**Spondylolysis and the Aesthetic Athlete**

# WEBSITE CONTENT

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# Spondylolysis and the Aesthetic Athlete

**Subheading**

**Spondylolysis** can lead to low back pain and nerve irritation. **Motor control exercise** can be added to practices to reduce complications so **YOU** can get back to practicing, competing and living.

## About

### Mission

To educate **female aesthetic athletes** of their risk of **spondylolysis.**
**Empower** them to take preventative action in a partnership with their support networks.
And understand the possible role of **motor control exercise** in managing or preventing lower back pain due to spondylolysis.

### Authors

**Siobhán Kibbey** I am a B.S. student and McNair Scholar at the University of South Carolina Arnold School of Public Health and South Carolina Honors College. I competed in trampoline and tumbling gymnastics, diving, and tennis in high school.

### History

As a trampoline and tumbling gymnast and diver, many of my teammates and I spent a large portion of our athletic careers fighting lower back pain. For the most part, we were underweight, hyperlordotic, flexible, and strong individuals bothered more by the performance and practice reductions brought on by our lower back than the moment-to-moment pain exacerbated by handsprings, loaded take-offs, and other hyperextension skills.

Given the statistics I encountered in my research, it appears more than likely that a significant percentage of us were suffering from spondylolysis. Spondylolysis is a stress fatigue defect of the pars interarticularis correlated with clinical instability, mechanical lower back pain, and sciatica. This condition is present in ~ **1 in 5 aesthetic athletes** -- athletes participating in strongly appearance-contingent sports such as diving, gymnastics, skating, and dancing.

I was deeply concerned by how many people are affected by this condition, which I had never heard of and could hardly pronounce (it's spon-dee-LO-ly-sis). Furthermore, it was very hard to decipher which interventions were relevant and evidence-based. Consequently, I dedicated my senior thesis to understanding this condition and to form an accessible resource (this website) for others to understand what it was, what they could do, and the stance of the current literature.

I hope that my website can serve as a useful starting point for an open dialogue between the athlete and his or her support network to take prevention-oriented steps. I also hope that this website can provide a source of empowerment by clearly explaining this condition and what peer-reviewed scientific research says about exercise therapy.

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**Disclaimers**

This site is intended to complement and not replace any advice or information from a medical or health professional.

The opinions expressed in this site are solely of the author, Siobhán Kibbey. They do not reflect the opinions or stands of any of the mentioned institutions or persons, including those at the University of South Carolina.

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## Spondylolysis: Introduction

### What is spondylolysis?

Spondylolysis (spon'di-lol'i-sis) derives from the Greek words "spondulos," meaning vertebra, and "lusis," meaning loosening or unbinding. It describes a condition where there is a bony defect or **fracture** in the **pars interarticularis** (literally the part between the [facet] joints) of the vertebral arch **of the spine** (see below). Spondylolysis has been found in approximately one-half of all young athlete patients complaining of low back pain (98) and it is considered by many clinicians to be the **most common cause of low back pain in adolescent patients** (43).

### What is NOT spondylolysis?

Spondylolysis is NOT spondylosis or spondylolisthesis. **Spondylosis** is an age-related condition of bony overgrowths on vertebrae; it is usually asymptomatic. **Spondylolisthesis** can result when bilateral spondylolysis allows the vertebra to slip forward from one another. After adolescence, only a small portion of spondylolysis cases (15%) progress to spondylolisthesis (109). Although there are similarities between the two conditions, **all of the research** presented in this website is intended to address cases of **spondylolysis and NOT spondylolisthesis.**

### Who are aesthetic athletes?

Aesthetic athletes are athletes who participate in sports where their performance is explicitly contingent upon appearance. Most notably, these are: **gymnastics, diving, skating,** and **dancing**. Spondylolysis is **three to ten times more common** in aesthetic athletes than the general population (98). Roughly **two-thirds of these cases** will present with **lower back pain** and/or **sciatica** (see Signs and Symptoms, below, 98). Aesthetic sports involve **repetitive hyperextension** and **rotation** of the lower (lumbar) spine, which makes it more susceptible to spinal injury (98).

### Tell me about the spine!

The spine provides the structural framework for humans to achieve upright posture and motion. It is usually divided into its four primary curves: the cervical (concave), thoracic (convex), lumbar (concave), and sacral/coccyx (convex) curvatures, described in descending location.

