EXAMINATION OF
THE LUMBAR SPINE
IN THE ATHLETE

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Examination of the Lumbar Spine in the Athlete
An AANEM Workshop

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INTRODUCTION

The assessment of any patient with low back pain (LBP) or related complaints, including athletes, must always be tailored to the unique circumstances of that individual. It is essential to not only understand anatomy, physiology, and examination as they relate to the lumbar spine, but also to have a working knowledge of the particular demands of that individual’s work, recreational activities, sports participation, or other pursuits. It is particularly important to understand the influence that these factors may have on spinal mechanics and force distribution, physical performance, and the individual’s psychosocial environment.

Sports participation presents unique issues in the assessment of individuals with LBP that may depend upon a number of distinct variables, including the level of sports competition, the particular sport and position played, age, equipment, and the time of the sporting season. With appropriate background information, it is possible to identify factors that may influence athletic performance and potential barriers to recovery (physical, psychosocial, or otherwise) and to derive a reasonable differential diagnosis for the patient’s complaints. Physical examination, as well as further diagnostic assessment, can then be directed to the appropriate areas of concern.

Generally speaking, there are several distinctions between lumbar disorders in athletes (and performing artists) and those in many other individuals. These include the following:

1. High level sports participation in adolescents and young adults is associated with a greater incidence of LBP and the presence of a higher rate of structural abnormalities in the spine.8,16,17

2. High velocity trauma associated with some sports may result in a greater percentage of significant structural injuries than is seen in the general population of patients with LBP.

3. Even in less traumatic sports, extensive training schedules, repetitive motions, and the development of large forces on a repeated basis can predispose to overload injuries, such as spondylolysis (a lesion in the pars interarticularis of the neural arch).12,19

4. Some sports are associated with particularly high rates of low back complaints, including gymnastics, football, weightlifting, dance, golf, and rowing.12,13,17,19

5. Younger athletes are particularly vulnerable to injury in growth regions of the spine and are relatively more susceptible to bony injury than soft tissue injury compared with adults.12

6. High demands on an athlete’s strength, agility, balance, motor control, and force production require that disruptions in these areas be evaluated and addressed.

7. Due to the high level of performance of athletes, their strength and motor control may be far more challenging to assess for the examiner than in members of the general population.

8. It is important to understand the concept of the "kinetic chain" in examining athletes. The lumbar spine frequently acts as a conduit for the transfer of force between the ex-
tremities. It may either be affected by disorders of the extremities (especially the lower extremities) or may, if not functioning properly, be a causal factor in injury to the extremities. Be aware of the potential for undiagnosed or under-treated injuries in the extremities that may impact the function of the spine.4,6

9. Pay attention to psychosocial issues. Psychological issues related to stressful life events have a direct relationship to injury prevalence. Also, secondary gain issues can be substantial problems and can be very different in adolescent athletes compared with adults. Injured high level athletes or performing artists essentially have occupational injuries and can have many issues in common with other injured workers, although the financial stakes can be extremely high.1,13

In establishing the diagnosis of a specific injury or anatomic source of pain in athletes, several factors should be considered. For injuries related to sports activities, the nature of the sport clearly may place an individual at risk for different types of injuries. High impact, collision sports, for example, can frequently be associated with traumatic bony or soft tissue injuries such as a vertebral fracture or significant ligamentous injury, while endurance sports, such as running, may be associated with more "over-use" or "over-load" injuries of soft tissue or bone. The age of the individual may also place that athlete at risk for specific conditions. Adolescent athletes with LBP have an extremely high rate of symptomatic spondylolysis, a diagnosis that is rare in older adults. Adolescents and individuals in their early 20s are also at higher risk for presenting with pain related to a seronegative spondyloarthropathy (e.g. ankylosing spondylitis) than are older individuals, while also having lower rates of discogenic injuries. Disc herniations are particularly frequent in individuals in their 30s, 40s, and early 50s, while older individuals are at increased risk for fractures, degenerative conditions, or a variety of neoplasms.1,14

Athletes also may be affected by a number of non-spinal conditions that can mimic low back or radicular symptoms. Sacral stress fractures can present with focal sacral pain and tenderness and may particularly occur in distance runners. Tendonitis or partial tears of the proximal hamstring tendon can result in gluteal and posterior thigh pain. These can be seen in cyclists, runners, and rowers, for example. An anterior compartment syndrome in the calf can result in pain that can be very similar to L5 radicular symptoms. Clearly, a large number of other anatomic structures can produce pain in the low back, pelvis, or lower extremities and providers need to be aware of the various possibilities that may result in a given set of symptoms.1,14

