Management of the Helmeted Athlete With Suspected Cervical Spine Injury

Kevin N. Waninger,* MD
From the Department of Emergency Medicine, Saint Luke’s Hospital, Bethlehem, Pennsylvania

Improper handling of an unstable neck injury may result in iatrogenic neurologic injury. A review of published evidence on cervical management in the helmeted athlete with a suspected spinal injury is discussed. The approach to the neck-injured helmeted athlete and the algorithms for on-field and emergency department evaluations are reviewed. The characteristics of the fitted football helmet allow safe access for airway management, and helmets and shoulder pads should not be initially removed unless absolutely necessary. Prehospital and emergency personnel should be trained in the indications for removal and in proper helmet, shoulder pad, and facemask removal techniques. If required, both helmet and shoulder pads should be removed simultaneously. Radiographs with equipment in place may be inadequate, and the value of computed tomography and magnetic resonance imaging in these helmeted patients has been studied. If adequate films cannot be obtained with equipment in place, helmet and shoulder pads may need to be removed before radiographic clearance. A plan should be formulated to prepare for such unexpected clinical scenarios as cervical spine injuries, and skills should be practiced. Airway and cervical spine management in these helmeted athletes is an area of ongoing research.

Keywords: helmet removal; cervical spine; football; ice hockey; trauma; sports; injury

METHODS

Computerized bibliographical databases (Medline, Sportdiscus) without language restrictions were searched to identify all relevant studies. The search covered the time period of January 1966 to December 2003 using the following keywords: cervical spine, football, helmet, injury, and sports. To be included, a study had to meet the following criteria:

1. The study must be a report published in a peer-reviewed journal by December 2003.

References 38, 112, 123, 141, 166, 169, 176, 184.

*Address correspondence to Kevin N. Waninger, MD, 211 North Barrington Court, Newark, DE 19702 (e-mail: knwaninger@aol.com).

No author or related institution has received any financial benefit from research in this study.

The American Journal of Sports Medicine, Vol. 32, No. 5
DOI: 10.1177/0363546504264580
© 2004 American Orthopaedic Society for Sports Medicine
MECHANISM OF INJURY

In contact sports such as football, the cervical spine is repeatedly exposed to potentially injurious cervical spine forces. Fortunately, most forces are dissipated by the cervical paravertebral muscles and the intervertebral discs through controlled spinal motion. However, the vertebrae, intervertebral discs, and supporting ligaments can be injured when contact occurs on the crown of the helmet and the body is positioned such that the force vectors are transmitted along the vertical axis of the cervical spine. Flexion and axial loading have been implicated in the majority of cases, although extension, lateral stretch, and congenital instability have also been reported. When the neck is in the neutral position, the cervical spine is slightly extended because of the normal lordotic curve. With the lordotic curvature of the cervical spine, energy is dissipated tangentially when the cervical spine is axially loaded. When a player flexes the neck 30° to tackle, block, or ram an opponent, the cervical spine is straightened, converting the protective lordotic cervical spine into a segmented column (Figures 1, 2A, and 2B). When the spine is in this straightened position and force is directed along its longitudinal axis, the intervertebral disks at first absorb the energy and are compressed. When maximum deformation is reached, continued compressive forces cannot be dissipated by controlled motion in the spinal segments, resulting in angular deformation and buckling with failure of the intervertebral discs and/or bony elements (Figure 2C). The resulting injury is a subluxation, facet dislocation, or fracture dislocation at 1 spinal level. Direct contact from the posterior rim of the helmet has been discounted as a significant mechanism of injury. The development of strong neck musculature could reasonably be expected to prevent some neck injuries, and isometric and resistance exercises should be a part of preseason conditioning for contact athletes. A similar mechanism of axial loading of the spine is implicated in ice hockey; when hockey players are hit from behind and driven into the wall with a hyperflexed neck, an infraction referred to as “boarding.” Data collected since 1977 outline the patterns of cervical spine injuries that have occurred in football (Appendices 1-5, available in the online version of this article at www.ajsm.org).

