Lumbar Spine Injuries in Football

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Paul A. Rizk, Austin W. Wallace, and Robert C. Decker

Introduction

Football is a high-impact game and injuries to the spine are common and, on rare occasions, can be catastrophic. Meron, over a 10-year period, found an injury rate of 10.10 per 100,000 athlete exposures in high school football. As a comparison, the risk was 3.04 per 100,000 for all sports [1]. Chung found the risks were increased in college football, particularly in Division I [2].

Brophy, in a review of the National Football League (NFL) Combine data over 14 years, found an increasing numbers of injuries detected over time. Low back pain occurred at an incidence of 8.3 per 100 players and spondylolisthesis at 1.01 per 100 players [3]. Mall reported that injuries to the axial skeleton accounted for 7% of all injuries in the NFL [4]. Spine injuries can result in missed playing time and shortened careers at any level. Within this chapter, we present the most common injuries to the lumbar spine and their basic management to help guide team medical professionals.

Spine injuries, when they occur, require proper evaluation and management. For catastrophic injuries, safe expedited transport to a hospital equipped to manage spine trauma is important. It is important to have a protocol and the proper medical equipment available as well a person responsible for evaluating the injured player and another for activating emergency services if needed. This individual or staff should be well versed on managing facemasks, helmets, shoulder pads, immobilization techniques, and transfer techniques [5–8]. The protocols for spine boarding and

P. A. Rizk · A. W. Wallace
Orthopedic Surgery Resident, The University of Florida, Gainesville, FL, USA

R. C. Decker (✉)
Division of Spine Surgery, Department of Orthopedic Surgery, The University of Florida, Gainesville, FL, USA
e-mail: deckerc@ortho.ufl.edu

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transport are the same as described in detail in Chap. 9 and should be followed for a suspected unstable lumbar spine fracture as well.

Training and planning should consist of reviewing various spine injuries so medical staff are competent to provide safe care and not to further injure the athlete. First steps in evaluation should include a thorough history including nature of injury as well as a physical exam in order to understand the injury mechanism and any neurological defects that may be present.

Lumbar Spine Fractures

Minor fractures of the lumbar spine are often due to repetitive activity or low energy impact. They include injuries to the transverse process, spinous process, articular process, or pars interarticularis. Most of these injuries can be treated nonoperatively [9].

Compression fractures occur from an axial load on a straightened spine. In this position, the force is transmitted through the vertebral bodies without the posterior structures offloading axial force as they normally do in lordosis. In compression fractures, the anterior column of the vertebrae fails leading to fracture. Neurological sequelae are not associated with compression fractures and management is usually with immobilization in a brace followed by therapy as a bridge to return to play once the fracture has healed and the patient is asymptomatic [10, 11].

When the anterior and middle columns of the spine fail, a burst fracture occurs. A burst fracture has a higher risk of neurologic and spinal cord injury due to potential displacement of the middle column into the vertebral canal. Based on the fracture, neurologic exam, and symptoms, management can range from nonoperative management with immobilization to surgical management with decompression and fusion [11]. Fractures can also occur with translation or rotation of the spine that often causes injury to the disco-ligamentous structures that creates increased instability of the spine often requiring surgical management.

Return to play is complicated as no high-quality evidence is available and is predominantly based on expert opinion. After fracture, return is based on bony healing on CT or mature fusion after surgery, painless range of motion, absence of neurologic deficits, and full strength of the extremities and lumbar muscles. Potential contraindications to returning to play include residual neurologic deficit, malalignment of the spine, narrowing of the spinal canal, loss of range of motion, and multilevel surgery.