A number of risk factors potentially associated with an increased risk of spinal injury or LBP in athletes have been identified, although some remain controversial. These include prior low back or lower extremity injuries, incomplete rehabilitation of prior injuries, decreased endurance, lower extremity muscle imbalance, high number of hours of participation per week, and the occurrence of stressful life events. Additional proximate causal factors associated with sports-related injury may include the individual mechanics and skill level associated with sports-specific performance, training patterns, and equipment or facility problems.11

As noted above, the physical examination of an injured athlete is guided by a differential diagnosis for that athlete’s condition, but should also always include several central elements, including an examination of lumbo-pelvic motion, palpation of the spine and related structures, and a neurological examination. Consideration does need to be given to the potential for significant structural injury, including fracture, and the examination should always be modified appropriately for a given patient in order to elicit essential information while avoiding further harm.

PHYSICAL EXAMINATION

Observation

The physical examination begins with observation. Movement patterns, preferred postures, inconsistencies, and gait abnormalities can all be noted by clinicians and their staff members throughout the patient’s time in the clinical setting. Formal observation should include an examination from the feet to the head. Alignment, foot position, relative pronation or supination of the feet, and knee, hip, and pelvic alignment should be noted. The spine should be assessed for alterations from normal alignment or resting curvature, including scoliosis, kyphosis, excessive or diminished lumbar lordosis, and the presence of a lumbar shift. Symmetry of shoulder height and scapular positioning are also important to note.1,14

Gait assessment should specifically include observation for gait changes suggestive of neurological deficits such as a steppage gait associated with dorsiflexion weakness or inconsistent foot placement with a wide-based gait suggestive of proprioceptive or cerebellar difficulties. Gait can be challenged further by testing tandem gait (heel-to-toe walking) or braiding. Balance can be assessed by observing gait and adding observation of single-leg stance with various postural challenges as appropriate. Testing of high level balance by having individuals stand on one leg and partially crouch with the addition of postural challenges, reaching, and other maneuvers can elicit deficits in trunk or pelvic strength or in dynamic balance that would not otherwise be appreciated by standard examination techniques.

Active spinal range of motion should be assessed for all patients. There is a great deal of debate as to what truly represents "normal" range of motion in the spine, how to quantify the
range of motion (e.g. inclinometry, distance from fingertips to floor, etc.), and the actual importance of any perceived deficits in motion. Gross lumbar flexion generally includes motion from the hips and lower extremities. Lateral flexion or rotation involves coupled motion at multiple levels, further complicating the assessment of "lumbar" motion. Despite these limitations, it is still important to assess active spinal motion in flexion, extension, rotation, and lateral flexion. Along with absolute degrees of movement, the examiner can assess symmetry of motion, the quality of motion, preferred movement patterns, pain or symptom reproduction associated with motion, the relative contributions of associated body segments to motion (e.g. hips), motor control, and inconsistencies between movement noted on formal examination and that seen during casual observation or while the patient is otherwise distracted. Motion should be assessed actively and only within the patient’s range of comfort.

**Palpation**

Palpation may aid in the localization of the patient’s symptoms, the identification of an injured structure, or the identification of associated soft tissue or bony abnormalities such as lymphadenopathy or soft tissue edema. Midline spinal tenderness may have different diagnostic implications from tenderness more laterally. Localized tenderness should also be distinguished from more diffuse tenderness, the latter of which is less consistent with a focal injury. Spondylolisthesis can frequently be appreciated by palpation in the lumbar spine. Palpation should variably include not only the lumbar spine, but also the iliac crests, sacrum, sacro-iliac joints, ischial tuberosities, proximal hamstring, and greater trochanteric areas to assess for the possibility of contributing problems from these regions.

**Neurological Examination**

The most common neurological manifestations of lumbar spine pathology involve the nerve roots or potentially the conus medullaris. However, the symptoms resulting from spinal pathology may frequently overlap with those of a variety of peripheral nerve processes, central nervous system (CNS) diseases, or anterior horn cell disease. Therefore, an examiner needs to be aware of the clinical presentations and neurological findings associated with these disorders.