Rule changes and educational efforts directed at athletes, coaches, and parents have been successful in decreasing the amount of cervical injuries. A high percentage of players, when surveyed, displayed poor knowledge of the dangers of “spearing” in football. Rules that penalize for spearing (hitting another player with the top of the head), instituted in 1976 by the National Collegiate Athletic Association (NCAA) and the National Federation of High Schools, coincide with the dramatic decrease in the number of cervical spine injuries in football (Figure 3). In an attempt to decrease the escalating number of cervical spine injuries in amateur hockey players, a coordinated educational program referred to as Safety Toward Other Players (STOP) provides a visual reminder for all players not to hit an opponent from behind, with STOP patches sewn above the numbers on the back of the jerseys (Figure 4). An accompanying educational program helps coaches teach players about the dangers of checking from behind. Some authors recommend that all body checking be banned at the amateur level to prevent injury.
MANAGEMENT OF THE HELMETED ATHLETE

The management of the neck-injured helmeted athlete begins on the field with proper positioning and immobilization of the cervical spine. Immobilization of the neck in a neutral position restricts movement of the unstable vertebral column in an effort to prevent damage to the enclosed spinal cord and nerve roots. Flexion and extension posturing of the traumatized neck may result in cord deformation and elongation of the neutral axis. Small amounts of abnormal intervertebral motion may cause damage.

Radiographic studies are required to accurately identify the presence or absence of a fracture or injury that would render the cervical spine unstable. Although guidelines for clearance of the cervical spine without radiographic studies have been published, most injured athletes would not qualify for clearance under these guidelines because of the mechanism of injury. Because a potential cervical spine injury cannot be fully ruled out on the field, the goal for emergency management is the safe, expeditious transport of the injured player to a medical facility with radiographic capabilities. A systematic, organized protocol for this management is essential to prevent further injury.

Radiographic studies are required to accurately identify the presence or absence of a fracture or injury that would render the cervical spine unstable. Although guidelines for clearance of the cervical spine without radiographic studies have been published, most injured athletes would not qualify for clearance under these guidelines because of the mechanism of injury. Because a potential cervical spine injury cannot be fully ruled out on the field, the goal for emergency management is the safe, expeditious transport of the injured player to a medical facility with radiographic capabilities. A systematic, organized protocol for this management is essential to prevent further injury. This involves communication between all parties involved in the care of the patient. In the past, there has been considerable debate over protocols for removal of equipment during on-field or transport management of helmeted football players with suspected neck injury. Inconsistencies in the treatment of football neck injuries in the prehospital setting have been well documented.

The rationale for leaving the protective equipment in place is to prevent progressive neurologic injury via inadvertent movement of an unstable cervical spinal segment. Experimental evidence demonstrates both the detrimental effect of continued compression and the protective effect of immediate immobilization on the injured spinal cord.

The need for immobilization begins at the site of the injury,
continues during transport and emergency department stabilization, and ends only when a cervical spine injury has been ruled out or definitively stabilized. There is a consensus on the removal of protective gear during the initial on-field assessment of the injured athlete. Sports medicine professionals universally discourage removal of a football helmet and shoulder pads when any cervical spine injury is suspected. Several studies have documented that the excessive movement resulting from helmet and shoulder pad removal may put the patient at risk (Table 1). The NCAA guidelines for football helmet management state that unless there are special circumstances, such as respiratory distress coupled with an inability to access the airway, the helmet should not be removed on the field when there is a potential head or neck injury.

