

# Burner Syndrome

## Recognition and Rehabilitation

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**In brief** Burner syndrome—brachial plexus injury—is common in contact sports, especially on the football field, but not always benign. Our case report describes a 15-year-old football player who suffered burner symptoms that resolved quickly but led to shoulder weakness and neck pain a few days later. Detailed serial clinical examinations are imperative for proper classification of burner injuries. Cervical root lesions, shoulder injuries, and other plexus or nerve involvement must be excluded. Rehabilitation includes physical modalities and range-of-motion, stretching, and strengthening exercises for cervical, shoulder, and elbow muscles. Prevention measures include preseason strengthening exercises and protective devices.

“**B**urner” or “stinger” syndrome, a presumed brachial plexus stretch or compression injury, is an extremely prevalent football injury. It occurs in approximately 65% of college football players, according to one survey of six teams,<sup>1</sup> and is also

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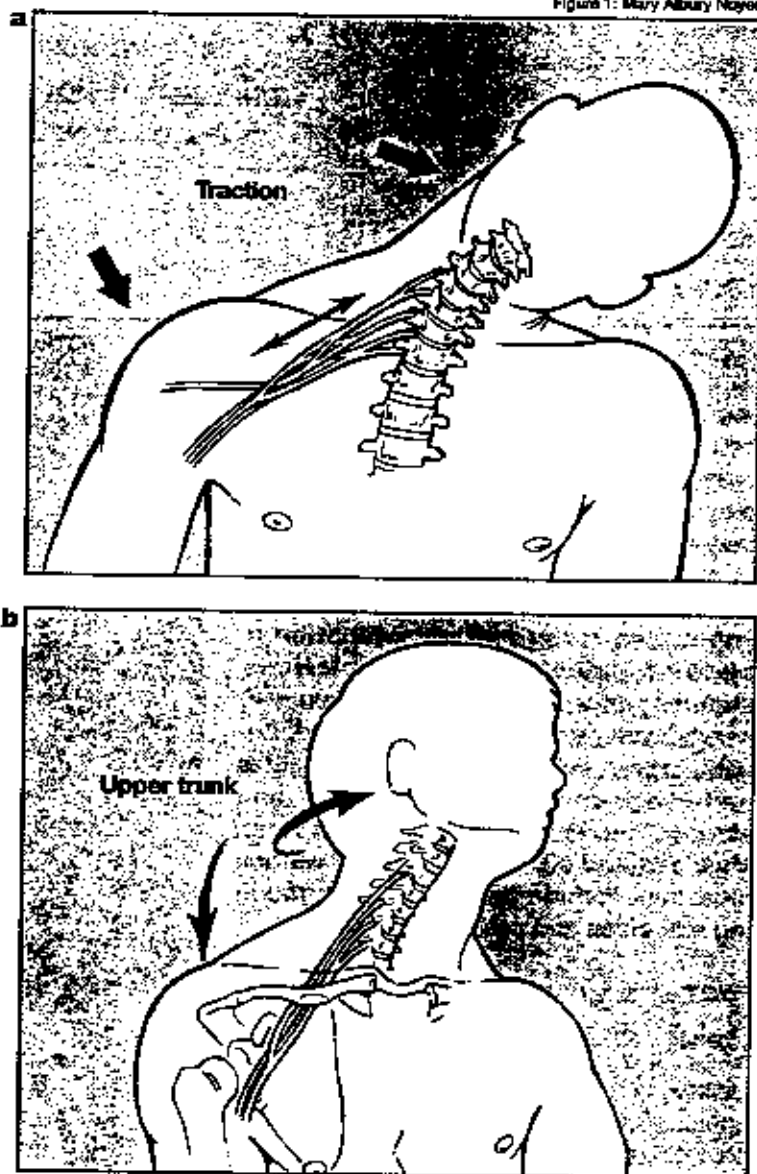
For CME credit, see page 104

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*Figure 1. A blow to the head causing lateral flexion and shoulder depression may cause a traction injury (a) to the upper trunk of the brachial plexus. A compression injury (b) can occur when a blow to the supraclavicular region causes lateral flexion with rotation and extension of the cervical spine away from the blow.*

Figure 1: Mary Albury Noyes



common in adolescent players. In the college survey,<sup>1</sup> 70% of the injured players said they had not always reported their burners, and 57% had suffered more than one. Burner injuries are also seen in wrestling, hockey, gymnastics, and equestrian and motocross events.

