Etiology, treatment, and prevention of athletic “stingers”

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“Stingers,” also known as burners and transient brachial plexopathy, are common athletic injuries, particularly in football players. They are thought to be caused by trauma to the brachial plexus or nerve roots. The player typically presents with an inability to move the involved upper extremity following a high-energy collision with another player. The athlete experiences burning pain and numbness in the affected arm and may attempt to “shake it off,” or may support the affected extremity with the contralateral arm. Weakness in shoulder abduction, external rotation, and arm flexion are reliable indicators that a stinger may have occurred. In most cases, the symptoms resolve within minutes, although the athlete should be followed closely with repeated examinations, as motor weakness may develop hours to days after the injury [1–3].

Mechanism and etiology

Chrisman et al first described stingers in 1965. The mechanism of injury in half of the recorded cases reviewed was undetermined. In the other half, the mechanism was determined to result from a direct force applied to the shoulder with the neck flexed laterally away from the contact point. The term “cervical pinch syndrome” was applied to this type of injury [4].

More recently, several additional mechanisms have been proposed. These include brachial plexus stretch or traction injury, nerve root compression in the neural foramina, or injury from a direct blow to the brachial plexus. A traction injury to the brachial plexus may occur from a direct blow to the head causing

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simultaneous contralateral lateral neck flexion and shoulder depression. This pattern of injury is often seen following a block or tackle in football. This is a similar mechanism of injury thought to occur in newborns developing an Erb’s palsy at birth, as the shoulder is caught and forcibly depressed in a narrow pelvic outlet during the birthing process. Compression of the nerve roots can also result in a stinger from forced lateral neck flexion causing an acute narrowing of the contralateral neural foramen. Finally, a direct blow to Erb’s point, located superficially in the supraclavicular region, caused by an opponent’s shoulder or helmet driving the affected athlete’s shoulder pad directly into the brachial plexus can result in a burner or stinger [2,5,6].

Anatomically, in most cases the injury is thought to involve the upper trunk (C5, C6) of the brachial plexus. Surgical exploration has demonstrated scarring of the C5 and C6 nerve roots to the anterior and medial scalene muscles [7]. The cervical nerve roots as they take origin from the spinal cord are particularly susceptible to being injured, because they do not have the protective epineurium and perineurium to aid in absorbing tensile and compressive forces. The dural dentate ligaments help to provide an anchoring effect of the cervical nerve roots by creating a counter-traction force when the brachial plexus is under tension. Also, the affected nerve roots may be situated in a narrowed neuroforamen secondary to degenerative changes resulting in osteophytes, disc-space narrowing, and facet-joint hypertrophy. It has been shown that in the cervical spine the C4/C5 neuroforamen becomes particularly narrowed with neck lateral bending, rotation, and extension. Finally, the plexiform nature of the brachial plexus itself makes it more flexible, resulting in a greater tolerance to tensile forces than the cervical nerve roots have. The plexus is also surrounded by more compliant soft-tissue structures. These anatomical differences place the more proximal nerve root-spinal nerve complex at greater risk to tensile and compressive injury than the more distal brachial plexus [6,8].

Meyer et al [3] reported on the relationship of cervical spinal stenosis and the incidence of stingers. They measured the Torg ratio[9], also known as Pavlov’s ratio [10], among 266 college football players. This ratio is determined based on an extension lateral cervical spine radiograph. As shown in Fig. 1, a distance (line A–B) measured from the midpoint of the posterior aspect of the vertebral body (point A) to the nearest point on the corresponding spinolaminar line (point B) is divided by the antero-posterior width of the vertebral body (line D), measured through the midpoint of the corresponding vertebral body. A Torg ratio of less than 0.8 indicates a stenotic cervical spinal canal. Meyer demonstrated that college athletes with a Torg ratio of less than 0.8 had a threefold increase in sustaining burners with cervical spine extension-compression type injuries [3]. Kelly et al performed a similar study in high school athletes, examining Torg ratios and foramen/vertebral body ratios to assess for foraminal stenosis. Based on these ratios, the authors demonstrated that athletes with cervical spinal canal or foraminal stenosis were at an increased risk of sustaining burners [11].

Levitz et al reported on athletes who developed recurrent burner syndromes. The authors determined that the most common mechanism of injury combined
cervical spine extension with ipsilateral-lateral flexion. This resulted in ipsilateral neural-foraminal narrowing and nerve-root compression. Furthermore, foraminal compression testing or performing a Spurling’s maneuver produced positive findings, with recreation of arm symptoms in 70% of the cohort. Magnetic resonance imaging (MRI) evaluation demonstrated a 53% incidence of cervical spinal stenosis and an 87% incidence of degenerative disc disease in this population. The authors concluded that the combination of cervical spinal stenosis and concomitant degenerative disc disease may lead to a higher incidence of recurrent or chronic burner syndromes in certain athletes [12].

