10 Nonsurgical Treatment of Spinal Injuries

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Summary
Athletes at both elite and amateur levels are subjected to unique forces to the spinal column that can lead to injuries uncommon in the general population. Injuries can range in severity from mild cervical or lumbar strain and sprain injuries, disk herniations, bulges, and ligamentous injuries to debilitating three-column injuries that result in spinal cord injury. Nonoperative management is often the preferred modality for treating less serious injuries. However, deciding whether to operate requires consideration of neurologic integrity, spinal stability, spinal alignment, and how the injury responds to conservative measures. Imaging and complete physical examinations with close follow-up are imperative in this patient population to allow for safe short return-to-play intervals. Despite improvements in managing the wide array of sports-related spine injuries, clear return-to-play guidelines remain poorly defined in this population.

Keywords: cervical, fracture, herniation, lumbar, nonsurgical, return-to-play, sports, thoracic

10.1 Introduction

Spine injuries are a significant problem faced by both elite athletes and physically active members of the general population.[1,2] A meta-analysis of six studies found that the lifetime prevalence of back pain in athletes across any anatomic region of the spine is between 47 and 90%.[2] These injuries can range from mild cervical strain to neuropraxia or complete spinal cord injury (SCI). The focus of this chapter is to describe the management of nonsurgical spine injuries, which may include strains or sprains to the supporting muscles, ligaments, and tendons; disk bulges; foraminal compromise; annular tears; and disk herniations.

It is well known that physical activity can increase the risk of back pain.[3,4] However, there is also evidence that strenuous exercise can prevent back pain.[5,6] Studies have hypothesized a U-shaped dose–response curve, indicating that, although a sedentary lifestyle can have deleterious effects on spine health, there are also potential risks associated with highly strenuous activity.[3,4,7] Athletes, especially those involved in contact sports, can be subjected to high levels of physical strain and high-speed force imparted on the cervical, thoracic, and lumbar spine, which places them at increased risk of injury to the spine and surrounding structures.

Spine injuries among athletes can differ from those in the general population in that there are often specific forces exerted on an athlete's spine related to the particular sport played. Generally, back and neck pain among athletes leads to increased treatment costs, lost playing time, decreased quality of life, and decreased performance.[8] Contact sports, in particular, can lead to axial load injuries of the cervical spine. Lumbar and thoracic soft-tissue injuries can result from axial load, a direct blow to the anatomy of the spine, hyperflexion, hyperextension, or rotational forces.

10.2 General Considerations and Initial Assessment

If an injury to the spine is suspected in an athlete, initial evaluation should begin with an on-field or sideline evaluation. On-field assessments should begin with identification of any neurological deficits through a detailed examination of the player's motor function, sensation, and reflexes. Although rare, more serious injuries, such as SCI, should be ruled out prior to further workup. If the player is exhibiting radicular symptoms or soft-tissue injury, the athlete can be escorted to the sidelines for further evaluation by the medical staff and athletic trainer. The context in which the injury occurred should be determined, and it can be helpful to review video of the incident when available. The patient's symptoms and location of any pain should also be clearly identified to help localize the region of injury.

Further evaluation on the sideline can focus on assessing the location and severity of pain, aggravating and alleviating factors, active and passive range of motion, and gait. Of note, players with suspected cervical spine injuries should also be assessed for concussion using the Sport Concussion Assessment Tool, because these injuries can often occur simultaneously. Imaging with anteroposterior and lateral radiographs can assess for bony fractures or malalignment. However, computed tomography is generally recommended because it provides higher resolution to evaluate for traumatic pathology. Players who are experiencing neurological deficits or symptoms should undergo magnetic resonance imaging (MRI), which permits better assessment for disk herniation and bulging, integrity of ligamentous structures, and neural compression. In the following sections, management of nonsurgical injuries involving the cervical, thoracic, and lumbar spine will be discussed in further detail.

10.3 Cervical Spine

10.3.1 Epidemiology

Cervical spine injuries without SCI are common in contact sports and can range in severity from minor muscle sprains and strains to ligamentous strain, disk herniations, annular tears, symptomatic radiculopathy, and stingers and burners. These injuries are more common among athletes who participate in contact sports, but noncontact cervical spine injuries can also occur. American football, wrestling, and gymnastics have the highest incidence of cervical spine injuries in the United States.[9,10] In Canada, ice hockey is the sport that is associated with the highest number of cervical spine injuries, whereas in Europe, rugby has the highest incidence of such injuries.[11,12] A study of 11 National Football League (NFL) seasons found that 987 of 2,208 (44.7%) spine injuries occurred in the cervical spine, more than in any other area of the spine.[13]