Disk Herniation

Disk herniations occur commonly in the lumbar spine (Fig. 7.1). Common symptoms are back pain with radiating pain down an extremity and sometimes neurologic deficits including numbness and weakness. Whenever suspected, a thorough

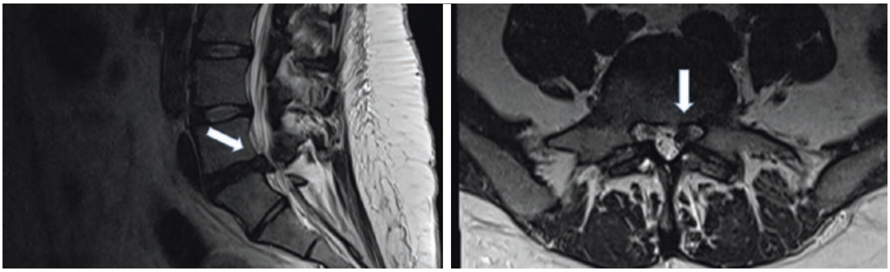

Fig. 7.1 Sagittal and MRI of the lumbar spine with arrows pointing to a posterolateral disk herniation

history and neurologic exam should be performed. MRI is the most appropriate non-invasive test to confirm the presence of a disk herniation. Gray, in a retrospective review of NFL players, found disk herniations represented 13% of all spine injuries. Most of the disk herniations occurred in the lumbar spine, and most frequently at L5–S1 followed by L4–L5. Lumbar disk injuries occurred most commonly in offensive lineman while blocking, though they can occur without contact [12].

Overall, disk herniations led to the second highest mean number of days lost of all spine injuries with spinal cord injuries accounting for the most missed days. Gray found that players suffering disk herniations missed a mean of 11 games due to injury [12]. Unfortunately, the database does not record injury grading, severity, or treatment provided. Additionally, it does not provide athletes' past history of disk pathology to help determine if the disk herniation is a new or older injury as disk herniations can be asymptomatic and predate injury [13, 14].

Treatment for disk herniation is often conservative to start including short-term rest, activity modification, medications, physical therapy, chiropractor treatment, and epidural steroid injections (ESIs). Medications commonly utilized include non-steroidal anti-inflammatory drugs (NSAIDs), oral steroids, and gabapentin [15].

ESIs have been considered a part of a lower back pain and radicular treatment in the young athlete since the 1950s (Fig. 7.2). Advanced imaging and higher demand of high-level athletes have changed the utilization of ESI over time. In 1980, Jackson evaluated 32 athletes who had low back pain associated with radiculopathy treated with ESI. Duration of symptoms prior to injection varied significantly ranging from 2 weeks to 18 months. ESI was successful in 44% of athletes. Other studies in the 1950s reporting on the general population reported a 67–70% success [16–18].

More recently and promising, Krych reviewed 17 NFL players who had 27 lumbar disk herniation episodes and underwent ESI. All diagnoses were confirmed by MRI and injections were performed within 14 days of onset of symptoms. Krych reported 89% return to play with only 2.8 practices and 0.6 games lost on average. The manner of injection did not affect the return to play. Risk for failure was associated with a sequestered disk fragment and weakness on physical exam. This study demonstrates how acute ESIs, a relatively low-risk procedure, can be efficacious in return to play for athletes [19]. Individual treatment plans should be customized

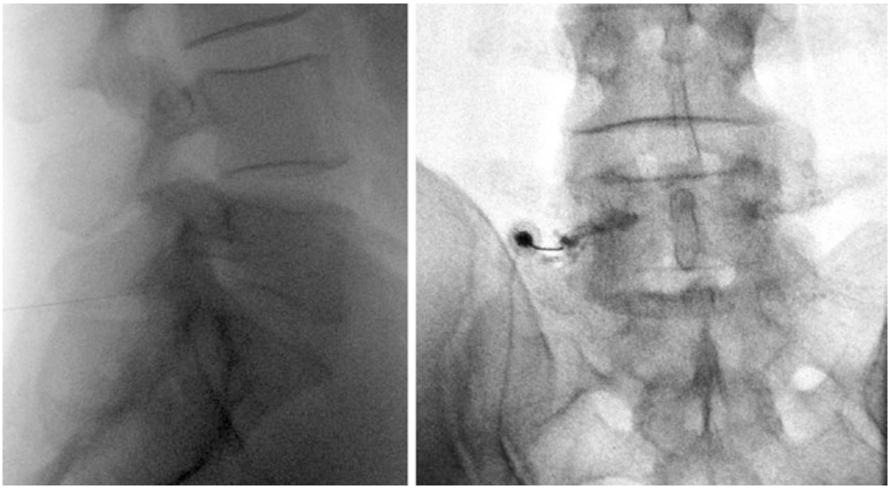

Fig. 7.2 Lateral and AP of the lumbar spine demonstrating a L5–S1 transforaminal epidural injection with contrast on the AP running along the L5 nerve root

based on the patient's symptoms and circumstances. If the patient is not sufficiently improved after a trial of conservative treatment including an ESI, then surgical removal of the disk may be an option [20].

