



# Current Trends in the Management of Lumbar Spine Injuries in Athletes

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## ABSTRACT

Lumbar spine injuries are prevalent among athletes and are likely to increase with the rising popularity of extreme sports. It is important for physicians to understand the basic anatomy of the lumbar spine along with the injury patterns that can occur with axial loading, hyperflexion and flexion-distraction forces. The majority of low back injuries in athletes are due to muscle strains and rarely need further treatment. Athletes that are subjected to repetitive hyperextension forces are at risk for spondylolysis with or without spondylolisthesis which requires further imaging to determine need for surgical intervention. Lumbar disk herniations are usually from axial forces and can be result in surgical emergencies, if they cause compression on the spinal cord or conus. Lumbar spine fractures can vary from stress fractures of the endplates to burst fractures or fracture-dislocations which require surgical intervention, if associated with neurologic deficit or instability. Similar to the management of cervical spine injuries, patients with a suspected lumbar injury should be evaluated systematically with full spine precautions and careful neurologic examination to determine need for transfer to higher care center.

**Keywords:** Athlete, Lumbar, Lumbar spine, Sports, Sports injury, Management.

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## INTRODUCTION

Lumbar back pain among athletes has been reported as high as 30%.<sup>1,2</sup> The rise in popularity of extreme sports involving higher velocities will likely increase the rate of lumbar spine injuries as there is a squared relationship between the velocity of the activity and the energy imparted at the time of collision. Herein, the typical injuries patterns and management strategies for adult and adolescent athletes will be discussed.

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## INCIDENCE

Low back pain and lumbar spine injuries have been well documented in a variety of sports, including competitive swimming. A prospective study of collegiate swimmers found that back strain was the second most common injury, accounting for 16.1% of all injuries.<sup>3</sup> The incidence of spine injuries among all levels of swimmers ranges from 3.0 to 37.1%. Butterfly and breaststroke are associated with the highest rates of back pain at 33.3 and 22.2% respectively.<sup>4</sup>

Shields et al investigated the incidence of spine injuries in competitive cheerleading and found that 26% of muscle strains involved the trunk with 41% of those specifically involving the lower back. Spotting and basing for stunts were the most common injury mechanisms associated with lower back strain (OR, 3.38; 95% CI;  $p < 0.01$ ).<sup>5</sup>

A 9-years prospective study of pole vaulters was initiated following a 2003 rule change that increased the size of landing pad and required a 2" thick, dense foam pad between the vault box and the landing pad.<sup>6</sup> Nineteen catastrophic injuries were incurred with four patients (21%) sustaining a spine fracture with one resulting in paraplegia. The most common injury mechanism was landing in or around the vault box, followed by landing off the sides or back of the landing pad. Although the overall number of catastrophic injuries decreased following the rule change, the number of injuries from landing in the vault box tripled.

Collision sports have notoriously high rates of lumbar injuries due to the multidimensional forces experienced during blocking and tackling. In a study of NFL players, 7% of all injuries involved the spine with 30.9% involving the lumbar spine and 3.9% involving the thoracic spine.<sup>7</sup> Only 0.6% of spine injuries resulted in spinal cord injury. The majority of lumbar injuries were due to noncontact activity (20.8%) or to blocking (18.6%). The players at highest risk for developing a lumbar spine injury were offensive lineman (18.3%) followed by defensive lineman (17.9%), defensive backs (12.2%), linebackers (11.9%) and special team players (8.2%).<sup>7</sup>

Skiers and snowboarders can sustain devastating spine injuries from mechanisms ranging from simple falls to high-speed collisions with stationary objects to impacts with the ground after jumps.<sup>8</sup> A retrospective review of

thoracic and lumbar spine fractures by Gertzbein et al in Aspen, Co, identified 114 significant spine fractures over a 5 years period (along with 32 isolated transverse or spinous process fractures). They found that the majority of fractures were simple compression fractures (71%) followed by burst fractures (23%). More significant injuries, such as distraction and rotation injuries, accounted for 4.4 and 0.9% of all lumbar spine injuries respectively.<sup>9</sup> There were no resultant neurological deficits. They calculated the risk of thoracic/lumbar spine fracture as 0.009% per ski/snowboarding day.