Airway Management

When serious injury occurs involving the head and/or spine, at times complicated by altered levels of consciousness, protective equipment such as helmets and shoulder pads may provide a hindrance to safe airway management. Airway obstruction from the tongue, mouth guard, or a foreign body is a possibility, with restoration of breathing as simple as establishing a patent airway. Chin lift–jaw thrust maneuvers should be initially accomplished without removing the football helmet or the facemask. In most unconscious athletes, these maneuvers will result in restoration of a patent airway. If these maneuvers do not succeed in restoring airway and breathing, alternative methods to gain rapid access to the airway and restore breathing must be implemented, such as a CPR pocket mask, bag valve mask/advanced airway maneuvers (Table 2), helmet removal (Table 3), and/or facemask removal (Table 4). Despite the fact that neurologic causes of cardiac arrest can occur with cervical spine injury above the C4 level, respiratory arrest secondary to spinal cord injury or cardiac arrest in the helmeted athlete is rare. The majority of football-related cervical spine injuries occur anatomically in the C5 to C7 vertebrae, and respiratory compromise with the need for airway control does not usually occur at these levels. However, the potential for respiratory compromise requiring ventilatory support exists because cervical spine fractures and instability above C4 have been reported. Despite the small number of reported cases of cervical spine–injured football players requiring intubation, the recent case of a professional football player requiring on-field intubation has brought this clinical issue to the forefront. Although cases of simultaneous cervical spine injury and intracranial injury have been noted in unhelmeted pediatric sports trauma, no cases of helmeted athletes with simultaneous cervical spine and intracranial injury have been reported.

In athletes with cervical spine injury and respiratory or cardiac involvement requiring airway management, protocols for equipment removal and cardiopulmonary resuscitation have been established, although the safety and efficiency of these protocols have not been well studied. When the decision is made that the helmeted athlete requires airway control, standard techniques with in-line stabilization are recommended. The airway maneuvers and techniques that cause the least cervical spine movement have been debated and are not well studied in the helmeted athlete (Table 2). Practitioners should choose the airway method and technique with which they have the greatest experience and skill. Neurologic deterioration from spinal cord injury may be associated with airway management.

There has been concern from prehospital personnel regarding the inability to fully evaluate the helmeted head and neck before transport for secondary injuries. However, the velocity of football contact is much less compared to vehicular trauma, and football does not usually cause the degree of underlying head injuries—requiring aggressive secondary survey evaluation—that may be seen with motorcycle injuries. Many of the cervical spine management protocols were designed for motorcycle helmets. Motorcycle helmets are often designed

References 2, 49, 110, 151, 171, 174, 182.

Figure 4. Safety Toward Other Players (STOP) patch worn on the back of an amateur hockey player as a visual reminder for players not to hit an opponent from behind.