Linemen have been shown to have increased risks of lumbar disk herniation compared to other position groups. Moorman reported on a higher incidence of lumbar endplate concavity in lineman compared to age-matched controls, theorized to be secondary to repetitive axial loading with extension during blocking. Athletes with endplate concavity had less general lumbar complaints than their age-matched controls. However, there was no difference in playing professional football, years played, games played, or games started with or without hyperconcavity of the lumbar spine endplates [21]. Additionally, Paxton noted that lineman endplate changes did not provide an advantage or disadvantage [22].

Hsu found that 82% of athletes were able to return to play after lumbar herniations. Offensive and defensive linemen were the most commonly affected positions. Eighty percent of professional football players treated surgically were able to return to play, while only 59% of those treated conservatively without surgery were able to return. These results were based on information made publicly available so they may represent an incomplete picture, as injury severity, nor treatment algorithms, were available [23]. Schroeder in his review of NFL Combine data looked at players diagnosed with lumbar disk herniations. For those treated nonoperatively or surgically, there was no difference in years played, games played, games started, or performance score compared to matched controls without a disk herniation. The affected level did not have an effect on career longevity, performance, or need for future lumbar surgery. No difference was seen based on the lumbar level herniated, which had been a concern as different levels innervate different muscles [24].

Current studies suggest a return to sport is possible following lumbar disk herniation with both conservative and surgical treatments. Most recommendations of return to play are based on expert opinion and should be tailored to the individual based on their symptoms, functional needs, and situation [25].

Low Back Pain

Half of adults will experience back pain within a given year. Likewise, back pain is common in football. Injuries can occur from trauma, overuse, or deviating from optimal kinematics. Hasselbrock estimated, from NCAA Injury Surveillance Program, an injury rate of 24.62 per 1000 athletic exposure for football. That was the highest rate of all college sports and more than double the next sport – female gymnastics. Most football lumbar injuries were strains followed by unspecified pain. Most athletes miss less than 24 hours of participation due to their injury [26]. However, low back pain can linger and effect play.

All instances of low back pain should have a detailed history and performance of an orthopedic and neurologic exam. History should include onset, chronicity, and location of the pain. Conservative management often includes NSAIDs, cold, heat, activity modification, and rest. Bracing can be used for short periods for pain relief or longer term for fractures. Physical therapy should be initiated once severe acute symptoms have subsided [9, 27]. Abdelraouf demonstrated a link between lower trunk musculature endurance and increased risk of low back pain when compared to healthy athletes. They recommended rehabilitation strategies that emphasized endurance of the trunk extensors and flexors [28]. Flexibility of hamstring and gluteal muscles should be addressed as well. When therapy is initiated, proper mechanics should be supervised closely.

Lumbar facet syndrome (LFS) can be suspected as a significant contributing factor to low back pain in athletes who perform repetitive extension and twisting motions [29]. Repetitive facet joint loading is suspected to result in facet joint capsule hypertrophy and inflammation resulting in activation of the numerous nociceptors and mechanoreceptors leading to localized and radicular pain [30]. Much like those suffering from lumbar disk herniation, patients will complain of localized low back pain exacerbated by twisting motions or hyperextension with pain that may radiate into the buttocks or posterior thighs. In cases of LFS, MRI can demonstrate a wide spectrum of findings from normal anatomy to subchondral edema at the joint space to severe degenerative facet joint changes and cysts.

