

[Orthopaedic Surgery]



Return-to-Play Recommendations After Cervical, Thoracic, and Lumbar Spine Injuries: A Comprehensive Review

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Context: Currently, there is a national focus on establishing and disseminating standardized guidelines for return to play for athletes at all levels of competition. As more data become available, protocols and guidelines are being refined and implemented to assist physicians, coaches, trainers, players, and parents in making decisions about return to play. To date, no standardized criteria for returning to play exist for injuries to the spine.

Evidence Acquisition: Electronic databases including PubMed and MEDLINE and professional orthopaedic, neurosurgical, and spine organizational websites were reviewed between 1980 and 2015.

Study Design: Clinical review.

Level of Evidence: Level 4.

Results: Although clinical guidelines have been published for return to play after spine injury, they are almost exclusively derived from expert opinion and clinical experience rather than from well-designed studies. Furthermore, recommendations differ and vary depending on anatomic location, type of sport, and surgery performed.

Conclusion: Despite a lack of consensus and specific recommendations, there is universal agreement that athletes should be pain free, completely neurologically intact, and have full strength and range of motion before returning to play after spinal injury.

Keywords: return to play; spine injury; sports; spine surgery

The annual incidence of spinal cord injury is approximately 40 cases per 1 million Americans, resulting in approximately 12,500 new cases each year.³² After motor vehicle accidents (38%), falls (30%), and violence (14%), athletic participation accounts for 9% of these injuries. While spinal cord injuries resulting in death or permanent paralysis represent the most devastating spectrum of injury, cervical strains, burners, and stingers are far more common. Up to 70% of college football players experience burners or stingers during a 4-year career.³ In the first 10 years after head-first tackling was banned in 1976, the rate of cervical injuries decreased by 70% at the high school level, from 7.72 per 100,000 to 2.31 per 100,000. Additionally, traumatic quadriplegia decreased by approximately 82% over the same 10-year period.^{5,43} Significant advancements

in personal protective equipment for contact athletes have contributed to the overall reduction in injury.^{35,44}

Standardized protocols have been, or are currently being, developed for return to sport after anterior cruciate ligament (ACL) reconstruction, concussions, and many other musculoskeletal injuries treated both operatively and conservatively. However, there is no such consensus for return to play after injury to the spine in athletes. The reasons for the lack of guidelines are multifactorial but likely due to the more complex anatomy and wide spectrum of injuries to the spine, as well as the decreased incidence of these injuries over the past 40 years. The myriad spinal conditions, injuries, and surgical options highlight the need to evaluate return-to-play guidelines after spine injuries according to each specific injury and its

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The following author declared potential conflicts of interest: Lawrence Lemak, MD, is a paid consultant for Drayer Physical Therapy and is Chief Medical Officer of Major League Soccer (MLS).

DOI: 10.1177/1941738115610753

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respective treatment modality. The purposes of this article are to (1) review the available literature regarding return to play after spine injuries, including those treated surgically, and (2) provide a comprehensive review of current guidelines for return to play after injury to each anatomic location in the cervical, thoracic, and lumbar spine.

CERVICAL SPINE

Torg and Ramsey-Emrhein,⁴² Cantu et al,¹¹ and Vaccaro et al⁴⁴ each proposed guidelines for the management of several major cervical spine injuries that included return-to-play recommendations. Torg and Ramsey-Emrhein⁴² divided return-to-play criteria into 3 separate categories based on risk of serious injury or reinjury: (1) no contraindication with no increase in risk of serious injury, (2) absolute contraindication with a clear increased risk of serious injury, and (3) relative contraindications with no clear evidence of increased risk but possible recurrent injury or noncatastrophic injury (see Table 1 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).⁴² Cantu et al¹¹ also divided return-to-play criteria based on contraindications very similar to Torg's (see Table 2 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>). Perhaps the most comprehensive guidelines are those proposed by Vaccaro et al,⁴⁴ which also followed the works of Torg and discuss recommendations in similar terms (see Table 3 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).

The 3 sets of guidelines are very similar, with some modifications made based on clinical experience and scientific data. The lack of consensus on the management of athletes after cervical spine injury has been highlighted.³¹ Published guidelines were used in the decision for return to play in only 1 of 10 clinical scenarios.