Soft touch and pin-prick sensation can be assessed well in most patients, and the examiner should note whether any abnormalities identified follow a dermatomal distribution suggestive of nerve root pathology, a stocking or stocking-and-glove distribution suggestive of a peripheral polyneuropathy, the distribution of one or several peripheral nerves suggestive of alternative peripheral nerve pathology, or a non-organic distribution. Proprioception, vibration, and temperature sensation may be tested, as well, particularly when there is concern for a spinal cord or CNS process, significant spinal canal stenosis, or the presence of a peripheral neuropathy.

Formal motor examination consists of several parts, namely strength, tone, coordination, muscle bulk, and involuntary movements. These different components can be variably important in athletes. Strength testing is generally done isometrically, but there are times when weakness can be better appreciated through dynamic or repetitive movements that address endurance (e.g. multiple toe raises to assess the plantar flexors or squats to assess the knee extensors). Weakness may be hard to identify by standard examination with highly trained athletes, and often some type of functional motion should be tested, occasionally outside of the standard clinical setting (e.g. training room). It is essential to be aware of key muscle groups by myotome, as well as the peripheral nerve origin of those muscles. Some of the important muscle groups/motions associated with lumbar myotomes are as follows:

- **L2** - hip flexion
- **L3** - hip flexion, hip abduction, knee extension
- **L4** - knee extension, ankle dorsiflexion
- **L5** - ankle dorsiflexion, great toe extension, ankle eversion, hip abduction and internal rotation
- **S1** - ankle plantarflexion

**Reflex testing** can further aid in the localization of neurologic injury and provide information on the relative components of upper and lower motor neuron injury. Although a neurological injury can often be localized to one site with either discrete upper or lower motor neuron features, occasionally patients will have both as a result of multiple sites of injury or as a result of certain disease processes in which a mixed pattern of upper and lower motor neuron features can be seen, such as amyotrophic lateral sclerosis (ALS). The segmental distribution of commonly tested deep tendon reflexes in the lower extremities is as follows:

- Patellar tendon reflex – L2, L3, L4
- Medial hamstring reflex – L5, S1
- Ankle jerk reflex (Achilles tendon) – S1

For the most part, the sensitivity and specificity of isolated tests for sensation, strength, and reflexes is relatively limited in the assessment of spinal conditions, particularly when any one single test is considered. There may be more utility in combining a variety of findings across multiple modalities, especially when the findings are consistently reproducible. The degree of con-
sistency between examination findings, history, imaging results, and self-reported levels of pain and disability for affected patients should always be considered when decisions on care are made.

**Hips and Lower Extremities**

Examination of an athlete with LBP should always include evaluation of the lower extremities and hips. The dynamics of the foot and ankle, including relative pronation of the arch, calcaneal alignment, and subtalar motion, can have a direct bearing on biomechanical issues "upstream" in the kinetic chain, particularly at the knee, hip, and lumbar spine. Similarly, abnormalities of knee range of motion or alignment may directly impact lumbar issues and should be assessed. The knee should be examined passively for range of motion and ligamentous laxity, in standing, and during the gait cycle. Abnormalities occurring during gait can occasionally be accentuated by having the patient run in the clinic or by formal video assessment on a treadmill. The lower extremities should also be assessed for relative atrophy or motion loss associated with prior injuries or subsequent care, such as calf atrophy after immobilization for an Achilles tendon injury or quadriceps atrophy after the repair of an anterior cruciate ligament tear.

Symptoms related to hip pathology can often be difficult to distinguish from symptoms related to lumbar pathology by history alone, and hip dysfunction may have a direct bearing upon lumbar mechanics, subsequent injury, and/or pain. Alterations in hip function can often be noticed by the alignment of the foot in standing or walking. Hip pain, prior injury, or relative weakness may also manifest as deficits in dynamic balance. Palpation of the hip girdle and sacral region is important for the identification of sacral disorders, such as a stress fracture, sacro-iliac problems, or soft tissue disorders that can result in lumbo-pelvic region pain. Passive hip range of motion should be assessed in all patients with lumbar complaints. Hip flexion, internal and external rotation, and relative tightness of the hip flexors can all be readily assessed with the patient supine on an examination table.