Much debate exists regarding the correlation between radiographic degenerative changes and clinical symptoms [31]. As such, if conservative management with cessation of aggravating activity, NSAIDs, and physical therapy fails, then diagnostic fluoroscopically guided injection of the facet capsule or medial branch nerve could be pursued [32]. Significant symptomatic relief, typically defined as 80% reduction of pain and the ability to perform previously painful activities, corroborates the diagnosis of LFS [33]. These patients can then be referred for facet joint denervation [31]. When performed in the appropriate patient and for the appropriate condition, facet joint neurolysis provides significant pain relief, reduces the need for analgesics, and minimizes disability. The relief from neurolysis typically plateaus between 3 and 6 months after the procedure and then diminishes thereafter due to nerve regeneration. The procedure can then be safely repeated and pain relief reliably again obtained [34].

While the literature is replete with studies examining the effects of lumbar facet neurolysis on low back pain in the general population, relatively little has been published specifically investigating the success in athletes. In 2003, Vad performed a prospective study examining the results of radiofrequency denervation in professional baseball pitchers. Twelve pitchers who had failed conservative management, including physical therapy and oral anti-inflammatories, underwent diagnostic medial branch blocks and subsequent neurolysis of the bilateral L4–L5 and L5–S1 zygapophyseal joints. This was followed by a graduated physical therapy regimen with progressive return to competitive pitching. The study reports that 83% returned to a pre-procedural pitching level and all experienced statistically significant lumbar pain relief [35]. While only a single study and a limited number of participants, the results are promising and suggest that athletes suffering from lumbar facet joint syndrome can be safely and successfully treated with facet joint neurolysis.

Spondylolysis can be a cause of low back pain. Spondylolysis is a bone defect of the pars interarticularis, a part of the vertebrae between the facet joints (Fig. 7.3). Fredrickson noted that in the asymptomatic general population, spondylolysis is present in 4.4% of children and 6% of adults [36].

The defect is believed to be created by repetitive trauma from shear loading of the posterior elements, particularly from lumbar hyperextension. Genetic predisposition is also believed to play a role as well. It most commonly occurs at L5 and can be associated with spondylolisthesis. Fatigue stress can lead to fracture and spondylolisthesis. Spondylolisthesis is a translation of one vertebral body on the adjacent

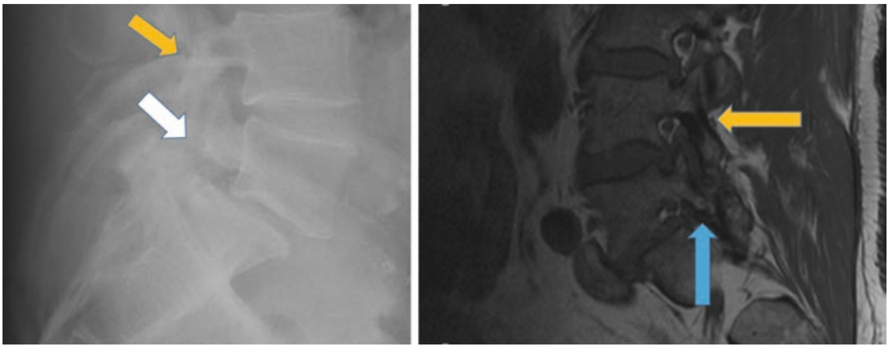

Fig. 7.3 Lateral XR and sagittal MRI of the lumbar spine in a patient with spondylolysis (pars defect) and spondylolisthesis. The white arrow is pointing to the spondylolysis at L5 on the lateral XR. You can see the break in the posterior elements at the pars interarticularis. The blue arrow illustrates the same disruption of the posterior elements on MRI. The orange arrows illustrate the normal anatomy at L4 on both the XR and MRI