Stingers and Burners

Stingers and burners are injuries to the cervical nerve roots that supply the upper extremities that result in transient loss in sensory and/or motor function that leads to stinging, burning, or radicular pain to the affected extremity.²⁹ Generally, symptoms are temporary and last a few seconds or minutes. These injuries can be acute or chronic but are typically the result of 1 of 3 mechanisms³⁵: (1) stretch or traction of the brachial plexus from bending of the neck to the opposite side, usually as a result of tackling or landing on the side of the helmet; (2) hyperextension of the cervical spine resulting in nerve root compression in the neural foramina; or (3) direct blow to the brachial plexus at its most exposed anatomic location, which is defined as Erb's point. These injuries appear to be more consistent with the last mechanism—direct compression—due to the decrease in injuries in American football players at the United States Military Academy after using protective shoulder pads.²⁹

Although the diagnosis of stingers/burners is usually evident from symptoms, it is important to consider more serious

etiology as part of the differential diagnoses. These include fractures/dislocations of the cervical vertebrae, disk herniation, transient neurapraxia, and congenital abnormalities (Figure 1).⁵

There is some controversy regarding return to play after a stinger- or burner-type injury. More than 3 episodes of stingers/burners may be a relative contraindication for return to play.^{11,45} There is consensus on return to play once the patient is completely symptom free and has full strength and range of motion without evidence of other injury on plain radiographs or advanced imaging. Players with a third stinger in the same season should undergo radiographs at a minimum.²⁷ For severe, persistent, or recurrent symptoms, magnetic resonance imaging (MRI), computed tomography (CT), and/or electromyography (EMG) are recommended to evaluate for congenital anomaly, stenosis, or further cord/nerve compromise.^{11,45}

Cervical Strains and Sprains

Cervical soft tissue injuries generally include a ligamentous sprain or muscular strain in the supporting structures of the cervical spine. These players may return to competition once they meet the 4 general criteria already described.⁴⁰

Of critical importance when evaluating the athlete with a suspected cervical strain is to rule out instability from complete ligamentous disruption. This can be particularly challenging in the young athlete, where ligamentous laxity is commonly seen as a normal variant.^{8,11,49} A complete and thorough physical examination is of critical importance. In these cases, radiographs should not demonstrate any subluxation of the cervical vertebrae; flexion/extension views should be obtained initially as well as 2 to 4 weeks after the injury.^{6,27} If instability is suspected based on symptoms or clinical examination, a hard cervical collar should be worn in the interim.¹¹

Cervical Stenosis and Cervical Cord Neurapraxia

With cervical stenosis and cervical cord injury, evaluation of the Torg ratio and its relationship to injury of the cervical spinal cord has been recommended.⁴¹ The Torg ratio is the distance from the midpoint of the posterior aspect of the vertebral body to the nearest point on the corresponding spinolaminar line and dividing this value by the anteroposterior diameter of the vertebral body measured on a lateral radiograph (Figure 2).⁴¹ The normal Torg ratio is 1.0, with any value lower than 0.8 indicative of spinal stenosis.⁴¹ Cervical cord neurapraxia may also present with transient quadriplegia/quadruparesis, which typically includes symptoms similar to central cord syndrome.¹¹ These symptoms manifest as temporary bilateral burning paresthesias and varying degrees of weakness involving the arms, legs, or all 4 extremities.^{11,44} In a retrospective study, the Torg ratio was extremely sensitive: 93% for transient neurapraxia in football players.⁴¹ However, the Torg ratio had a very low positive predictive value of 0.2% for determining future injury. Furthermore, the ratio may not be as accurate in professional football players due to their larger vertebral bodies that