All-terrain vehicle (ATV)-related spine injuries have increased significantly over the last two decades. In a study using the Kids Inpatient Database, ATV-related injuries increased 476 and 240% since 1997 for children and adolescents, respectively.<sup>10</sup> Spine injuries accounted for 7.4% of injuries with thoracic fractures comprising 39% and lumbar fractures comprising 29%. Though the overall incidence of injury was much lower for females, a significantly higher percentage of injured females sustained a spine injury.<sup>10</sup>

## Anatomy and Mechanics

The posterior longitudinal ligament (PLL) defines the anterior border of the lumbar spinal canal and runs along the posterior aspect of the lumbar vertebrae and disks. Posteriorly, the canal is bordered by the spinous processes and posterior ligamentous complex (supraspinous and interspinous ligaments, ligamentum flavum and facet capsules). The pedicles occupy the lateral aspects of the canal and connect posteriorly through the pars interarticularis to the lamina and spinous processes. Lumbar stenosis is defined as a canal diameter or canal area that is less than 13 mm and 1.45 cm<sup>2</sup> respectively.<sup>11</sup>

Common injury mechanisms in the lumbar spine consist of axial loading, hyperflexion and flexion-distraction injuries. Several classification systems for spine injuries have been described including the Denis three-column classification scheme and the more complex AO classification.<sup>12</sup> Regardless of classification scheme, the critical anatomy to assess is integrity of the middle column, posterior ligamentous complex and cross-sectional area of the spinal canal. These anatomical findings determine stability of the fracture pattern guide treatment.

## Lumbar Spine Injuries

### Low Back Strain

Muscle strain is the most common lumbar spine injury in athletes. Direct blows or rapid eccentric muscle

contraction can cause strains of the paraspinal muscles. Forced flexion of the torso can cause ligamentous sprains or capsular facet injuries.

The typical presentation consists of localized pain and decreased range of motion without radiation or neurologic deficit. Imaging should be considered based on the mechanism of injury. Anteroposterior and lateral radiographs are the appropriate first step followed by flexion-extensions views to evaluate spinal stability.

The evidence-based recommendations for treatment for isolated soft-tissue injuries include spinal manipulation therapy and nonsteroidal anti-inflammatory medications.<sup>13,14</sup> Heat, exercise and core stabilization may be beneficial, but supporting evidence is currently lacking.<sup>15-17</sup> Return to play is contingent upon full, painless range of motion.

### Pars Defects—Spondylolysis and Spondylolisthesis

Spondylolysis and spondylolisthesis are not uncommon lumbar spine injuries in athletes and most commonly occur at the L5 vertebra—affecting L5-S1 level. This injury is frequently caused by repetitive hyperextension and axial loading in sports, such as gymnastics, ballet and football (particularly offensive and defensive lineman).<sup>18</sup> It has been demonstrated that nearly 40% of athletes with back pain lasting for more than 3 months had pars interarticularis abnormalities.<sup>19</sup> The asymptomatic prevalence of spondylolysis is up to 15% in college football players 11% in gymnasts.<sup>19,20</sup> Pars defects account for a much larger percentage of lumbar spine injuries in adolescent *vs* adult athletes. Athletes aged 9 to 15 years are at highest risk for progression of their spondylolisthesis.<sup>21</sup>

The most common presentation is low-back pain exacerbated by extension, but without radiculopathy. Patients may compensate with knee and hip flexion on ambulation, accompanied by shortened stride (Phalen-Dickson sign). In some cases, the slip may so severe that it is palpable. Other signs include contracted hamstrings and inferior paraspinal muscle spasms.

Imaging work-up of symptomatic lumbar hyperextension should include plain films, CT and bone scintigraphy or single photon emission computed tomography (SPECT).<sup>22</sup> The amount of slippage is assessed on lateral plain films. CT is the gold-standard for definition of the osseous architecture of the pars. SPECT imaging may enable detection of occult and acute 'stress' fractures in symptomatic patients without plain film evidence of a defect.