Epidemiology

Stingers or burners are most commonly reported in collision sports, most notably football. These injuries have also been reported in wrestling, hockey, basketball, boxing, rugby, and weight lifting, among other activities [6]. Up to 65% of college football players have reported suffering from at least one stinger during their college careers [3]. A study of 180 collegiate athletes who reported 216 cervical nerve-root, plexus, or peripheral nerve injuries revealed that a stinger was the most common symptomatic upper-extremity injury [13].

Although stingers have been reported in up to 65% of college football players, most players sustaining a stinger do not report them for fear being removed from play or because the injury maybe viewed as insignificant. Amongst football players reporting at least one burner, 17% were offensive lineman, 18% were defensive linemen, 11% were offensive backs, 30% were defensive backs, 5% were receivers, and 2% were punters [2]. Additionally, according to Meyer, overall, 40 (15%) of 266 college football players reported at least one symptomatic stinger, with 31 (11.6%) of them complaining of concomitant neck pain. In
this large series, athletes sustaining stingers missed an average of 10.7 practice days [3].

Physical assessment and grading of stingers

Sideline evaluation of the injured athlete usually demonstrates upper-extremity weakness and a burning type pain. The weakness usually resolves when the burner has passed. Athletes with nerve-root injuries generally maintain a slightly flexed cervical spine posture to alleviate pressure of the affected nerve roots at the neural foramen. The involved limb may be held elevated to help alleviate or lessen tension in the upper cervical nerve roots.

The on-field health care provider must perform a thorough examination of the cervical spine, including palpation of all structures for points of tenderness, localized swelling, or deformity. The athlete should be asked to actively rotate, laterally bend, forward flex, and extend the neck without limits of comfort. A neurological examination should include strength testing of all muscle groups, sensory evaluation of all dermatomes, and assessment of deep-tendon reflexes. The unaffected extremity should be used as a point of reference. In the stinger syndrome, weakness in the upper trunk of the brachial plexus, including the deltoid (C5), biceps (C5, C6), supraspinatus (C5, C6), and infraspinatus muscles (C5, C6), is commonly seen [14]. A shoulder examination should include the clavicle, acromioclavicular joint, and supraclavicular and glenohumeral regions. Erb’s point should be percussed to elicit any radiations or Tinel’s sign [6].

According to one study, a Spurling type maneuver was positive in 70% of patients.[12] This maneuver is performed with the patient laterally bending the cervical spine to one side while the examiner applies an axial load, applying a compressive force at the neural foramen. The test is considered positive if pain radiates into the ipsilateral arm, indicating nerve-root irritation [15].

Clancy classified burners based on Seddon’s criteria. A grade I injury is a neuropraxia, defined as a transient motor or sensory deficit without structural axonal disruption. Full recovery can be expected and usually occurs within 2 weeks following the event. Grade II injuries correlate with Seddon’s definition of axonotmesis, where axonal disruption occurs but with an intact outer supporting connective tissue known as the epineurium. The neural deficit is present for at least 2 weeks following the injury. Furthermore, axonal injury may be demonstrated on electromyographic studies (EMG) at 2 to 3 weeks after the injury. Grade III injuries persist for at least 1 year, with little to no clinical improvement. The injuries correspond to Seddon’s criteria of a neurotmesis, or total structural disruption of both axons and all supporting connective tissue [16].

Besides isolated injuries to the upper brachial plexus trunk, other potentially serious injuries must be considered during the on-field or sideline physical examination. Additional neck injuries in contact sports encompass a spectrum of serious clinical entities, including cervical spine fractures, facet joint dislocations, and damage to other soft tissue and neural structures. Lower brachial plexus trunk
injuries involving the C7 or C8 nerve roots are unusual following a stinger, as are persistent sensory deficits involving either the upper or lower extremities. Furthermore, stingers involving the upper extremity are always unilateral, and they have not been reported to involve the lower extremities. Bilateral upper extremity symptoms and deficits should prompt consideration of a spinal cord injury, as seen with transient quadriparesis. In this scenario, localized neck tenderness or stiffness with significant apprehension to active cervical spine range of motion should alert the team physician to a potentially serious injury requiring prompt immobilization of the cervical spine, as well as consideration of full spinal precautions with use of a spine board. The athlete should be transported to the nearest trauma center for full physical and radiographic evaluation. Further work-up may include more advanced imaging modalities such as an MRI or computed tomography (CT) scan [2,4,6,8,17].

Treatment

The management of the athlete suffering a burner is largely supportive. The team physician must be aware of the injury and realize its significance. The athlete should be removed immediately from athletic participation until the symptoms completely resolve. Once the symptoms resolve on the sideline, a decision must be made whether the athlete should return to the field. Management is divided into two phases. Phase I spans the time from the initial onset of symptoms to complete resolution. The extremity is rested and supported in a sling and pain is controlled with physiotherapy modalities and medication if necessary. Phase II consists of a rehabilitation regime. The affected extremity and entire upper body is rehabilitated to regain strength in all muscle groups, including those with subclinical involvement [4].

