Spine Injuries in Soccer

Nicolas Plais, MD; Stephan N. Salzmann, MD; Jennifer Shue, MS; Carlos Diez Sanchez, MD; Fabian J. Urraza, MD; and Federico P. Girardi, MD

Abstract
Soccer is the most popular sport in the world, with more than 270 million participants. It is characterized by repetition of short and intense actions that require high-coordination capacity. It is a sport where interactions with other players put the athletes at risk for traumatic injuries. Lower-limb injuries are the most prevalent injuries in soccer. Spine injuries are less frequent; however, they can impose serious and debilitating sequelae on the athlete. These injuries can be associated with long recovery periods preventing return to play. Moreover, specific repetitive activities (heading, kicking, etc.) can lead to chronic injuries. The cervical spine is particularly at risk for degenerative changes. Considerations for when an athlete should undergo spinal surgery and the timing of return to play present a difficult challenge to spine specialists. The objective of this article is to review the epidemiology, diagnosis, treatment, and prevention of spinal injuries in soccer.

Introduction
Soccer is the most popular sport in the world, with more than 270 million participants. It is a contact sport where interactions with other players put the athletes at risk for traumatic injuries. Lower-limb injuries are the most prevalent injuries in soccer. Spine injuries are less frequent; however, they can impose serious and debilitating sequelae on the athlete. These injuries can be associated with long recovery periods preventing return to play. Moreover, specific repetitive activities (heading, kicking, etc.) can lead to chronic injuries. The cervical spine is particularly at risk for degenerative changes. Considerations for when an athlete should undergo spinal surgery and the timing of return to play present a difficult challenge to spine specialists. The objective of this article is to review the epidemiology, diagnosis, treatment, and prevention of spinal injuries in soccer.

Epidemiology
(a) Soccer injury rates
Soccer is a contact sport and a high rate of injuries has been reported (ranging from 2 to 19 injuries per 1000 h of exposure) (1,2). These injuries occur most frequently in the lower limbs, affecting especially the hamstring (posterior thigh strain) and the knees (isolated injuries to the medial collateral ligament). They account for 60% to 65% of all soccer injuries (1).

(b) Factors affecting injury rates
In a recent systematic review of injuries in male soccer players, Pfirrmann et al. (6) summarized the risk factors associated with injury. Matches and young age were the most important factors. Owing to an increased intensity during soccer games, injury risks were higher for matches than for training. Moreover, due to weaker neck muscles and skeletal immaturity, female and elite youth soccer players also present a higher susceptibility to injury (6,8).

Cervical spine injuries also are significant, but more difficult to assess with accuracy as most of the studies evaluate “head and neck injuries” collectively. Rates range between 3% and 7% (6) in professional soccer and due to the inclusion of concussion, rates as high as 18% have been reported during international tournaments (4).

Injuries in soccer are not exclusive to elite players. Youth (pediatric and adolescent population) and amateur players also are exposed to spinal injuries (7). Higher rates of lumbar spine injuries and higher severity of these injuries have been reported in adolescent female soccer with a reported injury rate of 17% (8).
Specific Characteristics of Soccer

Injuries are classified as acute or overuse. Acute injuries are based on the presence of a single identifiable event causing the injury. Overuse injuries are due to repetitive microtrauma and present an insidious onset without any known trauma (1,7).

Soccer is a team and contact sport. Acute injuries represent two thirds of all injuries in soccer (6). Falls, tackles, struggles for the ball, and impact head to head or on goal posts (especially for goal keepers) are frequent. Up to 25% of these traumatic injuries are caused by foul play (5). Walden et al. (5) classified acute traumatic injuries as sprain, joint injury, strain, contusion fracture, and dislocations.

Owing to higher intensity and competitiveness, the risk of soccer injuries has increased. Wallace and Norton (9) reported an increase of up to 15% in ball speed, player density (congestion), and passing rates in soccer final games between 1966 and 2010. Players’ physical characteristics also have changed over the years. An increase in body mass index and body composition shows heavier, stronger, and taller players (a mean increase of 4 kg and 4 cm between soccer athletes of 1977–1978 and 2007–2008) (10). The athletes have developed more power but also are exposed to more acute and chronic injuries.