The lumbar (lower) spine has five vertebrae. Each of these vertebrae is separated by intervertebral discs that cushion the bodies. Behind each of the vertebral bodies is a bony ring (lamina) that forms a hole (neural foramen) to protect our spinal cord, adjacent blood supply, and exiting and entering nerves. The bony ring also has seven main processes. These are:

(1) The spinous process, which extends backwards, can be seen as superficial “bumps” running down the back, and forms the site for muscle attachments.
(2-3) The left and right transverse processes, which extend sideways and form the site for muscle attachments.
(4-7) The left and right inferior and superior articular processes, which connect vertebrae to one another by forming synovial facet joints by the articulation (meeting) of the inferior and superior articular processes of an upper and lower vertebra, respectively.

Spine defects usually occur in the **L5 or L4 vertebra** (60), which are the lowest two vertebrae of the lumbar spine. When both sides of the pars interarticularis are fractured (a bilateral defect), the inferior articular processes, lamina, and spinous process are physically separated from the superior articular process, pedicles, transverse process, and vertebral body. A weak fibrous connection forms at the site of defect. This weak soft tissue connection may be sufficient for healing (102). It also, however, brings additional nerve elements that increase pain as a method of monitoring stability to protect the spine (36).

**Fun Fact:** In a lumbar oblique x-ray, spondylolysis classically presents as a “Scotty Dog” collar. The pars defect appears as a collar on the neck (pars interarticularis) of a scotty dog. The scotty dog is formed by the outline of the superior articular process (ear), pedicle (eye/head), transverse process (nose), lamina (body), spinous process (body/tail), and inferior articular processes (legs).

## Spondylolysis: Symptoms & More

### Signs & Symptoms

The most common symptom of spondylolysis is **localized low back pain** (58). Athletes describe the pain using words like "**chronic**," "**dull**," "**achy**," "**recurrent**," "**constant**," or "**catching**" (44, 69). Usually, the pain worsens with activity, especially during hyperextension or activity mimicking sport movements (58). In gymnastics, walkovers, handsprings, rebounds, punching skills, dismount landings, and back twists have been reported to worsen pain (53). Although not yet reported in peer-reviewed research, similar loadings in other sports may also produce pain. Divers, for example may feel more pain during unaligned water entries and forward, inward, and back twisting skills.

The second most common symptom of spondylolysis is **sciatica** of the L5 or L4 nerve root (22). The majority will not experience nerve irritation, but those who do may feel **pain**, **numbness**, or "**pins and needles**" sensation in the areas (dermatome) with which the nerve connects. For example, if the L5 nerve root is affected, one may feel tingling along the leg from the outside of the knee down the shin and across to the big toe. If the L4 nerve root is affected, there may be symptoms radiating across the front upper leg (outside to inside), and down the inside of the shin or calf.

### Red Flags

In a clinical examination, "**Red flags**" indicating a more serious diagnosis must be ruled out. In the younger population, especially:
Any history of cancer, night pain, pain at rest, unexplained weight loss, or failure to improve (metastatic cancer flags);
Immunosuppression, prolonged high fever, or history of IV drug abuse, recent urinal tract infection, cellulitis or pneumonia (diskitis or osteomyelitis flags);
Recent major trauma or prolonged use of corticosteroids (vertebral fracture flags);
And pulsating mass in the abdomen, throbbing resting back pain, or history of artherosclerotic vascular disease (abdominal aortic aneurysm flags) (7).

### Diagnosis

After taking a history, a doctor will usually perform a physical examination. People with spondylolysis often have tenderness above the defect, muscle spasm, hamstring tightness, and relatively limited range of motion with back extension and single leg hyperextension.

Spondylolysis symptoms may appear similar to other low back causes, so X-rays can be taken to confirm presence of the lower vertebrae pars defect of spondylolysis. Single-photon emissions

computed tomography (SPECT), computed tomography (CT), and magnetic resonance imaging (MRI) may also be used to detect smaller defects, visualize surrounding soft tissue, or provide a more accurate staging of the spondylolysis (51). Spinal abnormalities are relatively common, however, and the presence of an abnormality does not necessarily mean that the defect is causing the low back pain.