Return to play

The athlete sustaining a first-time burner can return to the field that day if the symptoms have completely resolved. The athlete must demonstrate full painless cervical spine range of motion and upper extremity strength. An athlete sustaining repeat burners may return to sports that day if he or she has experienced fewer than three prior episodes of a burner lasting less than 24 hours. If the symptoms do not resolve on the sideline, the player should be prohibited from athletic participation until complete imaging analysis is performed to identify any causative pathological lesions.

Relative contraindications to future return to play include a prolonged symptomatic burner lasting over 24 hours or three or more previous episodes of a stinger. A relative contraindication implies the possibility for recurrent injury and should be discussed with the athlete, family, and coaches. The differential diagnosis of the burner/stinger condition should be fully considered with a
thorough physical examination and appropriate radiographic studies and advanced imaging modalities (MRI, CT) to explore relative and absolute con- traindications [14]. Contraindications to play are summarized in the box below:

**NO CONTRAINDICATIONS TO RETURN TO PLAY**

- Fewer than three episodes of a prior burner/stinger lasting <24 hours, with full range of cervical motion without any evidence of a neurologic deficit
- One episode of transient quadriplegia lasting >24 hours
- Three or more previous episodes of either a stinger/burner or two episodes of transient quadriplexis/quadriplegia; the patient must have full cervical range of motion and strength without neck discomfort

**RELATIVE CONTRAINDICATIONS**

- Prolonged symptomatic burner/stinger or transient quadriplexis lasting >24 hours
- Three or more previous episodes of either a stinger/burner or two episodes of transient quadriplexis/quadriplegia; the patient must have full cervical range of motion and strength without neck discomfort

**ABSOLUTE CONTRAINDICATIONS**

- More than two previous episodes of transient quadriplexis/quadriplegia
- Clinical history, physical examination findings, or imaging confirmation of cervical myelopathy/melomalacia
- Continued cervical neck discomfort, decreased range of motion, or any evidence of a neurologic deficit from baseline after any cervical spine injury


Electrodiagnostic tests are rarely necessary, because burners are usually associated with temporary neurological insults. Furthermore, abnormal spontaneous activity takes approximately 2 weeks to develop and may require 3 to 5 weeks to maximize. This is seen as fibrillation potentials in involved muscles. A C5 and C6 radiculopathic pattern may also be evident [4,6]. The most useful role for electrodiagnostic studies is to evaluate persistent weakness at 2 to 3 weeks, which
may show a regeneration type pattern. A suspected nerve-root injury should be further evaluated with an MRI [1].

Electrodiagnostic results are controversial markers for return-to-play criteria. Bergfeld demonstrated that, although strength may improve following a stinger injury, the EMG could continue to be abnormal in up to 80% of athletes at as long as 5 years follow-up [18]. Additionally, Speer and Bassett demonstrated that prolonged weakness following a burner might not be associated with an axonal injury, as indicated by a normal EMG results. They concluded that recovery of musculoskeletal strength is based on manual clinical examination, not EMG findings. Physical examination and appropriate imaging studies should therefore be the gold standards for return to play [19]. Vacarro et al suggested that when sequential EMG studies normalize, the athlete could return to the preinjury level of activity, as long as full cervical spine motion and muscle strength have returned [14].

Previous studies have demonstrated a relationship between cervical spinal stenosis and stingers, based on the Torg ratio [3,11]. Nonetheless, nearly one third of professional and amateur football players will have a Torg ratio less than 0.8 at one or more levels from C3 to C6 [20]. Importantly, cervical spinal stenosis may only be one factor of many that may predispose patients to stingers. Furthermore, before an athlete sustaining recurrent stingers returns to the playing field, the treating physician should undertake an appropriate work-up to diagnose any pathological lesions that might be contributing to this syndrome.

Prevention

Athletes reporting previous burners are at risk for recurrence. The addition of protective neck rolls and pads to football equipment to prevent excessive lateral flexion and extension of the neck is recommended. Similarly, higher riding shoulder pads have been advocated to help absorb the impact of contact while tackling. Straps connecting the helmet and shoulder pads are not advocated [1,4,19]. It can not be overemphasized that improper tackling techniques are a major component in stinger injuries and should be examined closely. Proper tackling techniques include the avoidance of dropping the shoulder and thus allowing the head and neck to be driven into excessive extension. Continued eye contact with the opposing player should allow for tackling in a more upright position [6].

Rehabilitation, including neck and shoulder strengthening programs, may be helpful. Regaining cervical spinal motion is essential, because it has been shown that persistent nerve-root inflammation is consistent with restrictive motion. Normal cervical spine extension is a necessary functional motion that may protect the athlete from a more serious injury sustained with a hyperflexed neck. Strengthening should begin with isometric exercises and progress to isotonic training, and should include the upper trapezius muscle as well [2,6].
References