On the other hand, overuse injuries account for 27% to 33% of all injuries (6). Soccer requires running at high velocities in rapidly changing surroundings. Players need to develop skilled activities at high velocities, like dribbling, kicking, jumping, and tackling. All these movements expose the spine to high demand of motion in flexion and extension, as well as twisting and axial rotation. Overuse spinal injuries are frequently related to improper mechanics and repetitive stress that adversely affect the stability of the spine (11). White and Panjabi (12) divided the mechanisms that support the spine stability into passive, active, and neuromuscular control. Deficits in any of these stability systems lead to injuries. A player needs strength, endurance, and neuromuscular control to execute a coordinated motor response and prevent injury by protecting joints from perturbation forces. As Donatelli et al. (11) emphasized, soccer players need more than just a normal range of motion (ROM). Dynamic stabilization and lumbo-pelvic control are of utmost importance to limit the impact of repetitive aggressive rotational movements.

Overuse injuries that affect the neck are a frequent subject in soccer scientific literature. Cervical heading is one of the most specific movements of soccer, and the repetitive stress on the neck has been associated with cervical degenerative injuries (13,14).

Types of Injuries

(a) Lumbar and thoracolumbar injuries

(i) Muscular injuries, sprains, and low back pain

Muscle strain is due to an abnormal stretching of the paravertebral muscles, and ligament sprain is defined as a tear of one of the solid spinal ligaments. Hyperflexion and hyper-extension, as well as axial rotation, place an excessive load on the spine muscles and ligaments. Patients present with pain and decreased ROM.

In every case, a thorough history and physical examination are necessary. The examination should include analysis of gait and posture, ROM, and observation of the back to look for hemangiommas, café au lait spot, or any spinal deformity or asymmetry of the pelvis or shoulders (7).

It is mandatory to rule out any possible red flags, such as neurological insult, fever, weight loss, deformity, night pain, or morning stiffness. The presence of any specific findings must be studied through complementary examinations. The diagnosis of muscle strain is one of exclusion, once all other possibilities have been elicited (7). Treatment is based on physiotherapy and rehabilitation programs that improve dynamic stabilization of the lumbo-pelvic-hip complex (core). Preventive programs with abdominal bracing, strengthening of hip and pelvic muscles that enhance core stabilization, and postural alignment are recommended (15). Return to play is allowed when the athlete is pain free and has full active ROM, normal strength, endurance, and flexibility (16).

(ii) Lumbar disk herniation

Herniated disks (HNP) are due to a tear in the fibrous ring of the intervertebral disk resulting in a bulging nucleus. Degeneration is the primary etiology but HNP also can be caused by trauma, especially in young patients. HNP are classified as central, posterolateral, foraminal, or extraforaminal. Patients complain of axial back pain with radicular pain that improves in the standing position and worsens when sitting, coughing, or sneezing. HNP can present as cauda equina syndrome with saddle anesthesia, bladder symptoms, and weakness. In the presence of neurological signs, complementary imaging examinations are necessary. X-rays provide useful information to rule out fractures or transitional abnormality. Magnetic resonance imaging (MRI) confirms the diagnosis.

HNP are thought to be more prevalent in athletes when compared with the general population (17); however, the treatment of HNP in athletes is essentially similar. Osterman et al. (18) has shown that lumbar microdiscectomy offers only short-term benefits compared with nonoperative patients. For this reason, in the absence of a progressive neurologic deficit or intractable pain, surgery is recommended after exhausting conservative treatment (19). For patients with persistent radiculopathy, epidural or transforaminal steroid injections have been shown to provide moderate short-term benefits (19) and rates of return to play as high as 89% in athletes (20).

