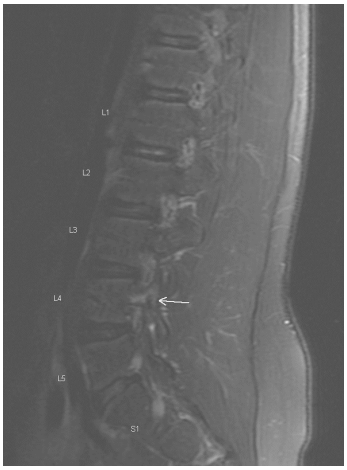
Rehabilitation Guidelines for Acute (early/progressive) Spondylolysis/Spondylolisthesis

Understanding the Injury

The lumbar spine consists of five stacked bones (vertebra). Spondyloysis (spon-dee-low-lisis) is defined as a stress fracture of the pars and can occur on the left, right or both sides of the bone (bilateral). The vast majority of these injuries are at the L5 bone, with the L4 level being the second most likely to be affected.

Spondylolysis occurs in 6-10% of the general population and has been found to be as high as 35-60% of the athletic population.(1,2) It is especially common in young athletes under the age of 16, who participate in sports that involve twisting or backward bending motions of the spine. This injury also runs in families and is more common in some population suggesting that there might be a hereditary component.

An x-ray, MRI, CT scan or bone scan can confirm the diagnosis and determine how new the injury is. The fracture line or the bony defect can be classified into various stages of acuity: early, progressive and terminal. In the early stage, bone edema might be a hairline fracture visible. In the progressive stage, the fracture may have progressed to a wider gap and in the terminal stage, the defect shows non-union, with little chance of healing. Because of this, terminal stage defects can often progress more quickly through rehabilitation. Not all lumbar stress fractures heal. If the stress fracture is only on one side of the bone (unilateral) and is detected as soon as possible (early stage), the likelihood of healing is ~70%.(3) If diagnosis and rest are delayed (progressive or terminal stage) then healing rates decrease to 28%.(3) The likelihood of healing also goes down if fractures are present bilaterally (on both the left and the right side). Eighty-five percent of athletes report good/excellent clinical outcome by year one, regardless of the fracture healing or not. (2)



MRI showing L4 pars fracture (fluid/signal to the left of the arrow)

Spondylolysis creates relative instability of the lumbar region. Rehabilitation focusing on specific training of muscles surrounding the lumbar spine that provide stability can be very effective in reducing and preventing pain and instability. These muscles are the deep abdominal muscles (transversus abdominis and internal oblique) and the lumbar multifidus. Training of these "stability" muscles in the lumbar spine provides a solid foundation for the athlete to integrate them into their sport-specific movement patterns. Exercises focusing on these muscles have been shown to significantly decrease pain and disability in people with spondylolysis/spondylolisthesis. This training effect persists for many years following only 10 weeks of practice (4).

Just like any bone fracture, stress fractures in the low back need time to heal. This means resting from all sporting and impact activities until there is little, to no pain. This usually takes 4-8 weeks but may take longer. In patients with a bilateral stress fracture, there is a rare complication where spinal alignment could be affected.
This condition is called spondylolisthesis (spon-dee-lowlis-thee-sis). If a small amount of slip occurs, research reports that it is still safe to participate in competitive sports. However, if too much slippage occurs, the bones may begin to press on nerves and orthopedic surgery may be necessary to correct the condition.