10.3.2 Strain and Sprain

The most common cervical injuries are to the soft tissue and muscles of the neck. These injuries often present with neck pain, restricted range of motion, and unilateral muscle spasm. The mechanism of these injuries often involves whiplash, with rapid flexion-extension or lateral flexion-extension causing trauma to the soft tissue of the neck. These injuries are managed with conservative measures, including rest, physical therapy, muscle relaxants, and nonsteroidal anti-inflammatory drugs (NSAIDs).[14]

10.3.3 Ligamentous Injuries

The stability of the cervical spine relies heavily on ligamentous structures. Disruption of these structures often results in neurological compromise. Some of the more severe ligamentous injuries of the upper cervical spine include atlanto-occipital dislocations, atlantoaxial dislocations, transverse ligament disruptions, C2–C3 disk space disruption, and locked facet joints. These injuries are rare in the low-energy setting of most sports. The craniocervical junction is stabilized primarily by the ligamentous structures in the region, so injury involvement of these structures generally necessitates surgical intervention to prevent catastrophic neurological injury.[15]

10.3.4 Disk Bulge and Herniation

Cervical disk herniations, disk bulges, annular tears, and spondylosis are common throughout many sports but are particularly common in football, baseball, and soccer players.[16,17,18] These findings can have a significant impact on players' ability to participate in their sport. Schroeder et al[19] found that college football players entering the NFL draft with a history of cervical disk herniation were less likely to be drafted and played less total time professionally. Prior studies have found that the rate of cervical disk herniations is significantly higher in contact athletes than in the general population.[20] Additionally, the patterns of this pathology differ; cervical disk herniations in contact sports like football are most commonly seen at C3–C4 and C5–C6, whereas in the general population, the most common level is C6–C7.[21,22] Presenting symptoms will often include cervical neck pain, radicular pain, upper extremity numbness, myelopathy, weakness, or transient quadriplegia. Diagnosis is established with MRI, the imaging modality of choice for cervical disk herniation.[23]

Nonoperative management is recommended for the initial treatment of cervical disk herniation in athletes without neurological deficits or myelopathy. Conservative measures should include a trial of NSAIDs, physical therapy, suspension of participation and contact, and epidural steroid injections. Despite conflicting evidence, much of the literature recommends operative management after 6 months of conservative management if symptoms persist or if imaging reveals evidence of spinal cord or symptomatic root compression.[24] However, soft disk herniations will almost always resolve with conservative measures, although resolution can take up to 6 months. Studies in football players, rugby players, and Major League Baseball pitchers have found that superior outcomes are associated with operative management in cervical herniation refractory to conservative management.[12,25,26]

Case Example: Cervical Disk Herniation

A professional running back in his early 30 s was evaluated for injury during a game after experiencing hyperflexion of his neck while being tackled by another player. Upon sideline assessment, he was full strength with no neurological deficits, but he did report significant left trapezius pain and spasms. Further workup with MRI of his cervical spine demonstrated a C4–C5 cervical disk herniation eccentric to the left and causing foraminal stenosis (▶ Fig. 10.1). The player opted to be managed conservatively with rest, NSAIDs, and a cervical collar. The player was reevaluated 3 months after the injury, with complete resolution of his symptoms. Repeat MRI 3 months after the injury showed almost complete resolution of the disk. The successful recovery of this player with conservative management highlights the importance of trialing nonsurgical approaches for athletes with acute cervical disk herniations and the potential resolution of symptoms on radiographic findings with time.

10.3.5 Definition of Cervical Stenosis

Cervical stenosis has been defined in a variety of ways over the years in the literature, reflecting the evolving understanding of the condition and its clinical manifestations. One of the earliest definitions involved sagittal measurement of the spinal canal diameter.[27] A recent study found that a minimal disk-level diameter cutoff of 0.8 cm had the greatest positive predictive value (84%) for SCI following minor trauma.[28] Another historically prominent definition is the Torg ratio, calculated by dividing the sagittal diameter of the spinal canal by the sagittal diameter of the vertebral body.[29] A ratio of less than 0.8 is defined as significant spinal stenosis and associated with higher risk for neurological injury.[30] A third definition is based on the space available for the cord (SAC) ratio, which measures the sagittal diameter of the spinal cord divided by the sagittal diameter of the spinal canal. The SAC ratio theoretically provides a more accurate definition of cervical spinal stenosis. Some literature suggests that the sagittal diameters of vertebral disks are larger in athletic populations than in the general population, thus yielding lower Torg ratios.[31] The SAC ratio is not affected by this possibly confounding variable. In a study of 1,211 subjects, anteroposterior cervical spinal cord diameters were found to be independent of spinal canal diameter, and SAC ratios of 62% or greater were found to increase the risk of spinal cord compression.[32] This study implies that using only spinal cord diameter may not accurately assess the risk of cord compression. When choosing a particular method, the choice should be based on the specific clinical context and the aspects of cervical stenosis that need to be assessed.