**Prognosis**

Over 80% of children non-surgically treated will recover within six months of treatment onset (42). Bony healing estimates propose that 75-100% of acute lesions heal, 50% of bilateral acute lesions (fracture on both pars interarticularis sides) heal, and no chronic defects heal, though fibrous union may be acceptable for recovery (42).

## Exercise Therapy: What is MCE?

### What is MCE?

Motor control exercise (MCE) incorporates **general trunk-focused strengthening exercises**, **whole-body movements**, and **trunk and hip stretching** in order to increase spinal stability. It is also known as lumbar stabilization exercise dynamic stabilization, neuromuscular training, neutral spine control, muscular fusion, trunk stabilization, and (segmental) stabilizing exercise.

### What are the other treatments?

Currently, the main treatment approaches considered by clinicians for chronic lower back pain due to spondylolysis are (1) minimal intervention, (2) spinal manipulative therapy, (3) general aerobic exercise, (4) motor control exercise, and (5) surgical interventions.

**Spinal manipulative therapy (SMT)** and **general aerobic exercise** can be combined with MCE to increase treatment effects (5, 15, 52, 63). SMT is "hands-on" mobilization and manipulations of spinal muscles by a chiropractor, physical therapist, or orthomanual therapist. **Surgery** is not recommended until after trying aggressive non-surgical treatments and bracing with and without sport participation (54, 73).

### What does the evidence say?

High quality evidence comparing MCE to other interventions in chronic lower back pain cases indicates that:

- MCE reduces **pain and disability** more than **minimal intervention** in chronic lower back pain cases (13, 19, 31, 96).
- MCE reduces **pain and disability** more than **general exercise** in chronic lower back pain cases (2, 20, 23, 25, 64, 104).
- MCE reduces **disability** more than **SMT**.
- MCE and **SMT** reduce intermediate and long-term **pain equally** (2, 23, 31, 82).
- **SMT** reduces **short-term pain** slightly more than MCE (5).

MCE interventions do not need to be exclusive. Moderate quality evidence **supports MCE** with **general exercise** (15, 52) and **SMT** (5, 63).

One high quality trial (69) found that MCE is particularly effective for spondylolysis cases over non-specific chronic low back pain cases.

Low quality evidence indicates that preseason MCE training sessions decrease lower back pain incidence and pain severity later in the season (21, 34). This evidence is promising support that MCE could serve as an effective prevention strategy.

Find the exercises **HERE**.

See more treatment recommendations in **Extra Tips & Tricks**.

## Exercise Therapy: How Does MCE Work?

**How does MCE work?**

People with spondylolysis have **clinical instability** at their defect site. **Clinical instability is correlated with symptom severity** (26, 27, 28). MCE works by **strengthening the spine's stability system** so that it can reduce clinical instability and thus symptoms. Hypothetically, then, MCE could be used preventatively to increase spinal stability before high-risk activities. Currently, though, there are not any published studies confirming this.

**How does the spine normally stabilize itself?**

In 1992, Panjabi (78, 79) created a model where three subsystems prevent clinical instability.
(1) The **control (neural)** subsystem of the spine feedback systems. Monitors forces on the spine and submits information to the active subsystem.
(2) The **passive (osseoligamentous)** subsystem of the spinal column. Provides structural foundation for neural and active subsystem to act upon.
(3) The **active (musculotendenous)** subsystem of the spinal muscles and tendons, which are grouped into **global** and **local muscles**. Global muscles are large torque muscles that do not directly attach to the spine. Local muscles are directly attached and provide segmental stability (10). Without the active subsystem, the lumbar passive subsystem can only withstand 90 N (9 kg) before buckling.

**What about during practice?**

Typical gymnastics skills create dramatically higher compression loads, from 4 times body weight in skill take-off **to 30 times body weight in landing** (roughly 2200-17,000 N for a 125 lb gymnast) (14, 53). Alternately, the elite diver has been reported to experience 2000 – 3300 Nm torque in the lower back upon water entry from 0 to 10° offset entry pitch angle, with torque increasing with pitch angle (35).

Consequently, it is very important for aesthetic athletes, especially those with clinical instability, to have **strong active subsystems.** MCE can strengthen the local system and provide the segmental stability for the global muscles to further act upon.

**Where can I learn more?**

If you would like to learn more about the rationale of MCE, you can read this paper (below), along with a full explanation of this project.