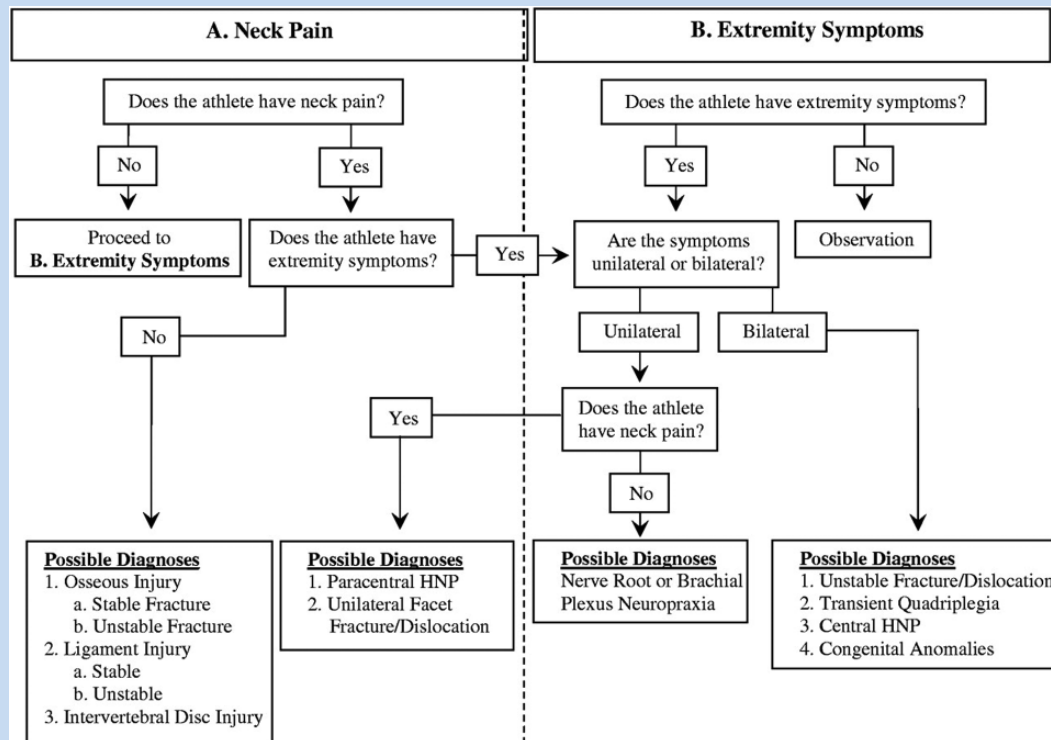


Figure 1. Diagnostic algorithm of cervical spine injuries. HNP, herniated nucleus pulposus. Reprinted with permission from Banerjee et al.⁵

inherently lower the ratio.²³ As such, it is not useful as a screening examination or to determine ability to return to play in contact sports.^{41,44}

Alternatively, cervical stenosis may be evidenced by the amount of cerebrospinal fluid surrounding the cord.¹¹ “Functional” spinal stenosis is defined as a cervical spine canal so small that it obliterates the protective cushion of the cerebrospinal fluid (CSF) or, in extreme cases, may deform the spinal cord itself.¹⁰ This should be an additional consideration in the evaluation of transient neurapraxia and return to play based on the premise that canal parameters measured on plain radiographs do not indicate functional stenosis.¹¹ Therefore, CT myelogram or MRI are needed to evaluate functional stenosis, which is a contraindication for return to play.¹¹

The general recommendation for players who experience an episode of transient neurapraxia is plain radiographs and MRI.²⁷ If these studies do not reveal a cord abnormality, fracture, or neural compression and the player meets the 4 general criteria, they may return to play. However, with stenosis, ligamentous injury, cord defects, or edema, return to play is contraindicated.^{27,40} There is some controversy regarding whether the above findings are absolute or relative contraindications.^{11,44} The decision to return to play should be determined on an individual basis considering the degree of

stenosis, the chance of reinjury dependent on sporting activity, and the severity of symptoms.