10.3.6 Neuropraxia, Stingers, and Burners

Cervical cord neuropraxia is most common among football players.[30] This injury involves sensory symptoms such as burning, radiating pain, and tingling involving the extremities in a

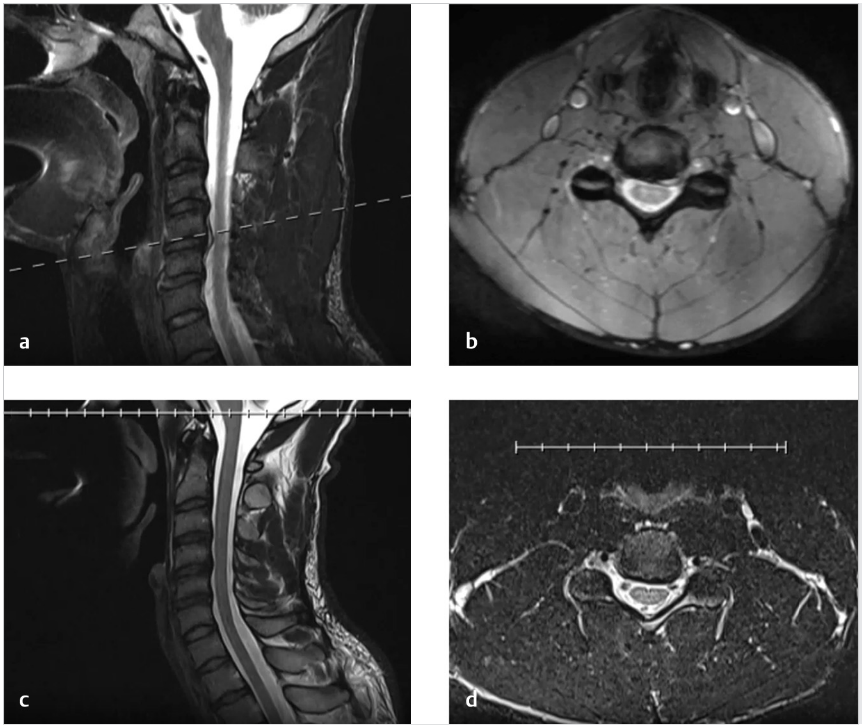

Fig. 10.1 Magnetic resonance imaging (MRI) of a football player in his early 30s with a C4–C5 cervical disk herniation after hyperflexing his neck following a tackle. Sagittal **(a)** and axial **(b)** T2-weighted MRI sequences show a C4–C5 cervical disk herniation that is eccentric to the left and causing foraminal stenosis at the time of injury. Sagittal **(c)** and axial **(d)** T2-weighted MRI sequences obtained at 3 months after the injury show almost complete resolution. (Used with permissions from Barrow Neurological Institute, Phoenix, Arizona.)

variety of distributions, including in the upper, lower, or ipsilateral extremities or all four extremities. Motor symptoms follow a similar anatomic distribution and can range in severity from paresthesia to weakness to paralysis. Importantly, neuropraxia usually resolves in less than 15 minutes and rarely lasts longer than 48 hours.[33] These injuries usually result from hyperextension or lateral compression of the cervical spine in which the canal diameter is narrowed. Preexisting cervical stenosis can put athletes at risk for neuropraxic injuries. Cervical traumatic neuropraxia is often managed conservatively if the symptoms resolve, but if the patient has persistent symptoms and a canal diameter of less than 8 mm, surgical intervention may be necessary.

Stingers and burners are common injuries that specifically refer to clinically mild cervical neuropraxia with more transient symptoms. In a study of 201 college football players, 65% reported having a stinger or burner in their 4-year career.[34] A stinger is often unilateral and is thought to be due to trauma to the brachial plexus, often caused by a tackle. Symptoms include sudden, sharp, stinging pain that radiates down the arm and then resolves in a matter of seconds to minutes. A burner injury exhibits a characteristic burning, radiates pain bilaterally, and can indicate underlying cervical stenosis. Stinger and burner injuries respond well to conservative management.