**Exercise Therapy: The Exercises!**

**BASIC ADIM**

First, you must learn to perform the basic **abdominal drawing-in maneuver (ADIM)** in **quadruped**, **standing**, and **supine** positions. Following exhalation, tighten your abdominal muscle and draw the belly button up towards the spine or rib cage, without flexing or extending your spine (maintain a neutral lumbar spine).

Practice holding the contraction for **8 seconds** in each position, **30 repetitions** each.

**THE EXERCISES**

**(1) 20x SUPINE ADIM + HEEL SLIDE (each leg)** • Starting in a hook-lying position, feet flat on the supporting surface, perform the supine ADIM and slide 1 heel on the supporting surface until the knee is straight. HOLD this for 4 seconds, then return to start. Alternate legs and repeat.

**(2) 20x SUPINE ADIM + LEG LIFT (each leg)** • Perform a supine ADIM and raise one foot 10 cm above the ground. HOLD this for 4 seconds, then return to start. Alternate legs and repeat.

**(3) 30x SUPINE ADIM + 2-LEG BRIDGE** • Perform a supine ADIM and raise butt above ground. HOLD this for 8 seconds, then return to start. Repeat.

**(4) 30x SUPINE ADIM + 1-LEG BRIDGE (each leg)** • Starting in a hook-lying position, feet flat on the support surface, perform the supine ADIM, straighten 1 knee, and raise the butt above ground. HOLD this for 8 seconds, then lower butt to ground, and return to start. Alternate legs and repeat.

**(5) 30x SUPINE ADIM + CURL-UP, ELBOWS RESTING ON SURFACE** • Starting in a supine position with one leg straight, one leg bent, and elbows resting on surface; place both hands under the lumbar spine in a neutral pelvic and lumbar position. Perform a supine ADIM and raise head and shoulders off the table. HOLD this for 8 seconds, then return to start. Repeat.

**(6) 30x SUPINE ADIM + CURL-UP, ELBOWS HELD ABOVE SURFACE** • Starting in a supine position with one leg straight, one leg bent, and elbows above surface; place both hands under the lumbar spine in a neutral pelvic and lumbar position. Perform a supine ADIM and raise head and shoulders off the table. HOLD this for 8 seconds, then return to start. Repeat.

**(7) 30x SUPINE ADIM + CURL-UP, ELBOWS UP, HANDS ON FOREHEAD** • Starting in a supine position with one leg straight and one leg bent, place both hands on your forehead. Perform a

supine ADIM and raise head and shoulders off the table. HOLD this for 8 seconds, then return to start. Repeat.

**(8) 30x HORIZONTAL SIDE SUPPORT + KNEES BENT (each side)** • Starting on side (one forearm extended flat on surface, knees together and bent, resting knee on surface), perform an ADIM and raise your hips and trunk off the surface. HOLD this for 8 seconds, then return to start. Repeat.

**(9) 30x HORIZONTAL SIDE SUPPORT + KNEES STRAIGHT (each side)** • Starting on side (one forearm extended flat on surface, knees together and straight, resting calf on surface), perform an ADIM and raise your hips and trunk off the surface. HOLD this for 8 seconds, then return to start. Repeat.

**(10) 30x HORIZONTAL SIDE SUPPORT + KNEES STRAIGHT + TRUNK ROTATION (each side)** • Starting on side (one forearm extended flat on surface, knees together and straight, resting calf on surface), perform an ADIM and raise your hips and trunk off the surface. HOLD this, then ROTATE the trunk backward and forward 4 times in each direction, then return to start. Repeat.

**(11) 30x HORIZONTAL SIDE SUPPORT + KNEES STRAIGHT + ROTATE SIDES** • Starting on side (one forearm extended flat on surface, knees together and straight, resting calf on surface), perform an ADIM and raise your hips and trunk off the surface. HOLD this, then SWITCH SIDES by rolling over onto the opposite elbow while maintaining a neutral spine. Roll back to start. Repeat.

**(12) 30x QUADRUPED ADIM + LEG RAISE (each leg)** • Perform a quadruped ADIM, and straighten 1 leg backward while maintaining a neutral lumbar spine position. HOLD this for 8 seconds, then return to start. Alternate legs and repeat.