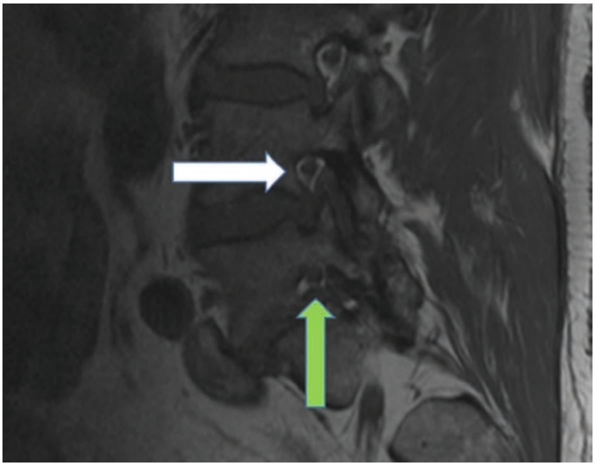

Fig. 7.4 Sagittal MRI image showing the exiting nerve roots at each level. The green arrow illustrates the compressed exiting L5 nerve root due to the spondylolisthesis. The white arrow demonstrates the normal exiting L4 nerve root surrounded by white fat indicating no nerve compression

vertebral body [37]. Low back pain is the main symptom, which can occur in the midline or over the facet joints laterally. Pain can also radiate to the buttock and posterior thigh. Symptoms can be exacerbated with rotation and hyperextension. Neurological symptoms may be present in cases where spondylolisthesis is present often correlating with the nerve root that exits at the involved level, usually L5 (Fig. 7.4).

Establishing a diagnosis can improve the chances of healing. Iwamoto stated that the primary goal for athletes with acute spondylolysis is healing and higher healing rates are seen if detected early [38]. Yamazaki found that high defect stage (stage related to how progressed the spondylolysis was with the lowest only showing a stress reaction on MRI and the highest defect demonstrating pseudoarthrosis on CT), stage of contralateral pars defect stage, and poor flexibility were negative prognostic factors for bone healing [39].

Lumbar radiographs can be performed to evaluate for spondylolysis. Iwamoto found that 69% of high school and college football players with low back pain had at least one abnormality on their radiographs [40].

Radiographic presence of spondylolysis was the single most important predictor of low back pain. High school players with spondylolysis had low back pain at a rate of 79.8% while only 37.1% of those without spondylolysis had back pain [40]. While athletes with spondylolysis may have pain, the presence of spondylolysis does not mean that it is going to be painful in the future. McCarroll found that spondylolysis was asymptomatic in 80% of NCAA football players [41].

Grodahl in review of published studies could not recommend patient history for diagnosing spondylolysis or spondylolisthesis. Palpation of step deformity may be useful for spondylolisthesis but one-legged hyperextension test was not supported for the diagnosis of spondylolysis [42]. Therefore, if suspected, imaging is the best way to confirm. The best initial radiographic study is a two-view plain film due to efficacy, low cost, and low radiation exposure (Fig. 7.5). MRI is helpful for early imaging looking for edema within and around the pars area, particularly in the

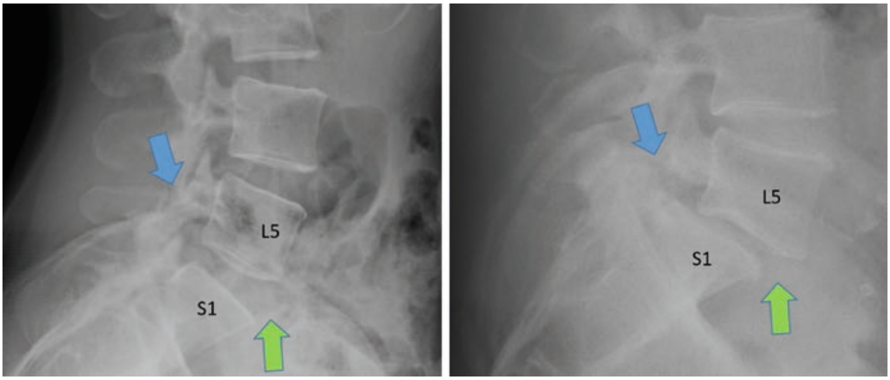

Fig. 7.5 Lateral XR of the lumbar spine showing the normal anatomy on the left and the spondylolysis and spondylolisthesis on the right. The blue arrows point to the posterior elements of L5. In the normal XR on the left, the posterior element is intact while on the right the posterior element is disrupted by the spondylolysis. The green arrows point to the anterior L5–S1 disk. The normal anatomy is demonstrated on the left while the right demonstrates a spondylolisthesis (slip) at L5–S1. With a spondylolisthesis, the anterior portions of the vertebral bodies are not aligned

ipsilateral pedicle, while CT scan is helpful in identifying spondylolysis, though with greater radiation exposure [43, 44]. Chronic pars defects will not show uptake on bone scan or MRI and CT scan can show bone definition and healing.