Case Example: Cervical Traumatic Neuropraxia

A professional football player in his mid-20s experienced loss of consciousness and transient quadriplegia after attempting a tackle on a kickoff. MRI following the injury did not show any T2 cord signal or other signs of traumatic injury, and the patient's cervical canal diameter at C5–C6 was measured at 10.4 mm at the time of initial injury. Repeat MRI 3 months later showed a canal diameter of 7.1 mm at the same C5–C6 level (▶ Fig. 10.2). This underscores the importance of exercising caution in treating players with small cervical canal diameter and their heightened susceptibility to neuropraxia. This player was cleared to return to play following resolution of symptoms and unremarkable imaging findings.

10.3.7 Fractures without SCI

Fractures of the upper cervical spine, such as hangman's or Jefferson fractures, are rare in sports. Injuries sustained while mountain biking have been reported as the most common cause of an upper cervical spine fracture in sports. In a Canadian study, 14 of 79 cervical spine injuries in mountain bikers were upper cervical fractures.[35] Odontoid fractures appear to be the most common upper cervical fracture.[35] In patients younger than 30 years, use of a hard cervical collar or halo vest is appropriate. For type I and III odontoid fractures without displacement or ligamentous injury, the use of a hard cervical collar or halo vest can promote healing of the fracture and high rates of fusion. The same conservative management can be used to treat type II fractures but is associated with a high rate of nonunion because such fractures occur at the watershed zone at the base of the dens. If there is no displacement or ligamentous disruption, other isolated C1 or C2 fractures, including bilateral hangman's fractures, can be treated conservatively with a hard cervical collar or halo vest for 6 to 12 weeks and may not require surgical intervention.[36]

One controversial pathology is that of incidentally found os odontoideum, a congenital abnormality of C2 with an isolated ossicle superior to and independent of a hypoplastic dens. Although the natural history of patients with os odontoideum in contact sports is not well-described, it is generally accepted

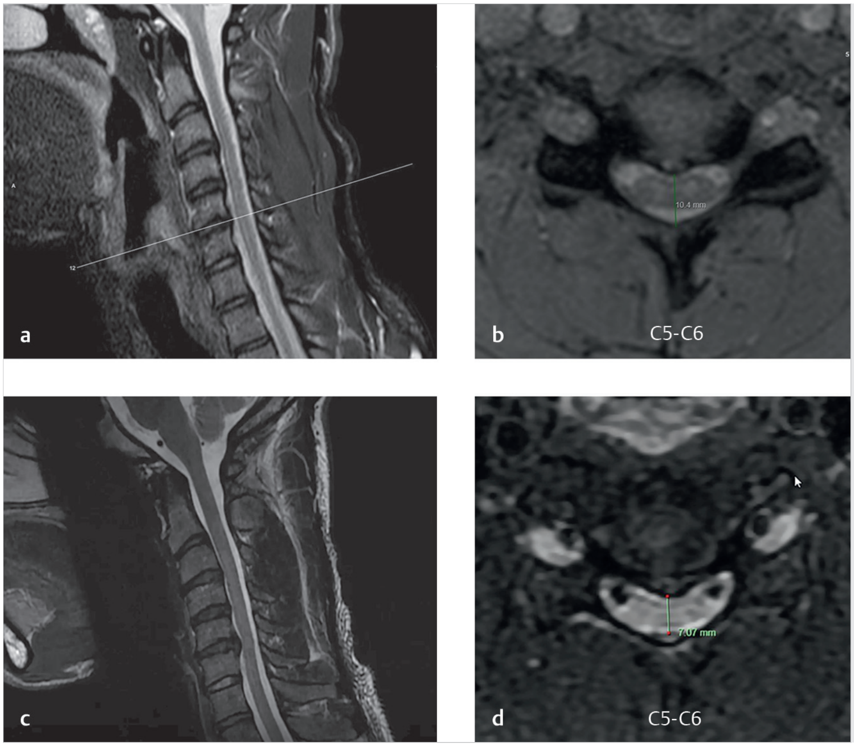

Fig. 10.2 Magnetic resonance imaging (MRI) of a football player in his mid-20s who experienced loss of consciousness and transient quadriplegia after attempting a tackle on a kickoff. Sagittal **(a)** and axial **(b)** MRI obtained at the time of the injury shows the spinal canal to be 10.4 mm in diameter. Sagittal **(c)** and axial **(d)** MRI obtained at 6 months after the injury showing a smaller canal diameter of 7 mm at C5–C6. (Used with permissions from Barrow Neurological Institute, Phoenix, Arizona.)

that these patients should refrain from playing contact sports given the high rate of instability at C1–C2 and higher risk for SCI.[37,38] Although definitive return-to-play guidelines have been difficult to establish, there is a general consensus that players who demonstrate radiographic healing of the fracture with normal alignment, unremarkable neurological examination findings, and pain-free full range of motion are able to safely resume training, followed by return to play.[36] Many surgeons will also recommend obtaining an MRI to ensure that there is no T2 cord signal before clearing the player to return to activities.[20,39] The presence of persistent T2 cord signal is considered a contraindication for returning to play even for asymptomatic patients.[20]