**(13) 30x QUADRUPED ADIM + LEG & ARM RAISE (each leg and opposite arm pair)** • Perform a quadruped ADIM, then straighten 1 leg backward AND raise the opposite arm forward while maintaining a neutral lumbar spine position. HOLD this for 8 seconds, then return to start. Alternate legs/arms and repeat.

**(14) 30x QUADRUPED ADIM + LEG & ARM RAISE AND CONTRACTION (each leg and opposite arm pair)** • Perform a quadruped ADIM, then straighten 1 leg backward AND raise the opposite arm forward while maintaining a neutral lumbar spine position. HOLD this for 8 seconds, then

lower WITHOUT returning to start (placing on supporting surface). Repeat. Alternate legs/arms and repeat.

**(15) 30x ROWING (standing and quadruped, each arm)** • Perform a standing ADIM, then pull a 1 to 1.5 kg weight in a rowing motion until the weight is at chest level. HOLD for 6 seconds, return weight to starting position. Repeat. Then repeat while performing a quadruped ADIM.

* All exercises illustrated and adapted from: (81) Rabin, A., Shashua, A., Pizem, K., Dickstein, R., & Dar, G. (2014, January). A clinical prediction rule to identify patients with low back pain who are likely to experience short-term success following stabilization exercises: A randomized controlled validation study. *Journal of Orthopaedic & Sports Physical Therapy, 44*(1) , 6-18, B1-B13.

**How are you doing?**

When performing these exercises, make sure to stop and ask yourself:

- Is my spine always in neutral position?
- Am I aware of my body in space?
- How is my body feeling?
- Am I fully completing every repetition and hold?
- Can I increase the intensity of what I am doing?
- Am I applying the ADIM to my sport? For example, do I keep my spine protected in ADIM during flips and landings?

**Exercise Therapy: Extra tips & tricks**

**Talk to your coach, family, and physician**

Having your **support network** on your side is important to achieving success with any intervention (24). **Talk** to your coach, family, friends, and medical professional about what you are going through. Ensure their support of your chosen intervention and their help in maintaining a **positive attitude**.

**Practice Good Form**

Good form is crucial to protecting your back. Make sure that you can perform skills safely before progressing. In the gym, use safety equipment like **Sting Mats** and **foam pits** to decrease impact loads during practice (14).

**Stretch**

For aesthetic athletes completing MCE, it is especially important to thoroughly **stretch** before exercising to increase the balance between the muscles of the upper core and pelvic floor (53). Also, **be wary of exercising within an hour of waking**, when the ligaments and intervertebral discs experience 80 and 300% higher stresses (1, 84).

**Cross-train**

Consider combining MCE with spinal manipulative therapy and general exercise. The body will sacrifice spinal stability for breathing, so it is important that aesthetic athletes **maintain high aerobic fitness** during their activities (62, 71). **Spinal manipulative therapy** can complement MCE and decrease short-term pain (5, 63) and **general exercise** can enhance the effects of motor control exercise (15, 52).

**Listen to your Body**

Playing through pain is not always good; learn to differentiate between “good” and “bad” pain. **Good pain** results from constructively pushing your body, is short-lived, goes away with rest, and does not interfere with daily activities, like walking or sleeping (61). **Bad pain** is generally any pain that is constant or increasing over time, does not improve with treatment, wakes you up during rest, or is associated with nerve damage numbness or tingling (61). Bad pain is associated with the failure or tendons, ligaments, cartilage, bones, or excessive muscle damage (61).

**Beware of Female Athlete Triad**

Female Athlete Triad is a serious condition where there is a problem with at least one of interrelated spectrums of**:**
(1) **energy availability** optimal to low energy availability with or without an eating disorder;
(2) **menstrual function** eumenorrhea to functional hypothalamic amenorrhea; and/or
(3) **bone mineral density** optimal bone health to osteoporosis (66).

Female Athlete Triad is present in varying degrees in **half of aesthetic athletes** (66). Athletes with menstrual dysfunction have increased risk for progression from spondylolysis to **spondylolisthesis.** They are also **2-4 times more likely to experience stress fractures** (9). Understand that a gymnast could have a normal-weight body mass index (BMI) and still be underweight due to relatively high muscle mass. Also understand that losing one's period is typically a sign of an underlying problem and not a healthy accomplishment.

**Print**
You can print out most of the information available on this website HERE. Share evidence with your loved ones and keep the MCE handout handy!

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