Treatment Options

The recommended treatment program for spondylolysis is usually a combination of the following:

- For acute or progressive spondys = rest/protection for the first 4 weeks, possibly longer: no sports participation, no physical education class, reduce backpack weight and avoid sleeping on your stomach (5)
- For chronic spondys = a brief period of activity reduction prior to starting stabilization exercises (5)
- Pain medications as needed/ recommended by your physician
- In addition to a calcium-rich diet, vitamin D is essential for bone health. Your provider may test your vitamin D level and if it is low, suggest that you take a vitamin D supplement. Research shows that vitamin D deficiency likely exists in orthopaedic trauma patients living in northern latitudes.(7) In Nebraska, over 60% of adolescents with spondylolysis were found to have low vitamin D levels.(8)

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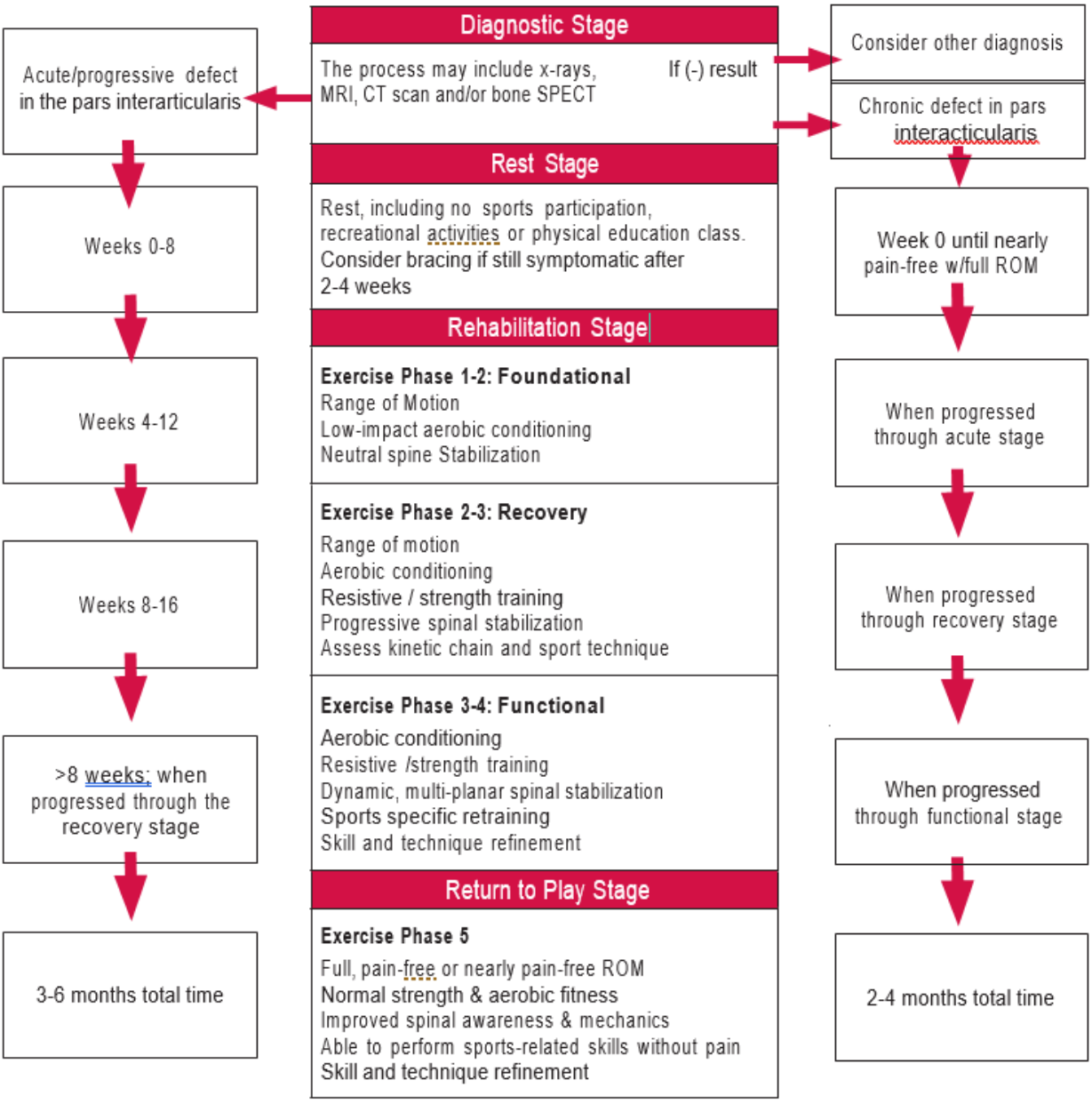
- Rehabilitation under the guidance of a physical therapist or athletic trainer.