Compression and burst fractures of the cervical, thoracic, and lumbar spine can occur among athletes when a neutrally aligned spine is subjected to an axial load.[40] These injuries are often seen in mountain bikers and rugby players.[35,41] Most compression and burst fractures can be managed conservatively with a hard cervical orthosis. Surgical fixation is indicated for patients with three-column injuries, instability, severe canal compromise, or neurological deficits. These treatment decisions can be guided by the subaxial cervical spine injury classification score.[42] This score incorporates three categories for the surgeon to assess: the morphology of the fracture, the integrity of the diskoligamentous complex, and the patient's neurologic status and deficits. The scores from each category are added together, with a score of 3 or less suggesting nonoperative management, a score of 4 being indeterminate, and a score of 5 or more indicating the need for surgical treatment. Additionally, fractures involving more than 1 cm in height, causing a significant kyphotic deformity, or having greater than 40% lateral mass involvement should be managed operatively.[42] Return to play can be initiated for players with no neurological deficits, no cervical pain, full range of motion, and radiographic evidence of fusion and healing without T2 cord signal.

Unilateral and bilateral facet fractures can present with symptomatic cervical pain without neurological symptoms. Unilateral and nondisplaced facet fractures can be managed conservatively with a rigid cervical collar in many cases. Cervical spine MRI can be obtained to assess for disruption of the joint capsule. In addition, dynamic flexion-extension radiographs can show translation of the vertebral bodies suggesting instability. Unilateral facet fractures without disruption of the facet joint capsule and without instability on dynamic radiographs can be managed with a rigid cervical collar. Some players may experience persistent neck pain after 6 to 12 weeks despite wearing a collar. Persistent neck pain after a trial of rigid cervical collar constitutes failure of conservative management, and the patient should consider surgery. Players with no neurological symptoms, full range of motion, no neck pain, and healing of the fracture on radiographic follow-up can be cleared to return to play. Once again, MRI can be obtained before a return to team activities to ensure the absence of T2 cord signal. Fractures involving the bilateral facets will often present with some level of instability and are not generally amenable to nonoperative management. Similarly, injuries that include capsular disruption or dislocation are best treated surgically.

10.3.8 Return-to-Play Recommendations

Athletes with strains and sprains must have resolution of symptoms and normal range of motion before return to play. For individuals with stinger injuries, return to play can be immediate if symptoms last less than 5 minutes. Bilateral symptoms, such as in burners, or persistent neurological symptoms warrant removal from play and further imaging to assess the extent of injury. Generally, athletes with cervical neuropraxia of all clinical varieties should be allowed to return to play in the absence of neurological symptoms if they have full strength and range of motion and if cervical stenosis is absent on imaging.[43] Cervical canals should normally be 10 to 14 mm in diameter. Athletes whose cervical spinal canals measure less than 8 mm are at high risk for injury and should be considered on a case-by-case basis for return to play.

Players with cervical disk herniation often return to play after treatment, whether treatment is conservative or operative. The primary indication for operative management after conservative management is persistent symptomatic disk herniation despite conservative measures for at least 3 months, signal changes, or evidence of cord compression on MRI. Return to play is permitted for players with improved symptoms and imaging findings showing a lack of cord compression.

For individuals with sports-related fractures in the upper cervical spine, such as odontoid and C1/C2 fractures, return to play after conservative treatment emphasizes radiographic healing, unremarkable neurological examination findings, absence of T2 cord signal, and return of full range of motion. Similarly, for compression and burst fractures of the cervical spine that are managed conservatively, return to play is permitted with radiographic evidence of fusion and absent T2 signal along with no neurological deficits, full range of motion, and no pain. The same principles for return to play apply to players with unilateral and bilateral facet fractures.

10.4 Thoracic Injuries

10.4.1 Epidemiology

Sports-related injuries of the thoracic spine are less common than those of the cervical and lumbar spine. However, one study has shown that injuries to the thoracic spine may involve the greatest loss of playing time.[16] Anatomically, the thoracic spine has a "fourth" column consisting of the rib cage, costosternal, and costovertebral junctions, providing stability to T1–T8.[44] As a result, 75% of spinal fractures occur below the T8 level.[44]

10.4.2 Strain and Sprain

Strain and sprain generally result from overuse or overstretching of certain muscles. Muscle tenderness, localized pain, and limited range of motion are common in these injuries. Many of the superficial muscles, including latissimus dorsi, rhomboids, and trapezius, have significant interaction with thoracic spinous processes; consequently, sports that involve significant use of these muscles are associated with musculoligamentous injury. In sports that involve a violent rotational motion, it is common to experience a sprain injury on the side contralateral to the dominant throwing arm.[45] Sprain injuries are treated conservatively with rest, ice and heat, and NSAIDs.