These general treatment principles do not change in athletes, but in the presence of a disc extrusion or motor weakness, the need for early return to play may tip the balance toward surgery. An individualized approach is recommended for each patient (20). When surgery is recommended, microdiscectomy is the gold standard (19). Lumbar microdiscectomy has favorable outcomes with reports of 75% to 100% of elite athletes returning to play within 6 months (16).

(iii) Thoracic disk herniation

Thoracic disk herniations (TDH) are rare. They represent only 0.25% to 0.75% of all disc herniations. As reported by Baranto et al. (21), they can be challenging to diagnose and have severe consequences for patients. The main clinical sign is pain, but patients can present with unSpecificant or confusing symptoms, such as thoracic pain that mimics an aortic dissection or pulmonary embolism and 90% with neurologic symptoms. Neurological deficits occur in 60% of the cases (22).

Conservative treatment, physiotherapy, and epidural steroid injections are the first-line treatment in patients with
pain and reduced ROM. However, in the presence of neurological disturbances or giant calcified TDH, surgery is indicated (21,22). Discectomy with or without fusion via posterolateral approaches are indicated for soft lateral hernias. Transthoracic approaches seem to be safer for giant, central calcified hernias (22), but are still associated with important morbidity and high rates of complications.

(iv) Degenerative disk disease

Kirkaldy-Willis et al. (23) described three phases of degeneration of the lumbar spine. Phase I is characterized by dysfunction and back pain, which are the most frequent findings during active sport life. As shown by Hangai et al. (24), severe LBP in youth can be a predictor of disk degeneration and most of the young players with LBP between 20 and 40 years old belong to this phase. Phase II is defined by instability and occurs later in life. Phase III is restabilization due to ligament calcification and spondylophyte formation. These typical phase III changes are infrequent findings in active soccer players.

Degenerative disk disease (DDD) is associated with a wide variety of intrinsic and extrinsic factors. Physical loading, specifically in competitive sports, has been associated with lumbar disk degeneration (24). Athletes who have been training for many years have an increased risk of DDD.

Öztürk et al. (25) reported an increase in osteophytes, decreased lumbar disk height, and lower values for vertebral endplate concavity indexes. When DDD is suspected, radiographic assessment with static X-rays (AP and lateral) and dynamic X-rays are necessary to check for stability. Segment instability has been defined (12) as translational instability for 4 mm of sagittal plane translation anteriorly or 2 mm posteriorly and as rotational instability for rotation >15° at L1-4, >20° at L4-5; and >25° at L5-S1. If neurological or motor dysfunction is suspected, an MRI should be done and is useful to grade the severity of DDD based on the Pfirrmann classification system.

In the general population, nonoperative treatment with pain medication, epidural or transforaminal steroid injections, behavioral therapy, and multidisciplinary rehabilitation constitute the main therapeutic approach for DDD (26). Surgical treatment is recommended when patients are not responsive to conservative treatments. Lumbar spine fusion is the gold standard when segment instability is confirmed. No studies have evaluated return to play after lumbar surgery for DDD, but a general consensus is return to play is permissible in asymptomatic patients with restored strength, flexibility, and endurance that present with radiographic evidence of solid fusion (16). Total disk replacement can be an alternative to fusion and has been indicated in patients with one level degenerative disease, absence of instability, mild endplate changes, and low pelvic incidence (PI) (27).

(v) Spondylolysis and spondylolisthesis

Spondylolysis is defined as a fracture of the pars interarticularis and can be unilateral or bilateral. Spondylolisthesis (SPL) is described as the slippage of the upper vertebrae over the one below it. As reported by Sakai et al. (28), much higher rates of spondylolysis (as high as 30%) have been reported in young athletes and in young soccer players in the Japanese pediatric and adolescent population, which was five times the national average (5.9%).