**Special Tests**

A number of different test maneuvers have been described for evaluation of lumbar and related disorders. Some of the more relevant ones are described below:\textsuperscript{11,14,15}

**Dural tension** tests are typically used to assess for lumbar root pathology.

1. Supine straight leg raise – the leg is elevated slowly by the examiner with the knee extended. This is generally considered positive if it reproduces leg pain between 30° – 70°. It is thought to indicate irritability of L5 & S1 roots. It can be modified or confirmed by the slightly lowering leg once pain occurs and either dorsiflexing the foot (sometimes termed Lasegue's sign or Bragard's test) or internally rotating the hip. The bowstring sign variesingly refers to raising the leg with the knee flexed and then slowly extending the knee (also sometimes referred to as Lasegue's test), and either relieving pain by flexing the already extended knee at the point of symptom reproduction or eliciting pain by pressing on the popliteal fossa of the elevated leg with the knee partially flexed.

2. Seated straight leg raise – consists of elevating the leg of a seated patient to move the flexed knee towards full extension or until pain or the end-point of a comfortable range of motion is reached. A positive test results in reproduction of the patient's leg pain when performed ipsilaterally. This should ideally be done while examining the feet or strength of the symptomatic side elicits reproduction of leg pain down the opposite (symptomatic) leg.

3. Crossed straight leg raise – considered positive when a supine straight leg maneuver performed on the asymptomatic side elicits reproduction of leg pain down the opposite (symptomatic) leg.

4. Slump test – While the patient is seated on edge of examination table, the leg raised to full extension at the knee, while the hip is flexed to 90°, and the patient "slumps" their trunk and neck into flexion. This is considered positive if pain is reproduced down leg.

5. Femoral nerve stretch test ("reverse straight leg raise") – With the patient prone, the knee is gradually flexed passively (and the hip extended, if tolerated) either to the end of comfortable range of motion or until reproduction of pain down the anterior thigh. The test is positive if this reproduces the patient's pain. This should be compared on both sides as almost anyone with tight quadriceps will have discomfort at end range. However, the quality of symptoms may be different between the two sides. This is generally felt to reflect pathology affecting the L2-L4 roots.

A number of tests for other joints or other types of lumbar pathology may be relevant in examining the athlete with lumbar complaints.

1. Patrick’s/FABER’s – hip flexion, abduction, external rotation – assessing for hip joint pathology. Hip scour or end range of internal rotation and adduction can also be used. To really be suggestive of hip joint symptoms, these maneuvers should reproduce groin pain.

2. Gaenslen’s test – for sacro-iliac (SI) pain. The patient is placed supine at the side edge of the examination table with both hips maximally flexed. The leg at the edge of table is
then extended slowly and allowed to fall below the height of the table while other hip remains held in flexion. Multiple other SI tests used have been described (Gillet’s, etc), although all SI tests of are of questionable reliability in terms of predicting a response to a selective injection of the joint under fluoroscopy.3,4

3. One-legged hyper-extension maneuver – This is felt to be indicative of spondylolisits when positive in a young athlete with focal low back pain, although no tests of sensitivity/specificity have been performed. The patient is asked to stand on one leg and then extend their trunk (arch backwards). Symptom reproduction ipsilaterally is felt to be a positive test.12

Non-organic Signs

Chronic pain behavior is often felt to display common physical examination findings suggesting symptom magnification and psychological distress, possibly an expression of suffering. Waddell et al18 defined and studied a group of five findings on physical examination, commonly known as "Waddell signs."

1. Tenderness – superficial, diffuse, non-anatomic.
2. Simulation – axial load on top of head (mild) or rotation of trunk with arms held against the side (maintaining alignment of hips & shoulders) elicits complaint of LBP.
3. Distraction – seated straight leg raise is negative while supine straight leg raise is readily positive.
4. Regional disturbance – give-way weakness or non-anatomic sensory loss noted.
5. Over-reaction.

The presence of three or more of these is felt to be indicative of a non-organic component to the patient’s pain (but does not imply that there is no true anatomic pathology, however).

Kinetic Chain & Muscular Balance

There are proposed objective "scored" methods of assessing kinetic chain function, essentially aiming to establish a sense of dynamic motor and postural control.3,5 These involve multilobar motions in different directions and postures. These are not necessarily practical in an office setting, but may be useful in establishing treatment goals and measuring progress of rehabilitation. Among the basic goals of rehabilitating an athlete with a spinal injury is to establish optimal physical performance while minimizing the chance of re-injury. In order to accomplish this, specific deficits in kinetic chain function must be identified through functional testing and observation in order to guide treatment. Testing has to be individualized to the abilities of the individual, the demands of their sport, and the nature of their injury. Multi-planar balance, postural control, force production and transfer, and sport-specific performance are all important components of higher level rehabilitation and core stabilization for injured athletes.6,7,10,19

REFERENCES