10.4.3 Ligamentous Injuries

Ligamentous injuries can represent more serious injuries and can be diagnosed by the evidence of instability on plain films or short tau inversion recovery changes on MRI. The notable anatomy in this region includes the supraspinous ligament, interspinous ligament, facet joint capsules, and ligamentum flavum. These ligaments compose the posterior ligament complex that limits flexion of the spine. Most injuries to the posterior ligament complex involve high-energy trauma with seat belts. These injuries are rarely seen in sports. MRI remains the gold standard in diagnosis and assessment of the posterior ligamentous complex stability.[46]

10.4.4 Disk Bulge and Herniation

Thoracic disk herniation is relatively uncommon and unlikely to be symptomatic. Notably, the thoracic disk is more likely to have calcification or complete ossification.[47] Most thoracic herniations respond well to conservative management, with the exceptions of giant herniated disks and giant calcified herniated disks, which often cause progressively worsening myelopathy.

10.4.5 Neuropraxia

Neuropraxia involving the thoracic spine is not widely reported or extensively studied in the literature. The thoracic spine is relatively stable and, compared with other regions, is less prone to those injuries that cause nerve compression or neuropraxia.

10.4.6 Fractures without SCI

Although fractures in the thoracic region caused by high-energy trauma are relatively common in the general population, such fractures are rare in sports. The posterior elements can be injured with flexion injuries or direct blows. One such injury is the clay shoveler's fracture, which is an avulsion fracture of the spinous process of the lower cervical or upper thoracic vertebrae. It has been reported in a variety of sports, including golf, baseball, wrestling, running, and volleyball, to name a few. It can be caused by either a direct blow or repetitive overload causing a stress fracture.[48,49,50,51] Among rowers, it is common to have strains and stress fractures at T4–T7 due to rhomboid, latissimus dorsi, and erector spinae contraction.[45] These fractures have a high rate of union and are managed nonoperatively with rest, analgesics, and physical therapy.[48]

Compression fractures of the thoracic spine have also been reported in sports, such as in a report of T12 compression fracture in a teenage basketball player by McHugh-Pierzina et al.[52] These fractures are usually treated conservatively with a thoracolumbar spinal orthosis for 6 to 12 weeks and activity restriction.[53] Long-term considerations for these types of fractures include monitoring over time for the development kyphotic deformity, which is evaluated on standing scoliosis radiographs.

10.4.7 Return-to-Play Recommendations

The stability of the thoracic spine makes it less prone to injury. For strains and sprains, if symptoms are relatively mild, the player may be returned to play during the game. The thoracic spine fractures that happen in athletes, such as avulsions of spinous process and compression fractures, are often managed conservatively with excellent results. Adequate healing should be demonstrated on follow-up radiographs before the athlete returns to play.

10.5 Lumbar Injuries

10.5.1 Epidemiology

Injuries of the lumbar spine are common among athletes, and low back pain is estimated to affect 10 to 15% of athletes.[54] Low back pain is a common complaint in the general population, with a lifetime prevalence estimated at 75 to 84%, with the 1-year point prevalence for adults being 28.4%.[55,56] Compared to the thoracic spine, the lumbar spine is significantly more mobile, constituting a risk of fracture in a low-energy and repetitive-stress setting. The lower lumbar spine is also subjected to the greatest static axial forces, which predisposes it to disk degeneration. Athletes who perform squats or similar exercises and repetitive actions, such as rowing, are predisposed to disk herniations or annular tears.

10.5.2 Strain and Sprain

Sudden twisting or bending motions can injure the muscles and soft tissues of the lumbar spine. These injuries result in lower back pain and stiffness. These injuries are treated conservatively with rest, ice and heat, and NSAIDs. The player may return to play when they are asymptomatic for 2 weeks if imaging demonstrates absence of a disk herniation. Patients with disk degeneration and disk bulges may return to play when they report 2 weeks of no symptoms while participating in practice.

10.5.3 Ligamentous Injuries

Among athletes, the most commonly injured ligaments in the lumbar region are the sacroiliac joints, interspinous ligaments, and supraspinous ligaments. Sprains and tears of interspinous and supraspinous ligaments and tendons commonly occur in athletes and cause acute-onset back pain with localized tenderness and thickening.[57] Treatment of these sprains is conservative, involving rest until asymptomatic for at least 1 week. Sacroiliac joint dysfunction is another common problem for athletes in sports with repetitive and asymmetric loading of the joint, such as football, basketball, powerlifting, gymnastics, and golf.[58] Treatment is conservative, with activity modification.