The injured player notices an immediate, severe, burning pain and prickly paresthesia that radiates from the neck, extending circumferen-

tially to the ipsilateral arm or fingers. Burner symptoms often include numbness and brief paralysis of the arm. Pain, paresthesia, and numbness usually abate within minutes; however, the athlete may experience shoulder weakness and muscle tenderness of the neck hours or days after the injury. Shoulder weakness does not always occur; its absence may account for unreported/untreated cases, since many burn-

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ers resolve with no further sequelae. In a study done at a private sports medicine clinic, burner syndrome accounted for only 0.003% of diagnoses.<sup>2</sup>

### Anatomy of an Injury

Several injury mechanisms have been proposed for burner injuries, including stretching and traction of the plexus, compression of the plexus, root lesions, and combinations of these.<sup>34</sup> The exact etiology is uncertain and controversial, but it is most likely a continuum from root injury to plexus involvement.

The mechanism most commonly described in the literature<sup>12,25,26</sup> is traction and stretching of the brachial plexus from a blow to the head or shoulder. Contact forces the shoulder and clavicle downward and forces the neck into extension on the ipsilateral side and flexion to the contralateral side (figure 1a). The action causes a traction injury to the upper trunk of the brachial plexus. Stretching, however, may also be accompanied by compression. A direct blow to the supraclavicular region—which may force the edge of the shoulder pad into the side of the neck or cause lateral flexion with rotation and extension of the cervical spine away from the blow—may compress the nerve roots of the brachial plexus (figure 1b).<sup>14,21,25</sup> It is hypothesized that plexus compression and stretching-traction mechanisms can occur together on the ipsilateral side. In addition, compression injuries may occur on the side opposite contact from compression caused by lateral neck flexion.

Clancy et al<sup>9</sup> devised a three-level burner classification system that relates the underlying pathophysiology to the severity of injury and correlates with Seddon's definitions of neurapraxia, axonotmesis, and neurotmesis.<sup>16,17</sup>

**Grade 1** burners, which appear to be most common, represent neurapraxia, the mildest lesion. A neurapraxia is a localized conduction block that causes loss of sensation and/or loss of motor function from selective demyelination of the axon sheath without true axonal disruption.<sup>16</sup> Complete recovery usually occurs within days to a few weeks.

**Grade 2** burners are axonotmesis injuries that produce significant motor and mild sensory deficits that last at least 2 weeks. Electromyographic (EMG) evaluation shows axonal injury with fibrillations and positive waves 2 to 3 weeks after injury. Axonotmesis disrupts the axon and myelin sheath but leaves the epineurium intact. Wallerian degeneration occurs distally from the injury site. Axonal regeneration/regrowth occurs at the rate of 1 to 2 mm per day; full or normal function is usually restored.

**Grade 3** burners are neurotmesis injuries, which disrupt the endoneurium. These severe injuries have a poor prognosis; motor and sensory deficits persist for at least 1 year. Without surgical intervention, regeneration may proceed slowly in an imperfect, poorly organized fashion. EMG changes show acute denervation and, subsequently, chronic changes (large, polyphasic motor unit potentials) consistent with reinnervation.

**Evaluation of an upper trunk plexus injury involves ruling out rotator cuff injury symptoms that can mimic a burner.**

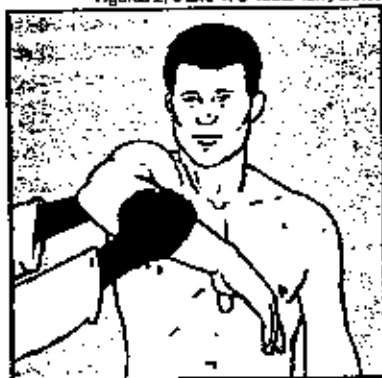
### Case Report

A 15-year-old male football player presented with left neck and shoulder pain and left shoulder weakness of 1-week duration.