Patients present with lumbar back pain and a positive hyperextension test. El Rassi et al. (29) reported 43% of children with SPL noticed that pain started with a high velocity kick. High-grade SPL shows a more complex clinical presentation with back pain, flat back with a lumbar step off, neurological deficits in 15% of the cases and in some cases, a bent-knee and hip-flexed gait. Spondylolysis behaves like a stress fracture due to repetitive stress. In an immature skeletal system, repetitive hyperflexion and hyperextension during the first and third phases of kicking (29) (Fig.) and axial rotation lead to a fracture of the pars interarticularis. Classically, two mechanisms have been identified according to PI, a spinopelvic parameter (31): 1) the “nut-cracker” in patients with lower PI and 2) the “shear” mechanism in patients with high PI. In 90% of cases, lysis occurs at L5, and the risk of slippage increases significantly in patients with high PI (31).

Radiographic assessment must consist of long-standing X-rays, an MRI, or a computed tomography (CT) scan. The MRI can detect a lysis at a very early stage. When the lysis is associated with slippage of the vertebra, the Meyerding classification is used to grade the degree of slippage of a vertebral body over the body beneath it (32). Recently, a new classification based on spinopelvic alignment has been presented (30). The detailed treatment of SPL goes beyond the scope of this review, and we will focus on the treatment alternatives for spondylolysis.

Conservative treatment for spondylolysis is the gold standard. It consists of activity restriction and the use of a thoracolumbosacro brace for 2 to 3 months. High healing rates are obtained within a short period of nonoperative treatment (33). When conservative treatment fails due to disabling pain or in the presence of progression to SPL, direct surgical repair of the lysis or posterolateral fusion are two alternatives (34). Pars fusion allows preservation of mobility at the L5-S1 segment. Positive outcome rates have been

**Figure:** Phases of kicking adapted from Rassi et al. (30) (A) Phase 1: hyperextension of the trunk, (B) Phase 2: contact with the ball, (C) Phase 3: hyperflexion of the trunk.
described with three different pars repair surgical techniques (Buck screw, Scott wiring technique, and Morscher hook screw) (34). A total of 80% to 100% of athletes achieved return to play within 6 to 12 months (16).

\textit{(vi) Thoracolumbar fractures}

Thoracolumbar fractures can be classified as stress fractures due to repetitive microtrauma or high-energy injuries. Stress fractures usually affect the endplates or the transverse apophysis. As soccer is a contact sport, Gotfryd et al. (35) warns about the risk of severe injuries due to high-energy traumatism in soccer games.

The revised AOSpine (AO = Arbeitsgemeinschaft für Osteosynthesefragen) injury classification system provides a framework for classification and treatment management (36). According to the injury mechanism (compression, tension band injuries, and translational injuries), fractures are classified into three main types and subtypes (Table 1). The assessment of neurological status and two other modifiers (suspicion of injury of the posterior ligamentous complex and patients’ specific comorbidities) are taken into account for the treatment algorithm.

The literature is scarce on the epidemiology of thoracolumbar fracture injuries in soccer. However, Gotfryd et al. (35) presented a case report of a thoracolumbar fracture during a professional female soccer game. Collision while jumping and falling on the back was the mechanism of the injury.

Patients with a thoracolumbar facture present with severe pain, disability, focal kyphosis, and in some cases, with neurologic deficit. To the authors’ knowledge, there are no reports of thoracolumbar fractures with neurologic deficits in soccer. Diagnosis consists of X-rays, CT scan, and an MRI when there is suspicion of a posterior ligament complex injury. The treatment depends on the type of fracture. There is a clear consensus for management with nonoperative treatment as a first option in stable fractures: types A0, A1, and A2 fractures (37). Treatment consists of a brace followed by intensive postoperative rehabilitation treatment. Controversies exist in A3, A4, and B1 fracture types. Types B2, B3, and all type C need to be stabilized surgically (37).

The role of minimally invasive (MIS) techniques is of particular interest in athletes (38). MIS techniques are associated with decreased morbidity and enable earlier mobilization and return to baseline function. In young patients and athletes with pure-bone injuries, short fixation through posterior percutaneous pedicular screws can be used as internal bracing to provide stability during the healing of the fracture. If the anterior column needs to be restored, a mini-open lateral approach is less aggressive than the traditional open lateral approach. Return to play is allowed, but never before 6 months. The patients must be pain free, present with complete ROM, endurance and strength, and radiographic evidence of fusion (16).