Cervical Disk Herniation

The prevalence of cervical disk herniation in the asymptomatic population is variable but may be 25% for those younger than 40 years and 60% for those older than 40 years.²⁰ There is a greater incidence of cervical disk disease in professional football players.⁴⁹ Asymptomatic disk herniation is not a contraindication to athletic participation.^{27,42} As long as these athletes meet the general criteria, there may be no need for physical activity limitation.⁸ However, symptomatic herniation is a contraindication for return to play.^{27,42}

In all guidelines, symptomatic disk herniation remains an absolute contraindication to athletic participation.^{11,18,42,45} The concern is that the relative spinal or foraminal stenosis caused by an acute disk herniation places the athlete at an increased risk for further and potentially more severe cord or nerve root damage.²⁷ Conservative management is the first-line treatment for acute cervical disk herniation.⁴⁹ Surgery should only be considered in the acute phase when myelopathy or progressive neurological deficits are present.⁴⁹ In American football players, excellent outcomes, higher return-to-play rates, and longer careers have been achieved surgically compared with conservative treatment.²⁴ This study only included players with

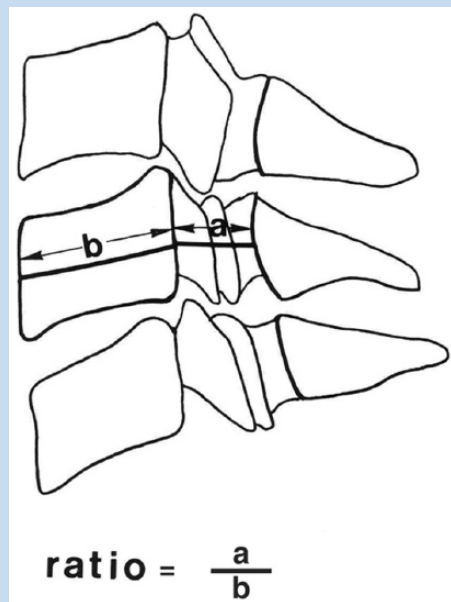


Figure 2. Torg ratio. “a” is the distance from the midpoint of the posterior aspect of the vertebral body to the nearest point on the corresponding spinolaminar line and “b” is the anteroposterior diameter of the vertebral body. Ratio is obtained by dividing “a” by “b.”

a single cervical-level fusion. Controversy remains about management and return-to-play guidelines for athletes with multiple fusion levels.^{11,44} Two-level fusions are considered a relative contraindication, even with a well-healed fusion in players who meet the general criteria.^{42,45}

No consensus exists regarding return-to-play recommendations after injury to the cervical spine. An individualized approach to each athlete is recommended that includes careful consideration of the mechanism of injury, the anatomy of the patient, the anatomic location of the injury, plain radiographs and advanced imaging, and the patient's recovery. The athlete should have, at a minimum, a full and pain-free range of motion with full strength and no neurologic findings before returning to play.

THORACIC SPINE

In contrast to the cervical and lumbar spine, there are no published guidelines for return to play after injuries to the thoracic region. These injuries are much less common due to the biomechanics of the thoracic spine, its relative immobility compared with the cervical and lumbar regions, and the protection afforded by the rib cage.⁹ Spinal stenosis is less likely to occur in this region due to the larger ratio of spinal cord to spinal canal diameter.⁹

Compression fractures, though common in the general aging population, are relatively rare in young athletes. According to the American Association of Neurosurgeons, approximately

750,000 vertebral compression fractures are diagnosed each year, mostly in postmenopausal women older than 80 years.⁴ There are no such statistics for professional athletes, and only a few scattered case reports exist in the literature. Compression fractures of the eighth and ninth thoracic vertebrae in a professional football player have been managed conservatively with a thoracolumbar spinal orthosis, with athletic participation after 3 months and a return after 2 years to professional football without limitation or pain.¹⁷ A T12 compression fracture in an 18-year-old basketball player was treated conservatively, and the patient returned to play after 3 months.³⁰ Similar treatment has returned patients to contact sports after healed compression fractures in the thoracic spine if the patient meets general criteria.³⁰ A similar conservative treatment approach and return-to-play criteria have been suggested for spinous process and transverse process fractures.¹⁶

Acute fractures of the spine with instability of the spinal column (burst or Chance fractures) are contraindications to athletic participation.¹⁶ After surgical stabilization, however, there are a few proposed return-to-play guidelines.^{17,30} Spinal fusions that bypass transition zones in the cervicothoracic or thoracolumbar region are an absolute contraindication to participation in contact sports.⁹ Similarly, fusions that terminate at these transition zones represent a contraindication for return to play.⁹ However, players may return to play if a fusion does not cross transitional levels and they meet general criteria.⁹