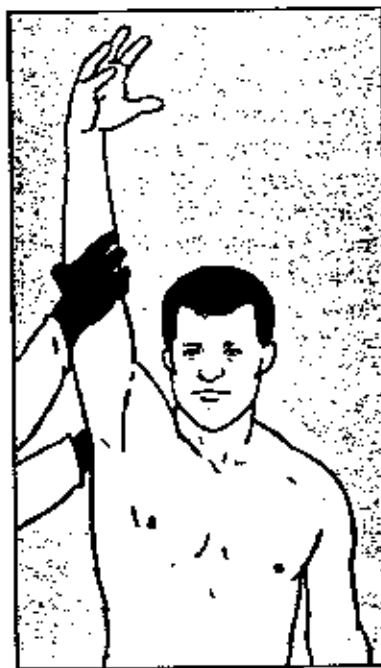
**History.** The history included two neck injuries while playing football. The first injury occurred during a tackle when an opponent's leg hit the left side of his neck, causing the patient's head to snap backwards and toward the right side. The patient said his left arm immediately felt "paralyzed and numb" and he had severe pain in his left shoulder and neck. His symptoms resolved in 5 minutes. He did not seek evaluation by his coach or trainer. Seven days later he sustained a second injury when he butted his helmet into an opponent's helmet, which caused severe shooting pain in his left neck and arm and weakness of the left upper extremity. He sought medical attention 1 week later for persistent neck and shoulder pain and left shoulder weakness. His medical history also in-

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**Figure 2.** The Hawkins sign indicates rotator cuff (especially supraspinatus) impingement. This can be used to differentiate rotator cuff injury from a burner. The examiner forcibly internally rotates the patient's proximal humerus while it is forward flexed to 90°. The test is positive if the patient experiences pain.



**Figure 3.** Like the Hawkins sign (above), the Neer test can be used to detect rotator cuff impingement. The examiner fully flexes the patient's shoulder to 180°. The test is positive if pain is produced at the end range of the arc.



**Figure 4.** The Spurling test can detect involvement of a nerve root in patients who have burner symptoms. The physician applies cervical spine extension, compression, and rotation toward the affected arm. The test is positive if it reproduces radicular pain in a nerve root distribution into the arm or upper back.



cluded a "neck strain" while playing football 4 years before this injury.

**Physical examination.** Examination 1 week after his second injury revealed antigravity strength of the left supraspinatus muscle with inability to accept any resistance, mild weakness of his deltoid and biceps with inability to accept full resistance, and diminished left biceps and brachioradialis deep tendon reflexes. Further examination of the shoulder revealed a positive drop arm test, negative Spurling test and Hawkins sign, and an equivocal Neer impingement test. Active range-of-motion testing demonstrated 80° of abduction with substitution of trapezius muscles for the deltoid and supraspinatus muscles, 70° of external rotation, 160° of flexion and full internal rotation (normal range of motion is 180° of abduction, 180° flexion, 90° internal rotation and 90° external rotation). Sensory testing with pin prick and light touch was unremarkable. Palpation revealed tenderness of the left upper and middle trapezius muscle.

**Diagnostic imaging.** Cervical spine films were negative for bony abnormalities. Magnetic resonance imaging (MRI) and computed tomography (CT) studies, performed because neurologic symptoms persisted, were normal.

**Diagnosis.** At this time, findings were most consistent with the diagnosis of a grade 2 burner. Though too early after the injury for an EMG to be accurate, evidence of significant motor deficits was present without objective sensory deficits.

**Treatment.** The patient was instructed to apply ice to the left upper trapezius muscle and to perform supine active assisted range of motion exercises of the left shoulder, seated active assisted range-of-motion exercises of the shoulder with a pulley, shoulder shrugs, and active range-of-motion exercises of the elbow and neck without neck extension. He was advised against participation in football or physical education.

**Outcome.** At 1-month follow-up, the patient was noted to have only minimal weakness on manual muscle testing of the external rotators and deltoid. Deep tendon reflexes were symmetrical. Occasional paraspinal neck pain persisted,

but neck range-of-motion was full and painless. Spurling test was negative, and arm pain was absent. At 2-month follow-up, strength and deep tendon reflexes were normal. He denied having arm or neck pain.