<table>
<thead>
<tr>
<th>References</th>
<th>Subjects</th>
<th>Methods</th>
<th>Subjects</th>
<th>Number of Techniques</th>
<th>Limitations</th>
<th>Results</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aprahamian et al</td>
<td>Cadaver (with and without surgically created C5-C6 instability)</td>
<td>Clinical palpation</td>
<td>N = 1</td>
<td>Helmet removal</td>
<td>Cadaveric study; motorcycle helmets; defects monitored by palpation; case study</td>
<td>Helmet removal techniques adversely affected preexisting injury</td>
<td>Do not remove helmet unless necessary; consider removal of motorcycle helmets with cast cutters</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>monitored by</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>palpation only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Donaldson et al</td>
<td>Cadaver (with and without surgically created C1-C2 and C5-C6 instability)</td>
<td>Video fluoroscopy</td>
<td>N = 6</td>
<td>Helmet and shoulder</td>
<td>Cadaveric study; football only</td>
<td>Unacceptable amount of movement with helmet and pad removal</td>
<td>Helmet and shoulder pad removal should be performed in a carefully monitored setting by at least 3 or 4 trained people</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pad removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastel et al</td>
<td>Cadaver (with and without surgically created C5-C6 instability)</td>
<td>Radiographs</td>
<td>N = 8</td>
<td>Helmet removal:</td>
<td>Cadaveric study; football only</td>
<td>To maintain neutral position, helmet and shoulder pads should be removed together</td>
<td>Helmet removal should be delayed until both helmet and shoulder pads can be removed together in a controlled setting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>no equipment;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>shoulder pads only;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>helmet and pads in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iselborn et al</td>
<td>Human volunteers</td>
<td>Radiographs</td>
<td>Not recorded</td>
<td>Degrees of movement</td>
<td>Abstract only; spinal movement that is clinically relevant unknown; technique to measure movement with radiographs</td>
<td>Unacceptable amount of movement with helmet removal attempts</td>
<td>Helmet removal techniques, flexion and lateral rotation of helmeted head produce unacceptable amounts of movement at C-5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>at C5 spinal segment during helmet removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metz et al</td>
<td>Human male volunteers</td>
<td>Radiographs</td>
<td>N = 8</td>
<td>Lateral radiographs</td>
<td>Healthy volunteers; hockey only</td>
<td>Significant movement of cervical spine with pads and no helmet</td>
<td>Immobilization with both helmet and pads, removal together after initial radiographs; secure chin to prevent head/neck motion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>without equipment;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>shoulder pads only;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>helmet and pads in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meyer and Daniel</td>
<td>Human male volunteers</td>
<td>Fluoroscopy and</td>
<td>n = 17 (static); n = 9 (fluoroscopy)</td>
<td>Comparison of</td>
<td>Healthy volunteers; motorcycle helmets</td>
<td>No difference in cervical motion with either removal technique</td>
<td>Helmet may be used to apply traction; helmet removal not required in the field unless airway problems exist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>radiographs</td>
<td></td>
<td>1-person and 2-person helmet removal techniques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LaPrade et al</td>
<td>Human male volunteers</td>
<td>Lateral scout CT</td>
<td>N = 10</td>
<td>Comparison of lateral</td>
<td>Healthy volunteers; hockey only</td>
<td>With helmet removed and shoulder pads in place, increased cervical lordosis (extension)</td>
<td>Removal of hockey helmet not recommended; it may lead to unnecessary cervical spine motion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>scans</td>
<td></td>
<td>radiographs with no</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>equipment; pads only;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>helmet only; helmet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and pads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palumbo et al</td>
<td>Cadaver (with and without surgically created C5-C6 instability)</td>
<td>Radiographs</td>
<td>n = 15 (intact); n = 8 (C5-C6 instability)</td>
<td>Helmet removal:</td>
<td>Cadaveric study; football only</td>
<td>Increased movement with “helmet only” and “pads only”</td>
<td>Helmet-only and pads-only immobilization violates the principle of splinting the cervical spine in neutral; removal of pads is an “all or none” proposition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>no equipment;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>helmet only; pads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>only; helmet and pads</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(continued)
with a continuous solid “full-face” guard that limits access to the face and airway (Figure 5D). Some studies have reported that removal of motorcycle helmets may not be without the risk of iatrogenic morbidity. However, unlike football injuries, the high-velocity vehicular trauma encountered in motorcycle accidents often involves greater head and neck trauma, including cervical spine injuries above the level of C4. A comprehensive secondary survey of the face and head may require removal of the bulky motorcycle helmet before transport, despite the risk. Supervised self-removal by the conscious patient may be an option for motorcycle helmet removal. The NATA protocol for helmet and shoulder pads removal effectively limits motion of the cervical spine.