LUMBAR SPINE

Two recent guidelines have been proposed for managing the following injuries to the lumbar spine: strain, herniated disk, lumbar stenosis, spondylolysis, and spondylolisthesis (see Table 4 in Appendix, available at <http://sph.sagepub.com/content/by/supplemental-data>).^{15,16}

Lumbar Strain

Strains in the lumbar region are among the most commonly encountered injuries and are responsible for 70% of low back pain in the general population.^{13,15} Radiographs or advanced imaging are warranted in athletes with persistent pain, neurologic symptoms, radicular type pain, or a clinical suspicion for more serious etiology. Management of these injuries is conservative and consists of rest, ice, anti-inflammatory medications, and progressive return to activity as tolerated by the athlete.²¹ Pain should be used as a guide for advancing activity levels, and the general criteria should be met before returning to competition.¹⁵

Herniated Nucleus Pulposus

Lumbar disk herniation is more prevalent in elite athletes compared with the general population, especially in gymnasts and American football linemen.^{28,48} Plain radiographs are of limited value in the evaluation of disk disease, and MRI is considered the gold standard. However, MRI findings should correlate with the athlete's symptoms and examination, as

herniated disks and degenerative changes are commonly seen in up to 35% of asymptomatic patients aged 20 to 39 years.²⁶ Herniation in athletes is often the result of the rigorous demands of weight training and performance. The body mass index (BMI) of some professional athletes, the repetitive and strenuous motions of tackling, and repeated lumbar flexion/hyperextension are also contributing factors (eg, gymnasts, football linemen).⁴⁸

Most athletes respond well to conservative management, including epidural steroid injections.¹⁶ Failed conservative management, cauda equina syndrome, or progressive, profound neurological deficit represent indications for surgical intervention. The SPORT (Spine Patient Outcomes Research Trial) studies illustrate excellent outcomes of surgical treatment of lumbar disk herniation in the general population⁴⁷ but may not be applicable to the professional athlete.

The Professional Athlete Spine Initiative demonstrated a very high return-to-play rate (81%) after surgical treatment of herniated lumbar disks,²⁵ as have other studies in professional athletes.⁴⁸ The notable differences in these outcomes and return-to-play rates are dependent on the age of the player at the time of surgery and the type of sport.²⁵ A case series of professional athletes undergoing lumbar discectomy found return-to-play rates stratified according to a time line.⁴⁶ The rates of return were 50% at 3 months, 72% at 6 months, 79% at 9 months, and 84% at 12 months; the overall rate of return was 89%. The mean time to return to play was 5.3 months.⁴⁶

With conservative management, the athlete should meet general return-to-play criteria before resuming activity. Return to play after 2 to 6 months is plausible for contact sports after percutaneous discectomy and microdiscectomy (see Table 4 in Appendix) and 4 to 8 weeks for lighter activities such as golf.¹

Spondylolysis

Spondylolysis has an estimated prevalence of approximately 3% to 6% in the general population, although this is higher in athletes.³⁸ The most common locations for this injury are at L5 in 85% to 95% of cases and L4 in 5% to 15% of cases.^{12,19,36} Spondylolysis is more commonly encountered in the skeletally immature athlete due to the vulnerability of the immature pars to repeated stress.¹⁶ These patients typically respond well to nonoperative management, with bracing and activity modification when compared with their skeletally mature counterparts.^{16,39} Patients typically present with localized lumbar pain that is worsened with extension. There should be a high index of suspicion in the skeletally immature athlete with these symptoms. Sports with repetitive stresses to the lumbar spine such as gymnastics, diving, weightlifting, and wrestling demonstrate the highest risk.^{12,19,36} Initial evaluation should include anterior-posterior and lateral radiographs. The diagnostic benefit of additional oblique films is currently controversial.⁷ Single photon emission computed tomography (SPECT) is helpful when initial screening radiographs are negative.¹⁶