\textit{(b) Cervical injuries}

The cervical spine is the most mobile and, thus, the most vulnerable part of the spine. In soccer, injuries to the cervical spine are rare, but they can cause considerable morbidity. Soccer is unique in that the head can be used to control and advance the ball. Players often have to compete for air balls, especially in the penalty area or near the midfield. Trauma or repetitive stress on the neck places players at risk for overuse injuries, as well as acute or traumatic injuries. As stressed by Killer et al. in a recent review on return to play after cervical spine injuries, there is limited literature on this topic, and guidelines are primarily based on expert opinion (39).

\begin{table}[h]
\centering
\footnotesize
\begin{tabular}{|p{2cm}|p{10cm}|}
\hline
\textbf{Type A Injuries} & Compression Fractures of the Vertebral Body \hline
Subtype A0 & Describe minor injuries and include transverse and spinous process fractures. Direct impact can lead to transverse fractures and spasms in the strong paraspinal muscles can produce avulsion fractures. \hline
Subtype A1 & Wedge-compression fractures with fracture of a single endplate without involvement of the posterior wall of the vertebral body. Slow loading axial forces produce wedge-shaped compression fractures. \hline
Subtype A2 & Split or pincer type. The fracture line involves both endplates but does not affect the posterior wall. \hline
Subtype A3 & Incomplete burst. Affect a single endplate and the posterior wall. \hline
Subtype A4 & Complete burst fractures. Involvement of both endplates and the posterior wall of the vertebral body. Burst fractures are caused by rapid-loading forces. \hline
\textbf{Type B injuries} & Tension band injuries \hline
Subtype B1 & Pure transosseous tension band disruption: Disruption of the posterior tension band due to a mono-segmental osseous injury. \hline
Subtype B2 & Posterior tension band disruption due to an osseoligamentous injury. \hline
Subtype B3 & Hyperextension with disruption of the anterior longitudinal ligament. \hline
\textbf{Type C injuries} & Translational injuries \hline
& They are characterized by the dislocation or displacement of the spinal column. These are the most severe injuries and can often be associated with neurologic deficits. \hline
\end{tabular}
\caption{AOSpine thoracolumbar fractures classification.}
\end{table}
(i) Muscular injuries, cervical sprains, and cervical pain

Cervical strain of the neck musculature and sprains of the ligamentous structures are the most common sports-related neck injuries (40). These injuries are underreported as the players are reluctant to stop playing despite these injuries. Treatment consists primarily of physiotherapy. Mastering the technical aspects of heading and developing the strength of the neck muscles is important to prevent such injuries.

(ii) Stingers/Burners

Stingers or burners are defined as transient episodes of cervical neuropraxia that affect one upper extremity. By definition, these symptoms resolve rapidly. Stingers are common in contact sports, like rugby or American football, but are much less frequent in soccer. Patients present with pain, weakness, and/or paresthesia and complain of burning or tingling sensations in the arm with transient weakness. All patients who experience a stinger must be examined thoroughly. Two main mechanisms of injury have been described, which include a traction injury to the brachial plexus and more frequently, neurologic deficits due to foraminal or canal narrowing (41).

Indication for return to play is controversial and based on expert opinion (41). No restrictions exist after a first episode (fewer than three stingers in less than 24 h), but players who suffer a second stinger in the same season should be removed from the current game. Finally, independent of the number of stingers suffered during the same season, return to play is allowed in players with full cervical ROM, a normal neurological examination, no signs of spinal cord abnormality, no fracture or signs of cervical spine instability, and an asymptomatic cervical disc.

Cervical cord neuropraxia or transient quadriplegia is defined as a neurologic deficit in more than one limb that resolves within 2 d. It has been associated with a forced hyperflexion or hyperextension on a stenotic canal.