Corrective exercise training is emphasized- beginning with gentle upper and lower body stretching and progressing to an individualized core strengthening routine that gradually builds over time.

- For most people a brace is not needed for this condition. Clinical outcome of patients treated with a brace to patients treated without a brace was not significantly different.(6) However, if 2-4 weeks of rest/activity restriction alone do not reduce the pain, then a brace may be beneficial.
- On rare occasions, orthopedic surgery should be considered when symptoms persist, there are associated nerve complications or there is a progressive slippage of the bone. In these cases, surgery can provide additional stabilization to the area.

Rehabilitation Timeline: Phases of the Exercise Progression

Stage	Rest/ Protection	Rehabilitation *Foundational*	Rehabilitation *Recovery*	Rehabilitation *Functional*	Return to Sport	Total Time to Return to Sport
Exercise Phase	1	2	3	4	5	
Emphasis	Rest/protection, Core initiation, Abdominal bracing	Static stabilization	Dynamic stabilization and coordination	Athletic enhancement and gradual return to activity	Development of maintenance exercise routine	
Duration	4-8 weeks	+1 - 4 weeks	+ 2 - 4 weeks	+ 2 - 6 weeks	Return to sport	2-6 months


Diagnostic Stage
The process may include x-rays, MRI, CT scan and/or bone SPECT
If (-) result
Consider other diagnosis
Chronic defect in pars interacticularis
Acute/progressive defect in the pars interarticularis
Rest Stage
Rest, including no sports participation, recreational activities or physical education class. Consider bracing if still symptomatic after 2-4 weeks
Rehabilitation Stage
Exercise Phase 1-2: Foundational
Range of Motion
Low-impact aerobic conditioning
Neutral spine Stabilization
Exercise Phase 2-3: Recovery
Range of motion
Aerobic conditioning
Resistive / strength training
Progressive spinal stabilization
Assess kinetic chain and sport technique
Exercise Phase 3-4: Functional
Aerobic conditioning
Resistive /strength training
Dynamic, multi-planar spinal stabilization
Sports specific retraining
Skill and technique refinement
Return to Play Stage
Exercise Phase 5
Full, pain-free or nearly pain-free ROM
Normal strength & aerobic fitness
Improved spinal awareness & mechanics
Able to perform sports-related skills without pain
Skill and technique refinement
Week 0 until nearly pain-free w/full ROM
When progressed through acute stage
When progressed through recovery stage
When progressed through functional stage
2-4 months total time
Weeks 0-8
Weeks 4-12
Weeks 8-16
>8 weeks; when progressed through the recovery stage
3-6 months total time

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PHASE 1 Rest & Protection, Core Initiation, Abdominal Bracing: begins on the first day of complete rest (Day #0) and continues for 4-8 weeks, depending on your progress. To promote proper healing of the stress fracture(s) it is important to rest completely and for the entire length of time recommended by your health care professional.

Appointments	• First rehabilitation appointment should be within 1-2 weeks of diagnosis, every 1-2 weeks thereafter
Rehabilitation Goals	• Allow sufficient time for healing to occur, hold all sports participation, protect the area • Pain-free with daily activities • Initiate deep abdominal stabilization recruitment • Gradually increase flexibility of key upper/lower body muscles
Precautions	• No active or passive lumbar extension ROM • Consider bracing if still symptomatic after 2-4 weeks rest
Suggested Therapeutic Exercises	• Abdominal bracing in various postures (supine, prone over pillow, 4 point, kneeling, standing) • Stretching exercises for key UE/LE muscles with emphasis on neutral spine alignment and in non-weightbearing postures • Supine 90-90 active knee extension hamstring stretch • Child's pose latissimus dorsi stretch • Supine pectoralis stretching in 90-90 shoulder position • Supine or side-lying hip flexor & quad stretching • Supine figure 4 piriformis stretching
Cardiovascular	• Light stationary biking

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PHASE 2 Static Stabilization: begins after the necessary 4-8 weeks of rest required to achieve significant pain reduction. It usually takes 1-3 weeks to master the foundational movement patterns in phase 2, depending on the individual.