Most athletes can be managed with conservative measures leading to good-to-excellent long-term outcomes. With spondylolysis, the first question that needs to be answered is if the lesion is acute or chronic. That can be determined by age, history, exam, and imaging. If acute, treatment is aimed at healing the injury and preventing nonunion. Rest with competition restriction is the initial mainstay of treatment with length of rest being dependent on age, acuity of injury, and symptoms.

In skeletally mature patients, recreational athletes, or chronic conditions with an acute flare, bracing can be used for pain control and as an adjuvant to activity modification during the inflammatory state and is discontinued once the patient's pain is improved to start physical therapy. In a mature or chronic patient, the goal should be symptom management without an expectation of defect union. Bracing may be contraindicated in a high-level athlete due to functional and strength loses while in the brace.

This period of rest can be longer than 3 months depending on clinical circumstances. Once symptoms improve, rehabilitation is added to the treatment with particular attention towards hamstring flexibility [39]. Older, advanced athletes may return faster depending on athletic requirements. Rehabilitation is started with low-impact aerobic conditioning and muscular stabilization. Once this is tolerated, the athlete is advanced to sport-specific training with attention focused on improving playing technique in a closely supervised fashion. Studies have shown healing between 3 and 6 months in skeletally immature patients, and this can be assessed by CT scan [38, 45]. If there is a question regarding back pain in adolescents, early referral to an orthopedic provider is warranted as Nielsen found earlier presentation to orthopedic providers decreased the time to diagnosis that can help with initiating appropriate treatment [46].

Both nonsurgical and surgical treatments of symptomatic spondylolysis can be effective in relieving pain and returning the athlete to play. An extended trial of nonoperative management is undertaken prior to operative consideration which is commonly a fusion or a direct repair of the pars defect [47]. Overley found that adolescent athletes return to play 92.2% of the time when treated nonoperatively. When surgery is required, the return to play afterwards decreases to 90.3%. Return to play can occur when symptoms have abated and fusion is mature [48]. For the advanced athlete, return can occur in the absence of neurologic symptoms and if they have demonstrated return to preinjury functional level even with continued symptoms. In general, treatment of spondylolysis and spondylolisthesis should be individualized based on the age, symptoms, sport, and level of competition [49].

Return to Play and Outcomes

Schroeder reviewed combined data on lumbar spine diagnoses as a predictor of outcome in professional football. Of the 2965 athletes reviewed, 14% were identified as having a preexisting lumbar condition with the most common being spondylosis, herniated disk, spondylolysis, and strain (followed by stenosis, fracture, SI joint pain, scoliosis, and kyphosis). Players without a lumbar diagnosis were more likely to be drafted. Players with a preexisting diagnosis, that were drafted, played for a shorter period of time, played less games, and started less games. However, there was no performance difference noted. Players with spondylosis, lumbar herniated disk, or spondylolysis were less likely to be drafted than controls, though there was no difference in career performance. Players with spondylolysis were associated with a shorter playing career, in both years played and games played. In further analysis between athletes who had been treated with nonoperative care versus micro discectomy for lumbar disk herniation, there was no difference in years played, games played, games started, or performance. Athletes treated with surgery, when compared to matched controls, did not demonstrate differences in years played, games played, games started, or performance [24].

Conclusion

The game of football places a tremendous amount of stress on the spine and injuries are common. Most injuries are minor and, with some basic treatment, an athlete can return to play quickly. However, catastrophic injuries do occur. Therefore, it is imperative to have a medical team that is aware of possible injuries, the treatment of injuries, a plan of care, and knowledge as to when to activate emergency services.

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