(iii) Overuse injuries: disk herniation and DDD in the cervical spine

Soccer is a contact sport and disk herniation from a cervical intervertebral disc prolapse or rupture can result from physical trauma to the cervical spine. Repetitive trauma on the neck also can cause a cervical disk herniation.

Heading is a common activity in soccer. During a game, players make head contact with the ball an average of five to six times (13) and practicing heading is an important part of training sessions. Cases of disk herniation in soccer athletes have been reported (42,43). Diabira et al. (42) present a case of a young soccer player with sudden transient tetraplegia after heading due to a C3-4 disk collapse and Kato et al. (43), a case of chronic spinal cord injury due to C3-4 disk herniation. These injuries may be acute, but are more often the result of a degenerative process and classified as chronic athletic injuries (39).

Although high-level evidence on the clinical impact of heading is largely lacking, there is consensus that it produces long-term effects on the cervical spine due to recurrent impact and trauma (13,14,44). Sortland et al. (13) reported posttraumatic changes in former soccer players, with more pronounced degenerative changes in the lower cervical spine, especially at the uncovertebral joints and a decreased ROM compared with a control group. Other authors have reported early degenerative changes in the cervical spine (10 to 20 years earlier) in soccer players (44).

Cervical disk herniation can be asymptomatic or present with neck pain, nerve root compression (radiculopathy), or spinal cord compression (myelopathy). Patients with asymptomatic herniated disks should present with complete and painless ROM before being allowed to return to play (39).

In the cases of myelopathy, surgery is indicated. In patients with radiculopathy, surgery may be indicated only after failure of conservative treatment. Anterior cervical decompression and fusion (ACDF) is the most frequently used technique to approach cervical disk herniation. Symptomatic disk herniation is an absolute contraindication to return to play (39). However, Molinari et al. (45) have reported successful return to competitive sports after a single-level ACDF. Moreover, Kepler et al. found that patients who undergo one- or two-level fusion and demonstrate successful union and full ROM only present a relative contraindication to return to play (39). Finally, new MIS techniques, such as MIS posterior foraminotomy, allow resection of the disk herniation while decreasing the risk of destabilization. These techniques are

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Table 2.
AOspine upper and lower cervical fractures classification.

<table>
<thead>
<tr>
<th>I. Occipital Condyle and Cranio cervical Junction Injuries</th>
<th>II. C1 Ring and C1–2 joint</th>
<th>III. C2 and C2–3 joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A Isolated bony injury (condyle)</td>
<td>Type A Isolated bony injury (arch)</td>
<td>Type A Bony injury only without ligamentous, tension band, discal injury</td>
</tr>
<tr>
<td>Type B Nondisplaced ligamentous injury (craniocervical)</td>
<td>Type B Nondisplaced ligamentous injury (transverse atlantal ligament)</td>
<td>Type B Tension band/ligamentous injury with or without bony injury</td>
</tr>
<tr>
<td>Type C Any injury with displacement on spinal imaging</td>
<td>Type C Atlantoaxial instability/translation in any plane</td>
<td>Type C Any injury that leads to vertebral body translation in any directional plane</td>
</tr>
</tbody>
</table>
especially attractive in young patients and athletes who typically seek to return to play sooner (46).

(iv) Fractures, dislocations, and ligamentous injuries in the cervical spine

Cervical vertebral fractures or dislocations are the most common causes of catastrophic neurologic injury in sports (39). They are classified in injuries that affect the upper cervical (47) or the subaxial spine (48). Inspired by the AO classification for the thoracolumbar system, two recent classifications of cervical vertebral injuries are based on three morphology types: type A for bony or compression injuries, type B for tension band, and type C for translational injuries (Tables 2 and 3). Neurologic status and different modifiers complete the classification.

Literature is scarce on traumatic cervical injuries in soccer, but isolated cases are cautionary for serious spine injury due to falls, collisions, or tackles (49). Recently, Silva et al. (40) reported two cases of severe neck injuries due to a burst fracture at C5 and a hyperextension injury that lead to tetraplegia.