### TABLE 1

<table>
<thead>
<tr>
<th>References</th>
<th>Subjects</th>
<th>Methods</th>
<th>Subjects</th>
<th>Number of Techniques</th>
<th>Limitations</th>
<th>Results</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peris et al129</td>
<td>Human male volunteers</td>
<td>Fluoroscopy and radiographs</td>
<td>N = 7</td>
<td>Helmet and shoulder pads are removed according to NATA protocol; disk height, translation, angulation, cord space compared to baseline</td>
<td>Uninjured healthy volunteers</td>
<td>Only minimal changes from baseline for each study parameter during the removal protocol</td>
<td>The NATA protocol for helmet and shoulder pads removal effectively limits motion of the cervical spine</td>
</tr>
<tr>
<td>Prinsen et al132</td>
<td>Human male volunteers</td>
<td>Fluoroscopy and radiographs</td>
<td>n = 11 (football); n = 10 (hockey)</td>
<td>Cervical displacement during helmet removal, during cervical collar application, and without helmet; pads remained in place</td>
<td>Healthy volunteers; football and hockey helmet data combined</td>
<td>Documented alterations in cervical vertebrae position during helmet removal, cervical collar application, head at rest</td>
<td>Helmet removal by prehospital personnel not recommended unless specific clinical indication and personnel are trained in helmet removal</td>
</tr>
<tr>
<td>Stephenson et al160</td>
<td>Human male volunteers</td>
<td>Radiographs</td>
<td>N = 13</td>
<td>Helmet removal: no equipment; helmet only; pads only; helmet and pads</td>
<td>Abstract only; healthy volunteers; hockey only</td>
<td>Ice hockey helmet removal alters cervical alignment when pads left in place</td>
<td>Helmet removal should be delayed in hockey until both helmet and shoulder pads can be removed together in a controlled setting</td>
</tr>
<tr>
<td>Swenson et al166</td>
<td>Human male volunteers</td>
<td>Lateral scout CT scans</td>
<td>N = 10</td>
<td>Helmet removal: no equipment; shoulder pads only; helmet and pads</td>
<td>Healthy volunteers; football only</td>
<td>Increased cervical lordosis with pads only; no difference with no equipment and both helmet and pads in place</td>
<td>Helmet removal should be delayed until both helmet and shoulder pads can be removed both helmet and pads in place together in a controlled setting</td>
</tr>
<tr>
<td>Tierney et al169</td>
<td>Human male volunteers</td>
<td>MRI</td>
<td>N = 12</td>
<td>No equipment; helmet and pads; measure sagittal space of cord (SS), cord diameter (SD)</td>
<td>Clinically significant amount of SS and SD unclear; football only</td>
<td>SS greater supine and with pads</td>
<td>Helmet and pads should be maintained during spine board immobilization</td>
</tr>
<tr>
<td>Waninger et al184</td>
<td>Human male volunteers</td>
<td>High-resolution cameras; video motion analysis</td>
<td>N = 30</td>
<td>Helical angles determine range of motion inside immobilized helmets and pads</td>
<td>Football, ice hockey and lacrosse; amount of clinically significant movement unclear; extrapolated head-to-neck motion</td>
<td>Range of motion inside all 3 helmets was not significantly different</td>
<td>Supports the safety of prehospital stabilization with helmet/pads in place in all 3 sports</td>
</tr>
</tbody>
</table>

*NATA, National Athletic Trainers’ Association.*

Radiographs

The NCAA117 and the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete85 both recommend that the helmet with facemask removed and the
shoulder pads remain in place during the initial clinical and radiographic assessment in the emergency department. Only after radiographs have been obtained and reviewed should the helmet and shoulder pads be removed in a controlled environment. Standard 3-view imaging provides reliable screening for most patients with blunt trauma. However, the protective helmet and shoulder pads worn by athletes may interfere with the adequate visualization that is required for spinal clearance. Proper visualization of the cervical spine by radiographs was not adequate in 2 small studies using normal volunteers, and one would expect radiographs to be more problematic in actual players (Table 5). Protective helmets and shoulder pads have metal and plastic components that interfere with adequate visualization of the entire cervical spine, the helmet and shoulder pads need to be removed or mechanically altered.

Initial CT evaluation has been recommended in acute cervical spine trauma. Lateral CT scout films have been used with good success in several research studies, and a study looking at the feasibility of CT scanning in the initial workup of the helmeted athlete has shown that CT films with helmet and shoulder pads in place were adequate for initial diagnosis and triage. An MRI of acute spinal cord injury in the unhelmeted patient provides excellent visualization of neurologic and soft tissue structures. Two studies used MRI in protocols to study spinal cord diameters in helmeted athletes, but all metallic pieces were removed from the helmet before the scans, and special custom-made shoulder pads with no metal components were used. With present-day football helmets, the amount and type of metal within the helmet results in sufficient field inhomogeneity and skew artifact to preclude adequate evaluation of the cervical structures, rendering MRI evaluation in this setting clinically limited. The replacement of ferromagnetic components in the helmet with MRI-compatible materials by the manufacturers would be required to perform adequate imaging in these patients using present-day MRI technology. If adequate visualization of the cervical spine is not obtained by radiographs with equipment in place, initial triage may be justified to bypass radiographs and go directly to CT evaluation in these high-risk patients with protective gear in place. If immediate CT scanning is not available, then equipment may need to be removed in the emergency department before radiographic clearance.