Based on the physician's advice the patient did not return to football for the rest of the season, but was able to play competitive basketball 4 months after his initial injury.

### Screen for Nerve Deficits

A player who has burner symptoms is removed from competition. Field examination will probably demonstrate decreased sensation and weakness if paresthesia is present. A brief nerve root screen can be performed without removing the football uniform. The biceps are tested bilaterally for the C-5 nerve root, the wrist extensors for C-6, the triceps for C-7, and the interosseous muscles for C-8 and T-1. Neurologic deficits and burning paresthesias usually resolve within 5 minutes. The athlete may return to play when symptoms have resolved, upper-extremity range of motion and strength are normal, and full and painless cervical motion is present. However, it is imperative to follow the athlete closely with a postgame examination and successive examinations for several days to detect any recurrence of weakness.

Clinical examination of patients with burners commonly reveals weakness in the C-5 dominant muscles supplied by the upper trunk of the plexus: the supraspinatus, deltoid, and biceps muscles. Rarely does one find weakness of the serratus anterior or rhomboid muscles,<sup>9</sup> which are innervated by C-5 and C-6 roots of the long thoracic and dorsal scapular nerves, respectively. Injury to these nerves suggests a lesion proximal to the plexus at the root level.

Rotator cuff injury can involve many of the same muscles as an upper trunk plexus injury; thus, it is important to distinguish between these entities and also to rule out concurrent rotator cuff involvement. The Hawkins sign (figure 2) and Near test (figure 3) evaluate impingement of the rotator cuff muscles and, if positive, suggest rotator cuff injury. The drop arm test, if

positive, indicates supraspinatus weakness, which could be the result of pain from a tendinitis or tear, or could stem from an upper trunk plexus injury. The Spurling test (figure 4) is a foraminal or nerve outlet narrowing maneuver that is positive when nerve root compression is present.

Radiographs of the cervical spine are routinely performed to rule out bony abnormalities if neck pain or neurologic deficits persist. The routine series includes flexion and extension views to rule out spondylolisthesis or instability, and the odontoid view to rule out C-1 or C-2 instability or fracture. If flexion and extension views suggest instability, an oblique view is ordered to rule out a pars interarticularis fracture. If neurologic deficits persist, MRI and CT of the cervical spine may be ordered to rule out both soft tissue and bone injuries such as a herniated disc, congenital central canal stenosis, lateral recess stenosis, and cord anomalies such as an arteriovenous malformation or tumor.

Due to the extraordinary strength of some athletes, detection of clinical weakness may be difficult. Preseason baseline strength test results can help detect a significant decrease of strength. Successive, detailed examination is imperative for all patients. In an EMG study by Robertson et al<sup>10</sup> of 10 patients with a history of a burner injury, five demonstrated acute denervation with a normal clinical examination. In grade 2 injuries, subsequent and recurrent weakness may not develop until 2 to 3 days after injury. Strength can be tested by looking for asymmetry in exercises such as pushups or pull-ups.

If symptoms persist, an EMG can help delineate the extent and severity of injury; however, acute denervation is not usually evident on EMG until 2 to 3 weeks after injury.<sup>10</sup> An EMG is not necessary when symptoms resolve in 2 to 3 weeks.

### Active Treatment Strategies

In the acute phase, ice massage to the upper trapezius and shoulder can help decrease pain and inflammation of a secondary muscle strain. Instituting the PRICE principle is helpful.

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- Protect the injured body part. A sling may be necessary in some cases, such as with significant weakness of the rotator cuff muscles.
- Relative rest. The patient rests the injured extremity while maintaining aerobic conditioning with leg exercises.
- Ice.
- Compression. An elastic bandage wrap may be useful if there is significant shoulder or upper-arm swelling.
- Elevation if the patient has significant shoulder or arm swelling.

If neurogenic muscle weakness, which may occur after a grade 2 or grade 3 burner, is present, strength training is contraindicated in early rehabilitation.