Mehnert et al. (14) analyzed the potential acute injuries after heading. Soccer heading is a complex activity that involves the neck muscles in addition to the trunk and the legs. Axial loading injuries on a spine straight (spear tackler’s spine) or cervical hyperflexion and hyperextension does not apply routinely to heading when proper technique is used. However, spontaneous impact or rotational overload can lead to severe injuries or instability (50).

Most benign fractures, such as isolated spinous fractures or compression fractures without instability, can be managed nonoperatively. The presence of instability, facet dislocations, flexion-distraction, translational injuries, or neurologic deficits may be operative criteria. Return to play is possible after a cervical fracture, but never before 8 to 10 wk (39). Painless, full ROM, radiographic evidence of healing of the fracture, as well as rehabilitation and recovery of muscle strength is necessary. Kepler et al. (39) lists conditions that are absolute contraindications for return to play (Table 4). Finally, in patients with a spinal cord concussion, there is limited evidence to guide return to play.

Conclusions

Spine injuries are common in elite soccer players. Soccer is a contact sport in which heading, kicking as well as hyperextension, hyperflexion, and rotational repetitive movements place players at risk of overuse and acute spine injuries. Prevention and training are critical to avoid long-lasting injuries. In addition, abdominal bracing, hip and pelvic muscles, core and neck muscle strengthening are of paramount importance. Most spinal soccer injuries do not require spinal surgery. Surgery is an option if symptoms return or worsen. Return to play is possible after spine surgery.

The authors declare no conflict of interest and do not have any financial disclosures.

References


Table 3.

AOSpine subaxial fractures classification.

<table>
<thead>
<tr>
<th>Type A Injuries</th>
<th>Compression Fractures of the Vertebral Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtype A0</td>
<td>Minor, nonstructural fractures.</td>
</tr>
<tr>
<td>Subtype A1</td>
<td>Wedge-compression fractures</td>
</tr>
<tr>
<td>Subtype A2</td>
<td>Split fractures</td>
</tr>
<tr>
<td>Subtype A3</td>
<td>Incomplete burst. Affect a single endplate</td>
</tr>
<tr>
<td>Subtype A4</td>
<td>Complete burst fractures. Involvement of both endplates and the posterior wall of the vertebral body.</td>
</tr>
<tr>
<td>Type B injuries</td>
<td>Tension band injuries</td>
</tr>
<tr>
<td>Subtype B1</td>
<td>Posterior tension band injury (bony)</td>
</tr>
<tr>
<td>Subtype B2</td>
<td>Posterior tension band (bony capsulo-ligamentous, ligamentous)</td>
</tr>
<tr>
<td>Subtype B3</td>
<td>Anterior tension band injury</td>
</tr>
<tr>
<td>Subtype BL</td>
<td>Bilateral injury</td>
</tr>
<tr>
<td>Type C injuries</td>
<td>Translational injuries</td>
</tr>
<tr>
<td>Subtype C1</td>
<td>Translational injury in any axis displacement or translation of one vertebral body relative to another in any direction</td>
</tr>
<tr>
<td>Type F injuries</td>
<td>Facet injuries</td>
</tr>
<tr>
<td>Subtype F1</td>
<td>Nondisplaced facet fracture</td>
</tr>
<tr>
<td>Subtype F2</td>
<td>Facet fracture with potential for instability</td>
</tr>
<tr>
<td>Subtype F3</td>
<td>Floating lateral mass</td>
</tr>
<tr>
<td>Subtype F4</td>
<td>Pathologic subluxation or perched/dislocated facet</td>
</tr>
</tbody>
</table>

Bilateral injury

Table 4.

Absolute contraindications for return to play.

- Atlantoaxial fusion
- Antlantoaxial rotatory fixation or instability
- Subaxial instability
- Trauma induced sagittal malalignment
- Cervical stenosis
- Persistent neurological findings
- Limitation of ROM
- Three or more level anterior or posterior cervical fusion