10.5.4 Disk Bulge and Herniation

Lumbar disk herniation is highly prevalent among athletes and is a significant source of low back pain. Disk herniations account for 28% of lumbar spine injuries in football, usually in the L4–L5 or L5–S1 disk.[16] Among football players, lumbar spine injuries are most common among offensive and defensive linemen.[59] A study of 342 professional athletes found no significant difference in outcomes for nonsurgical and surgical treatments of lumbar disk herniation.[60] The same study found that Major League Baseball players who underwent microdiskectomy had significantly shorter careers.[60] A study from Japan that included 308 athletes found that 59.7% of college baseball players showed signs of disk degeneration, and 89.5% had low back pain at some point in their life.[61] A 17-year study of players in the National Basketball Association, which included 12,594 injuries among 6,145 players, found that 10.2% of all injuries (1,279 of 12,594 injuries) were lumbar spine injuries.[62] Lumbar disk degeneration comprised 0.9% of total injuries (110 of 12,594 injuries) but accounted for 2,151 (3.6%) of total games missed (2,151 of 59,179 games).[62]

Lumbar disk herniations can present with low back pain, radicular pain, and occasionally weakness. Some provocative tests, such as the straight leg raise (Lesgue test), can be used to test for lumbosacral nerve root irritation. Although this test may have positive results in the setting of a herniated lumbar disk, it is not specific and can have positive results in patients with many other lumbar pathologies. Initial treatments for herniated lumbar disks are conservative and include activity modification, anti-inflammatory medications, core strengthening, physical therapy, and epidural steroid injections.[60,63,64] Surgery is generally reserved for players for whom initial conservative management fails.

Careful consideration should be given to cases in which young athletes who participate in baseball, basketball, and gymnastics present with signs of spondylosis. Generally, spondylosis is managed conservatively in the absence of neurological signs or radiculopathy. The approach to management of lumbar disk herniation should be tailored to the individual athlete. Current guidelines support conservative management for 1 week to 6 months, followed by consultation with a spine surgeon if symptoms persist.

10.5.5 Spondylolysis and Spondylolisthesis

Several studies have shown increased radiographic degenerative changes in younger athletes who participate in baseball, basketball, swimming, and gymnastics.[61,62,65,66] Furthermore, the prevalence of spondylolysis is high in the athlete population, with an estimated 47% of young athletes who present with low back pain receiving a diagnosis of spondylolysis.[67] Lumbar isthmic spondylolysis is especially common among gymnasts due to repetitive hyperextension of the lumbar spine, resulting in chronic joint stress. The incidence of this injury is notably higher among gymnasts than among the general population (11% vs. 2.3%).[68] Definitive diagnosis of spondylolysis begins with anterior–posterior and lateral radiographs, followed by computed tomography to better view the pars interarticularis.[69] Conservative management with a hard brace has been shown to yield favorable results in 94% of patients with early spondylolysis, with the effectiveness of the treatment dependent on computed tomography and MRI signal intensities.[70] Bilateral pars defects, which progress to spondylolysis in approximately 85% of cases, can be initially managed through a combination of stabilization and physical therapy.[71,72] This treatment protocol typically involves use of a stabilization brace for 8 to 12 weeks in conjunction with a graduated exercise program featuring isometric core and hamstring exercises. If conservative measures fail, injection of the pars defect can be considered. If the latter does not provide relief, or if instability of greater than 4 mm is observed, consideration should be given to direct pars repair or lumbar fusion.

Lumbar isthmic spondylolisthesis refers to the displacement of lumbar vertebrae anteriorly with respect to the lower vertebrae and represents a more severe pathology on the continuum of spondylolysis injuries. For low-grade spondylolisthesis, treatment is nonoperative. Reports of unilateral acute pars defects in pediatric patients have demonstrated osseous healing with bracing for 3 to 6 months.[72,73] However, it is generally advised to discontinue bracing once symptoms have resolved, regardless of whether radiographic evidence of healing is found.[74]

10.5.6 Definition of Spinal Stenosis

Lumbar spinal stenosis, a condition characterized by narrowing of the spinal canal, can pose unique challenges to athletes, subjecting the vertebrae, ligaments, and disks to unique forces. Spinal stenosis is differentiated into three main types: central stenosis, lateral recess stenosis, and midzone stenosis. Central stenosis involves narrowing of the vertebral foramen due to bulging disks, osteophytes, and thickened yellow ligament. Lateral recess stenosis involves compression of the nerve roots in the foramen. Midzone stenosis refers to compression within the foraminal zone located anterior to the pars interarticularis. This type of stenosis is more commonly a result of spondylolysis.