Initial treatment includes bracing and activity modification, followed by progressive physical therapy.¹⁶ Good to excellent results have been reported in 80% of athletes with spondylolysis treated conservatively.¹⁴ These athletes are allowed to return to play once they have met the general criteria for contact sports, usually a minimum of 4 to 6 weeks.¹⁶ Longer periods of rest and immobilization (8-12 weeks) have also been advocated.³³ Regardless, for athletes who fail conservative management, surgical treatment with iliac crest bone grafting and posterolateral fusion have been recommended.^{22,38}

Return to play after surgical treatment of spondylolysis is controversial, and formal criteria are lacking. Guidelines do not recommend return to contact sports after fusion of spondylolysis.^{15,16} A survey of 261 Scoliosis Research Society (SRS) members found that 27% to 36% of surgeons allowed these patients to return to collision sports 1 year postoperatively.³⁷ Fusion after spondylolysis is not always a contraindication to return to contact sports, but the time frame for return is variable.⁹

Spondylolisthesis

An isthmic spondylolisthesis is the result of bilateral pars fractures or defects that result in anterior slippage of the vertebral body.³⁹ Radicular pain and weakness may be present from foraminal or central stenosis depending on the severity of the slip. As with spondylolysis, the majority of low-grade spondylolistheses are treated conservatively, though bracing is more controversial.¹⁵ Surgery is typically reserved for traumatic cases, higher grade (III-IV) slips, and failed conservative management.^{15,16,33,39}

Specific return-to-play recommendations vary among spine surgeons³⁴ but generally include a pain-free full range of motion, the absence of neurological deficit, and evidence of bony fusion on plain radiographs.^{9,15,16,33} Good outcomes have been reported in patients undergoing posterolateral fusion for spondylolysis and spondylolisthesis.²⁸ Return to sport is feasible after direct pars repair, which preserves spinal motion²⁸ in athletes with these conditions.^{13,34} Direct pars repair may be advantageous in the athletic population.

Lumbar Stenosis

In young athletes, lumbar stenosis usually results from structural deformities such as spondylolisthesis, kyphosis, scoliosis, or disc herniation. Pain is worse with activity and better with lumbar flexion. Radicular pain and decreased strength and sensation may also be present. Unless the athlete has cauda equina syndrome, profound neurological deficit, or instability, the initial treatment is conservative.¹⁵ Rest from activity, nonsteroidal anti-inflammatory medications, and progressive therapy with return to play are included in most conservative protocols.^{2,15} Studies are not available on surgical treatment of spinal stenosis in athletes.²⁸

Return-to-play guidelines for lumbar stenosis after surgical intervention are variable and highly dependent on the type of surgery performed (see Table 4 in Appendix). Athletes

may resume noncontact activity once they meet general criteria.¹⁵ As stated earlier, athletes have returned to play with excellent outcomes after lumbar discectomy for disc herniation.^{25,48} However, contact or collision sports are not advised after lumbar fusion for herniation or stenosis.²⁸ After laminectomy, the time frame for return to contact sports is usually 4 to 6 months.^{1,15} Persistent neurological deficits, spinal instability, and postfusion procedures prohibit participation in collision sports.² Lumbar fusion alone or with interbody techniques may not be a

contraindication to returning to contact sports after a complete recovery.⁹

CONCLUSION

Currently, there are no standardized consensus guidelines for return to play after spine injuries. However, there is good general agreement on 4 fundamental criteria that must be met for a player to return to playing a sport; the athlete should be pain free, have full range of motion, full strength, and no evidence of neurologic injury.



Clinical Recommendations

SORT: Strength of Recommendation Taxonomy

A: consistent, good-quality patient-oriented evidence

B: inconsistent or limited-quality patient-oriented evidence

C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
Return-to-play recommendations after spine injuries are widely variable, but at a minimum, general criterion should be met prior to resuming athletic participation. These criteria include the following: full strength, painless and full range of motion, and full strength without neurologic deficit. ^{9,11,16}	C
Absolute contraindications to return to play for contact sports include but are not limited to: atlanto-occipital fusion, evidence of bony or ligamentous instability, symptomatic disc herniation, neurologic deficit, myelopathy, Arnold-Chiari malformation, and multilevel (2-3) spinal fusions. ^{11,42,44}	C
There is a lack of consensus regarding specific return-to-play criteria after spine surgery and injury. ^{16,28}	C

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