Appointments	• Every 7-10 days
Rehabilitation Goals	• Maintain pain free (or nearly pain free) range of motion • Pain free with daily activities • Increase abdominal and core strength • Ensure normal hip and thoracic mobility • Progress flexibility and lumbar stabilization to weight-bearing postures • Improve pelvic proprioception • Maintain/ Increase flexibility in key upper/lower body muscles • Re-establish aerobic fitness
Precautions	• No active or passive lumbar extension ROM
Suggested Therapeutic Exercises	• Crunches • Double leg bridges • 4 point alternate arm or leg raises • Side lying hip abduction or clam shells • Side Planks • Upright rows with abdominal bracing in sitting • Sitting on Swiss ball, alternate lifting an arm or leg
Cardiovascular Exercise	• Light -moderate stationary biking • Deep water jogging in pool with floatation vest
Progression Criteria	• Noticeable increase in abdominal strength • Can accomplish full and pain free lumbar flexion and lateral flexion range of motion • Ability to hold bridge and side plank for 30 seconds without pain • Ability to maintain neutral spine posture during dynamic arm or leg ROM

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PHASE 3 Dynamic Trunk Stabilization & Coordination: can be initiated when the goals of phase 2 are met. On average, this will begin ~2-3 months from Day #0. It usually takes 2-4 weeks to achieve the goals in this phase, depending on the individual.

Appointments	• Every 1-2 weeks
Rehabilitation Goals	• Continue increase in abdominal strength • Eliminate muscle flexibility imbalances and ensure normal joint mobility: hip and thoracic spine • Resume lumbar extension in non-weightbearing postures • Progress aerobic fitness • Begin sport specific drills to prepare for return to sports participation
Precautions	• Avoid prolonged back pain with initiation of lumbar extension AROM
Suggested Therapeutic Exercises	• Single leg bridges • Oblique trunk rotation in hook lying (progress to med ball) • Supine hamstring curls on Swiss ball • Squats emphasizing hip hinge and overhead reach • Push- ups • Multi-planar strength progression, including forward, lateral and diagonal lunges • Dynamic control exercise beginning with low velocity, single plane activities and progressing to higher velocity, multi-plane activities • Sport/work specific balance and proprioceptive drills • Stretching for patient specific muscle imbalances • OK to resume upper body weightlifting with spine neutral
Cardiovascular	• Moderate intensity stationary biking or elliptical machine • Shallow water jogging and jumping drills in pool (immersed to chest depth)
Progression Criteria	• No increase in pain with lumbar range of motion and sport skills • Physician collaboration

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PHASE 4 Athletic Enhancement and Return to Activity: when the goals of phase 3 are met, you can initiate this phase. It usually takes 2-4 weeks to achieve the goals depending on the individual. This phase takes into account the unique demands of the sport: progresses into impact loading through running and jumping, provide sport-specificexercises and leads to the development of a maintenance program.

Appointments	• Every 1-2 weeks
Rehabilitation Goals	• Maintain flexibility in key muscle groups • Maintain strength in abdominals and hip muscles • Initiate lumbar extension AROM if necessary for sport • Initiate impact loading of the spine including jogging, running, jumping/landing
Suggested Therapeutic Exercises	• In stance, Diagonal #1 and #2 trunk rotation patterns with medicine ball (wood chops) • Lunges (forward, backward, side) with dumbbells or medicine ball • Body weight suspension exercises (such as TRX) • Progression to Impact Loading (see Addendum A) • Gradual exposure to sport-specific activities and drills, making sure to concentrate on spine stability
Impact Loading Progression	• Impact control exercises, starting in one plane before multi-plane, beginning 2 feet to 2 feet, progressing toward 1 foot to the other foot (bounding) then to single leg (hop) • Initiate return to running progression once patient shows good single leg control and tolerance to bounding • Monitor landing forces to create a gradual progression, manipulating the amplitude, velocity and external force as necessary.
Cardiovascular	• Moderate-high intensity intervals with stationary biking • Initiate Impact Loading on land (see Addendum A)
Progression Criteria	• Successful completion of a comprehensive exercise program • Be able to demonstrate sport-specific skills and practice drills without pain. This depends on the sport; and may include intervals of sprinting and pivoting; jumping and landing, back hyperextension and/or twisting.

