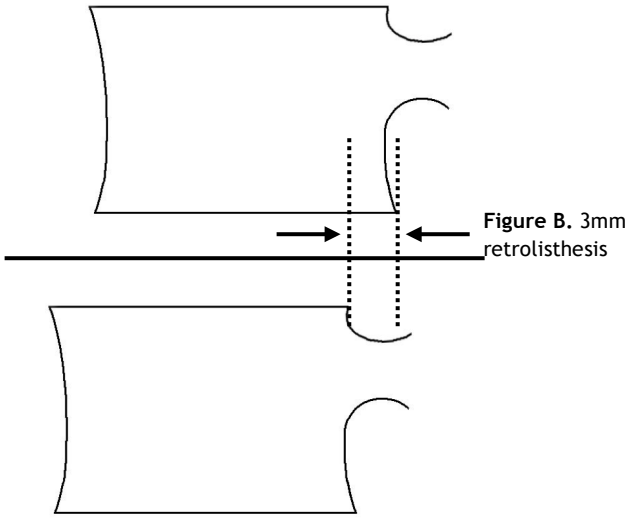


Figure B. 3mm retrolisthesis

Flexion view **Extension view**

1. The combined findings of the 2 views above (which are stress views) must represent a total sagittal translation of > 4mm to meet the standard for radiographic hypermobility.
2. A or B alone does not indicate radiographic hypermobility.
3. The criterion is met in the diagram above by adding the listhesis in the flexion and extension views yielding a total sagittal translation of 6mm.
4. This criterion could be met in other ways. For example, a 1mm anterolisthesis on neutral could become a 6mm anterolisthesis on flexion for a total of 5mm of sagittal translation. (*Not shown*)

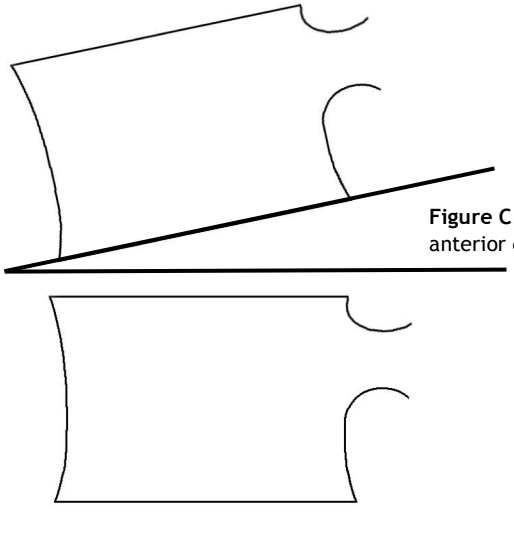


Figure C. 8 degrees of anterior disc wedging

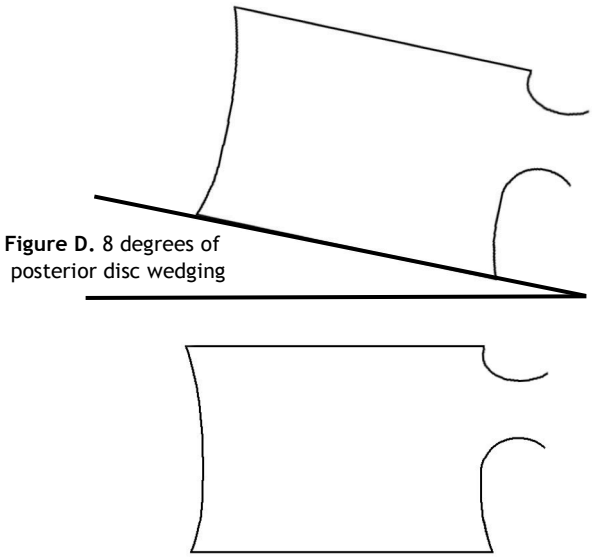


Figure D. 8 degrees of posterior disc wedging

Flexion view

Extension view

1. The combined flexion and extension findings (which would require stress views) must represent a total sagittal rotation of >10 degrees change from the neutral view to meet the standard for radiographic hypermobility
2. C or D alone does not indicate radiographic hypermobility
3. The criterion is met in the diagram above by a total sagittal rotation of 16 degrees.
4. This criterion could be met in other ways. For example, a 0 degree angle on extension could become 12 degrees of anterior wedging on flexion. (*Not shown*)

APPENDIX II: Quick Reference Table

History	• In general, lower back symptoms dominate (pain sometimes refers into buttock and posterior thigh). • Often aggravated by activity (especially lifting, weight bearing, hyper extension) and worse throughout the day. • Improved by rest and by flexion. • Rarely, radicular symptoms into lower leg; even more rarely cauda equina symptoms (with spondylolisthesis than with spondylolysis) **Spondylolysis** • Prevalence of symptomatic spondylolysis: 3-6% • Patients are typically teenagers • Pre-test probability is as high as 47% in LBP in young athletes • Pain may be lancinating in the acute phase
Physical Exam Findings	• Patient may stand with increased flexion at the hips and knees (Phalen Dickson sign), *more likely in spondylolisthesis* • A functional scoliosis is present in 60% of *spondylolisthesis* cases. • There may be a dimple in the skin over the spine, suggesting spina bifida (risk factor for *spondylolisthesis*) • AROM may be normal (but flexion may be limited if hamstrings are in spasm); sometimes flexion provides pain relief • Pain may be aggravated by hyperextension (most commonly), rotation, or lateral flexion to the side of lysis • In acute cases, focal tenderness over the lumbar spine (*more likely in spondylolysis*) • Hamstrings frequently in spasm (*especially in spondylolysis*): may cause hypolordosis and involuntary knee flexion during SLR • Psoas may be short and tight bilaterally. • Passive leg extension test may be positive (more likely in *unstable degenerative spondylolisthesis*) • In *spondylolisthesis cases*, there may be a palpable step off defect (often at L4-L5 junction). • There may be segmental hypermobility (*spondylolisthesis cases*). • Rarely, neurological deficits and SLR are positive (more likely if *significant listhesis* is present and severe)
Special Tests	• AP & lateral radiograph; AP axial L/S spot and/or obliques if necessary • MRI, CT, SPECT for occult pars fractures; and MRI if associated with neurological signs
Conservative Care Treatment Options	**Spondylolysis & initial treatment for Spondylolisthesis** • Avoid offending sports and activities that require repetitive flexion and extension for 2-3 weeks to see if symptoms resolve, but more likely 3-6 months (better outcomes associated with > 3 months). • An external brace (common but optional) worn 23 hours a day for 3-6 months. **Subacute Spondylolysis & Spondylolisthesis** • Flexion exercises (manual therapy to relax psoas) • Hamstring stretching • Spinal manipulation (sometimes positioning patients in flexion bias) • Flexion distraction therapy • Treat other joint dysfunction and soft tissue findings as appropriate • Lumbar stabilization exercises in neutral pelvis (often delayed for a few months until after brace is removed; outcomes may be better if initiated before 10 week).