**Patients who have neurogenic muscle weakness after a burner should avoid strength training early in rehabilitation.**

Immature motor endplates may be damaged by resistance training, and EMG evidence of active reinnervation ideally should be present before pursuing more advanced types of strength training—usually 4 to 6 weeks after injury.

In grade 3 injuries, distal nerve regeneration is not usually possible without surgical repair and reapproximation of the nerve sheaths.

During rehabilitation patients should maintain their cardiovascular fitness and perform active assisted range-of-motion exercises of the cervical spine and shoulder. The patient should begin supine and progress to a seated position.

Cervical strengthening should begin with isometric neck exercises that consist of flexion, extension, and shoulder shrugs. With proper instruction, the athlete can progress to diagonal flexion and extension, then to exercise using machines or free weights.

After shoulder range of motion is nearly full in all planes, isometric or closed-kinetic-chain strengthening should be initiated with progression to isotonic and isodynamic exercise. Scapulothoracic motion should be carefully assessed; movements should be smooth and isolated, avoiding substitution and cocontraction. Rehabilitation should include concentric and eccen-

**Table 1. Return-to-Play Criteria for Patients Who Have Burners**

Resolved neck pain, arm pain, and dysesthesia
Full pain-free neck range of motion
Full pain-free upper extremity range of motion
Normal strength on manual muscle testing, preferably compared with preseason measurements
Normal deep tendon reflexes
Negative Spurling test

tric strengthening for external rotation (supraspinatus, infraspinatus, and teres minor muscles), internal rotation (subscapularis muscle), abduction (deltoid and supraspinatus muscles) and extension (triceps muscle). We prefer to strengthen the external rotators and internal rotators in 45° of abduction, which provides a more functional and presumably more vascular plane of motion.<sup>20</sup>

The scapular stabilizers (serratus anterior, latissimus dorsi, trapezius, rhomboid, and levator scapulae), which serve as the foundation of shoulder movement, take on special importance and should be emphasized accordingly. Elbow flexion and extension exercises allow concentric and eccentric strengthening of the biceps and triceps. Proper posture should be emphasized with avoidance of thoracic kyphosis, rounded shoulders, and head-forward posture.

It is our opinion that an athlete with a grade 2 or 3 injury should not resume competition until full strength and range of motion of the upper extremity and neck returns and until EMG findings are negative for acute denervation and do not demonstrate increased insertional activity, fibrillation potentials, or positive sharp waves (table 1). Complete recovery from a grade 2 or 3 injury may take more than 6 months.

#### Avoid Recurrence

Preventive measures include shoulder pads and neck rolls, fitted appropriately for the ath-

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letes' height and weight, to help prevent extreme cervical extension and lateral deviation. Shoulder pads accomplish four functions: They absorb shock, protect the shoulders, and, to a lesser degree, prevent extreme side flexion and hyperextension of the neck.<sup>14</sup> Most neck rolls that attach to the top of shoulder pads rotate away from the neck at the moment of contact, which leaves the cervical spine vulnerable to compression or hyperextension.<sup>10</sup>

A recent development in sports neck orthoses is the Cowboy Collar (McDavid Knee Guard, Inc, Chicago), currently worn with traditional shoulder pads by professional football players. Compared to the common neck roll, the high-brimmed Cowboy Collar extends several more inches above the shoulder pads. The collar was developed to produce a cantilever effect rather than the fulcrum effect of conventional neck rolls. A recent *in vitro* study,<sup>15</sup> however, demonstrated no significant difference between the two regarding the limitation of neck/cervical

spine hyperextension and lateral flexion.

Preseason baseline strength testing with objective measurements such as the bench press or biceps curis may help identify arm weakness in athletes who suffer burners later in the season. Evidence indicates that injuries recur in approximately 57% of patients who incur a burner injury.<sup>1</sup> Aggressive, year round neck and shoulder strengthening is important, especially for those who have a history of a burner injury. (See "Sidestepping Burners: A Preseason Strategy," page 71.)

#### Play It Safe

Physicians have a role in educating coaches, trainers, physical therapists, parents, and athletes about preventing, recognizing, and treating burners. Everyone's goal is the same: to keep players safely in the game. **FSM**

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