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PHASE 5 Independent Exercise Program and Re-injury Prevention Program: At this point you are cleared to participate in your athletics. Your physical therapist or athletic trainer will provide you with specific exercises that will aim to enhance your athletic performanceand may help to prevent future injuries. Depending on the extent of your injury, you may need to continue to avoid certain weightlifting moves such and Olympic style squats and deadlifts.

Rehabilitation Guidelines for Chronic Spondylolysis/Spondylolisthesis

PHASE 1 Dynamic Trunk Stabilization & Coordination: In chronic cases true boney healing is very unlikely, thus there is no complete rest or bracing to initiate the rehabilitation process. The process starts with creating better control and protection of the spine based on the muscles of core and hips, as well as coordination of movement patterns.

Appointments	• Every 1-2 weeks
Rehabilitation Goals	• Increase in abdominal/core strength • Eliminate muscle flexibility imbalances and ensure normal joint mobility: hip and thoracic spine • Start lumbar extension in non-weightbearing postures that are painfree • Program aerobic fitness • Modify sports participation and weightlifting to decrease pain and compensatory movement patterns
Precautions	• Avoid prolonged back pain with lumbar extension AROM

Suggested Therapeutic Exercises	• Single leg bridges • Oblique trunk rotation in hook lying (progress to med ball) • Supine hamstring curls on Swiss ball • Squats emphasizing hip hinge and overhead reach • Push- ups • Multi-planar strength progression, including forward, lateral and diagonal lunges • Dynamic control exercise beginning with low velocity, single plane activities and progressing to higher velocity, multi-plane activities • Sport/work specific balance and proprioceptive drills • Stretching for patient specific muscle imbalances • OK to resume upper body weightlifting with spine neutral
Cardiovascular	• Moderate intensity stationary biking or elliptical machine (avoid long asymmetrical striding or high impact that can provoke symptoms)
Progression Criteria	• No increase in pain with lumbar range of motion and modified sport skills

PHASE 2 Athletic Enhancement and Return to Activity: when the goals of phase 1 are met, you can initiate this phase. This phase takes into account the unique demands of the sport: progresses into impact loading through running and jumping, provide sport-specific exercises and leads to the development of a maintenance program.

Appointments	• Every 1-2 weeks, as needed
Rehabilitation Goals	• Maintain flexibility in key muscle groups • Maintain strength in abdominals and hip muscles • Initiate impact loading of the spine including jogging, running, jumping/landing

Suggested Therapeutic Exercises	• In stance, Diagonal #1 and #2 trunk rotation patterns with medicine ball (wood chops) • Lunges (forward, backward, side) with dumbbells or medicine ball • Body weight suspension exercises (such as TRX) • Progression to Impact Loading (see Addendum A) • Gradual exposure to sport-specific activities and drills, making sure to concentrate on spine stability
Impact Loading Progression	• Impact control exercises, starting in one plane before multi-plane, beginning 2 feet to 2 feet, progressing toward 1 foot to the other foot (bounding) then to single leg (hop) • Initiate return to running progression once patient shows good single leg control and tolerance to bounding • Monitor landing forces to create a gradual progression, manipulating the amplitude, velocity and external force as necessary.
Cardiovascular	• Moderate-high intensity intervals with stationary biking • Initiate Impact Loading on land (see Addendum A)
Progression Criteria	• Successful completion of a comprehensive exercise program • Be able to demonstrate sport-specific skills and practice drills without pain. This depends on the sport; and may include intervals of sprinting and pivoting; jumping and landing, back hyperextension and/or twisting.