10.5.7 Fractures without Instability

Severe unstable fractures and injuries to all three columns are rare in sports. More commonly seen are minor fractures involving the pars interarticularis, articular process, transverse process, vertebral end plate, or spinous process that can result from repetitive activity or low-energy impacts. Almost all of these fractures are treated conservatively with rest, ice, NSAIDs, muscle relaxants, and bracing.[64] Isolated unilateral facet fractures in the lumbar spine are treated in the same manner and rarely require surgical intervention.[75] When there is concern for a more severe thoracolumbar fracture that is potentially unstable, the thoracolumbar injury classification and severity score can help guide further treatment. This score is calculated by assessing the fracture morphology, the integrity of the posterior ligamentous complex, and the patient's neurological status (▶ Fig. 10.3). Points for each category are assigned, and the total number of points determines whether the fracture is stable and can be managed conservatively, indeterminate, or unstable and requires surgery. The thoracolumbar injury classification and severity score is detailed in Chapter 8.

10.5.8 Return-to-Play Recommendations

A systematic review found that, among athletes with lumbar disk herniation, operative and nonoperative groups have comparable return-to-play outcomes.[64] Two studies showed that the number of players who returned to play and the number of games played were lower for National Basketball Association players who received surgical treatment for lumbar disk herniation.[76,77] The return-to-play criteria for lumbar disk herniation involve symptom resolution, restoration of full range of motion, and the ability to perform sport-specific movement without pain regardless of operative or nonoperative management.

Return-to-play guidelines are varied after nonsurgical treatment of spondylolysis, but returning to competitive play after 2 to 12 weeks of treatment and symptom resolution has been effective.[72,73,78] In a study of 73 patients with spondylolysis managed conservatively with a Boston Overlap Brace, 80% returned to play in 4 to 6 weeks.[79] Miller et al reported excellent long-term outcomes and high return-to-play rates (91%) in patients with spondylolysis and spondylolisthesis managed

TLICS: Three Independent predictors				
1	**Morphology** Immediate stability	- Compression - Burst - Translation/rotation - Distraction	1 2 3 4	- Radiographs - CT
2	**Integrity of PLC** Long-term stability	- Intact - Suspected - Injured	0 2 3	- MRI
3	**Neurological status**	- Intact - Nerve root - Complete cord - Incomplete cord - Cauda equina	0 2 2 3 3	- Physical examination
	Predicts	**- Need for surgery**	0–3 4 >4	- Nonsurgical - Surgeon's choice - Surgical

Fig. 10.3 Thoracolumbar Injury Classification and Severity Score (TLICS). CT, computed tomography; MRI, magnetic resonance imaging; PLC, posterior ligamentous complex. (Reproduced with permission from Radiology Assistant www.radiologyassistant.nl]).

nonoperatively if the initial slip was less than 30%.[80] All of the patients in this cohort improved with conservative management and returned to their respective sports; at longest follow-up, only 22% of athletes limited their recreational activities.[80] An important return-to-play consideration in spondylolysis is to confirm bony union with radiographs.[81]

Fractures of the lumbar spine are often conservatively managed with bracing, and patients should expect to return to play when their preinjury activity level is possible without pain and there is radiographic evidence of bone healing.

10.6 Conclusion

Activity in various sports introduces unique mechanisms of force that can lead to spinal injuries in a young population. The decision regarding operative versus nonoperative management is often guided by the principles of neurologic integrity, stability, and alignment. Regardless of the treatment, imaging and close clinical follow-up are important, especially when the patient's return to play is being considered. Generally, the decision to allow an athlete to return to play is made when the player is neurologically intact, free of symptoms, and has a full range of motion without pain.

10.7 Clinical Pearls

- Sprains, strains, burners, and stingers are spine injuries that can often be managed conservatively with rest, physical therapy, and NSAIDs.
- Nonoperative management is recommended for the initial treatment of disk herniations in patients without myelopathy, with operative management generally recommended if symptoms persist after 6 months.
- Neuropraxia is common among football players and includes burning, radiating pain, and tingling, often stemming from hyperextension. Although they may initially raise concern for cord injury, symptoms usually resolve quickly.
- Return-to-play recommendations vary based on the athletic sport and type of injury, but generally require resolution of symptoms and normal range of motion before return can be considered. Athletes with fractures should show evidence of healing on radiographic imaging before returning to play.

10.8 Disclosures

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this manuscript.

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