The goals of management of a pars defect in the athletic population are alleviation of pain and prevention of instability progression. Nonsurgical management of



symptomatic pars defects is contingent upon the degree of spondylolisthesis.<sup>23,24</sup> Low-grade slips can be managed with a period of restricted activity until pain improves followed by gradual return to activity.<sup>13</sup> In the event of pain recurrence, lordotic bracing is recommended for a period of 3 to 6 months or until pain subsides.<sup>24-26</sup> Bracing can also be augmented with an external bone growth stimulator which may potentially expedite treatment.<sup>27,28</sup>

Fracture healing should be monitored on plain radiographs and should demonstrate some healing by 3 months. Single photon emission computed tomography imaging can be utilized plain films are inadequate for visualization of the defect or when interval change is otherwise difficult to assess. Once pain resolves, rehabilitation should be focused on core strengthening, lower-limb flexibility, and back range-of-motion. Athletes with low-grade slips can usually return to competition after completion of a rehabilitation program.<sup>29</sup>

High-grade slips, progressive slips or slips with refractory symptoms warrant surgical management. Low-grade slips can be treated by direct fusion of the pars defect with favorable rates and return to noncontact sports.<sup>29</sup> Higher-grade spondylolisthesis generally requires arthrodesis and literature and recommendation for return to play thereafter is limited.

### *Intervertebral Disk Herniation*

Acute disk herniations are caused by axial loading that increases intradiscal pressure. The nucleus pulposus is extruded through the annulus fibrosus into the spinal canal or neuroforamen compromising the space available for the spinal cord and the exiting nerve roots. The resultant neurologic compression can cause transient or permanent symptoms or deficits. Athletes, such as basketball players and baseball pitchers, place a significantly greater amount of force through their lumbar spines than the general population.<sup>30</sup>

Primary clinical evaluation of a known lumbar disk herniation should exclude the two surgical urgencies: cauda equina (CE) and conus medullaris (CM) syndrome. Spontaneous pain is more common in CE than CM and usually described as radicular pain in the perineum, lower back, thighs, legs or bladder. Sensory loss in CM is usually bilaterally symmetric in a saddle distribution whereas sensory loss in CE can be unilateral and asymmetric. Similarly, motor dysfunction is symmetric in CM and asymmetric in CE. Autonomic symptoms, including bladder and impotence, occur early in CM and later in CE. The reflex exam can also vary with absent ankle and knee jerk in CE and isolated absent ankle jerk in CM. Overall, the clinical picture for CM is bilateral and sudden *vs* a more gradual and unilateral onset for CE.

The initial treatment strategy of a herniated lumbar disk, even in athletes, should be conservative. Iwamoto et al reviewed rates of return to play (RTP) in athletes managed nonoperatively and found 78.9% of patients were able to return to their previous level of competition at 4.7 months.<sup>31</sup>

Watkins et al reviewed their case series of professional athletes treated surgically with microdiscectomies from 1996 to 2010 and found that the average rate of return to sport was 89% with an average RTP of 5.8 months. For players treated during their competitive season, 50% returned at 3 months, 72% at 6 months, 77% at 9 months, and at 1 year 84%.<sup>32</sup>

Hsu has extensively studied this topic. He found an 81% rate of RTP in linemen and 74% with NFL offensive skilled position players.<sup>33,34</sup> In NBA players, Anakwenze et al found only a 75% RTP.<sup>35</sup> Based on the specific needs and wishes of the athlete, both operative and nonoperative treatment can lead to expected RTP of greater than 70%.