PHASE 3 Independent Exercise Program and Re-injury Prevention Program: At this point you are cleared to participate in your athletics. Your physical therapist or athletic trainer will provide you with specific exercises that will aim to enhance your athletic performance and may help to prevent future injuries. Depending on the extent of your injury, you may need to continue to avoid certain weightlifting moves such and Olympic style squats and deadlifts.

Addendum A

This portion of the rehabilitationis designed to allow the athlete to gradually load the spine for a safe return to sport. It should be used with a with a specific rehabilitation program from your physical therapist or athletic trainer. The athlete should be able to complete the entire program before return to sport is allowed. Before doing the program each day, the athlete should warm up with 10-15 minutes of low impact activities such as stationary biking. The athlete can progress to the next level when the previous level has been completed without pain or apprehension. The athlete should rest every third day. Your provider may modify this routine to fit the specific athletic demands of the sport. For example, a long-distance runner, a basketball player and a gymnast will all have different impact loading requirements.

JOGGING	RUNNING	JUMPING / LANDING
Jog 10 minutes at ½ speed	6 x 40 yards at ¾ speed	5 x 5 reps hop in place
Jog 15 minutes at ½ speed	10 x 40 yards at ¾ speed	5 x 10 reps hop in place
Jog for 20 minutes at ½ speed	6 x 40 yards at full speed	2 x 1 minute jump roping
Jog 10 min at usual pace	10 x 40 yards at full speed	4 x 1 minute jump roping
Jog 12 min	6 x 40 yards at ¾- full speed with cutting/ pivoting every 5 yards	6 x 1 min jump roping
Jog 15 min	10 x 40 yards at full speed with cutting/ pivoting every 5 yards	5 x 5 reps vertical jump squats 3 x 20 sec multidirectional single foot hopping
Jog 20 min	10 min sport specific drills: Such as carioca, side shuffle, retro running, skipping 6 x 30 second fast-paced intervals	5 x 8 reps vertical jump squats 3 x 30 sec multidirectional single foot hopping
Jog 25 min	20 min sport specific drills: Such as carioca, side shuffle, retro running, skipping 6 x 45 second fast-paced intervals	5 x 8 multidirectional jump squats
Jog 30 min	30 min sport specific drills: Such as carioca, side shuffle, retro running, skipping 6 x 60 second fast-paced intervals	5 x 8 multidirectional single leg leaping/ bounding Burpees

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REFERENCES

1. Herman MJ, Pizzutillo PD, Cavalier R. Spondylolysis and spondylolisthesis in the child and adolescent athlete. Orthop Clin North Am. 2003 Jul;34(3):461-
2. Iwamoto J, YSato, T Takeda, and H Matsumoto. Return to sports activity by athletes after treatment of Spondylolysis. World J Orthop 2010 November 18; 1(1): 26-30.
3. Fujii K, Katoh S, Sairyo K, et al. Union of defects in the pars interarticularis of the lumbar spine in children and adolescents. The radiological outcome after conservative treatment. J Bone Joint Surg Br 2004:86;225-31.
4. 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 (Phila Pa 1976). 1997 Dec 15;22(24):2959- 67.

5. Standaert CJ. New Strategies in the Management of Low Back Injuries in Gymnasts. Current sports medicine reports, 2002, Vol.1(5), p.293-300
6. 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.
7. Bee CR, Sheerin DV, Wuest TK, Fitzpatrick DC. Serum vitamin D levels in orthopaedic trauma patients living in the northwestern United States. J Orthop Trauma. 2013 May;27(5):e103-6.
8. McClellan JW, Vernon BA, White MA, Stamm S, Ryschon KL. Should 25-hydroxyvitamin D and bone density using DXA be tested in adolescents with lumbar stress fractures of the pars interarticularis? J Spinal Disord Tech. 2012 Dec;25(8):426-8.