### *Unstable Fractures and Dislocations*

Bony injuries of the lumbar spine vary by sport due to the unique forces associated with each activity. Lumbar fractures can be categorized into those resulting from repetitive microtrauma (stress fractures of the vertebral endplates) or acute high-energy injuries (including burst fractures or fracture/dislocations). Slow-loading axial forces typically result in wedge-shaped compression fractures while rapid-loading forces can result in a burst pattern with or without retropulsion of bone into the spinal canal.<sup>36</sup> Fracture-dislocation injuries result from rapid acceleration/deceleration injuries or rotation forces combined with compression, tension, shear or translational forces.<sup>37</sup>

Lower impact sports, such as weightlifting, involve slow-loading axial loads to the lumbar spine resulting in acute or chronic compression fractures. Compression fractures are usually stable and can be managed conservatively.<sup>36</sup> Flexion-distraction injuries are rarely seen in lower impact sports and result primarily when either poor technique or excess weight is used.<sup>36</sup>

Activities involving high speeds and forces, such as skiing, snowboarding, luge, automobiles, ATVs and motorcycle racing usually lead to the most severe and devastating spine injuries.<sup>36</sup> In skiing and snowboarding, compression fractures are the most common thoracolumbar spine fractures seen, typically resulting from an uncontrolled impact after a period of being airborne.<sup>38</sup> Fracture/dislocation injuries in this population are sustained when athletes collide with other objects (such as trees or poles) at high speeds. These injuries can be associated with neurologic injury and frequently require

surgical management. Less severe fractures seen with high-energy activities include transverse process or spinous process fractures. These fractures are caused by strong paraspinal muscle spasms sustained at the time of injury that result in avulsion from the bone.<sup>39</sup> These fractures do not require surgical intervention but can be an indicator of the severity of injury force and alert physicians to associated injuries.

Studies examining ATV spinal injuries have shown that spinal fractures are more commonly seen in older adolescents than younger children and involve primarily the thoracic spine followed by lumbar spine.<sup>40</sup> Compression and burst fractures are the most common fractures and account for 31% of the ATV spine injuries. Neurologic deficits were present in 14% of these patients and surgical stabilization was required for 24% of the patients.<sup>40</sup>

Compression fractures can be managed conservatively if they are stable. Surgery is indicated for burst fracture when there is a neurologic deficit or radiographic evidence of instability. Unstable burst fractures are defined as those involving the posterior ligamentous complex, result in greater than 30° of kyphosis, or result in 50% loss of vertebral body height. Surgical management of these burst fractures usually involves decompression of bony and ligamentous structures with fusion from either an anterior or posterior approach.<sup>37</sup>

### On-field Management of a Player with a Suspected Low Back Injury

Management of an athlete with a suspected spine injury should always begin the ATLS protocol with assessment of the patient's airway, breathing, circulation and resuscitation provided as needed.<sup>36</sup>

Full spine precautions should be maintained at all times. All equipment should be left on with the exception of facemasks to allow for airway access. A brief history should be obtained including presence of pain, numbness, weakness or paralysis followed by an assessment for head injuries including loss of consciousness, altered mental status and ability to cooperate with exam. When examining an awake and alert patient with low back pain after an injury, the neck should be stabilized and a minimum of three people should cooperatively perform a log roll to palpate the spinous processes and paraspinal musculature. If an athlete has any midline pain, they should be moved onto a rigid backboard and prepared for transportation to a medical facility. Once on a backboard, a complete sensory examination of all dermatomal distributions should be performed including reflexes, such as ankle jerk clonus, patella reflex and achilles reflexes. Straight leg raise test can be performed bilaterally and motor testing of the great toe flexion/extension, knee flexion/extension and hip flexion/

extension and add/obvious extremity fractures, consider more advanced imaging based on the injury pattern including orthogonal X-rays, CT and/or MRI. Depending on injury severity, patients should be referred to either urgent or outpatient medical centers for comprehensive evaluation of pain or decreased level of activity. Only patients demonstrating an optimal level of activity with little to no pain and no neurologic deficits should be allowed to return to activity.<sup>36</sup>

### SUMMARY

Lumbar spine injuries in sports can be significant injuries impact athlete participation and level of performance. Especially, athletes performing at the competitive level experience unique forces on the spine the predispose them to debilitating lumbar injuries. Having a clear understanding of the mechanism and management of both simple and catastrophic spine injuries is crucial for medical providers to ensure these injuries are appropriately addressed.

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