**TABLE 2**

<table>
<thead>
<tr>
<th>References</th>
<th>Study Variable</th>
<th>Problems</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Godwin et al</td>
<td>Evaluate whether football equipment would interfere with ability to intubate by emergency medicine physicians</td>
<td>Abstract only; training manikin; physicians inserting ETT</td>
<td>Endotracheal intubations are difficult and often unsuccessful in athletes wearing protective athletic equipment; recommend alternative means for securing an airway in these athletes</td>
</tr>
<tr>
<td>Kleiner and Miller</td>
<td>Evaluate whether football equipment would interfere with ability to intubate by EMT-P</td>
<td>Abstract only; training manikin; EMT-Ps inserting ETT</td>
<td>Endotracheal intubations are difficult and often unsuccessful in athletes wearing protective athletic equipment; recommend alternative means for securing an airway in these athletes</td>
</tr>
<tr>
<td>Kleiner and Miller</td>
<td>Evaluate whether football equipment would interfere with the ability to secure ETT or ETC by EMT-P</td>
<td>Abstract only; training manikin; EMT-Ps inserting ETT</td>
<td>ETC can be inserted quicker than ETT in an athlete wearing protective equipment</td>
</tr>
<tr>
<td>Kleiner et al</td>
<td>Evaluate whether football equipment would interfere with ability to secure ETC by ATCs</td>
<td>Abstract only; training manikin; ATCs inserting ETC</td>
<td>ETC can be safely inserted in an athlete wearing protective equipment</td>
</tr>
<tr>
<td>Kleiner et al</td>
<td>Evaluate whether football equipment would interfere with ability to secure LMA by ATCs</td>
<td>Abstract only; training manikin; ATCs inserting LMA</td>
<td>LMA can be safely inserted in an athlete wearing protective equipment; ATCs can perform insertion compared to EMT-Ps and physicians</td>
</tr>
<tr>
<td>Miller and Kleiner</td>
<td>Evaluate whether football equipment would interfere with ability to secure ETC by EMT-Ps</td>
<td>Abstract only; training manikin; EMT-Ps inserting ETC</td>
<td>ETC can be safely inserted in an athlete wearing protective equipment</td>
</tr>
</tbody>
</table>

*ETT, endotracheal tube; EMT-P, emergency medical technician–paramedic; ETC, esophageal tracheal Combitube; ATC, certified athletic trainer; LMA, laryngeal mask airway.*
Helmet and Shoulder Pad Removal (at least a 2-person procedure)\textsuperscript{124}

1. Person A is positioned at the top of the patient’s head and manually stabilizes the head and neck by placing an arm on each side of the patient’s head. The hands of person A, with thumbs pointing up, stabilize the patient’s head.
2. Person B removes the facemask if it has not already been removed.
3. Person B removes the facemask by cutting or unsnapping it.
4. Person B removes the cheek/jaw pads from the helmet by slipping the flat blade of a screwdriver or bandage scissors between the pad snaps and the helmet’s inner surface and twisting slightly. Pull firmly and slowly to slide the pad out. Remove the pad on the other side in the same way. Note that the design of the Riddell Revolution helmet does not allow helmet removal with removal of the traditional jaw pads.\textsuperscript{164} Jaw pads cannot be removed in this helmet. The jaw pads need to be deflated by puncture with an 18-gauge needle before removal. This is an important distinction regarding the Riddell Revolution helmet.
5. Person B deflates the air inflation system by releasing air at the external ports with an open inflation needle (18-gauge or air pump needle). Most helmets have internal air pockets that secure the helmet tightly against the head. These inflated pockets must be deflated before helmet removal. The inflation needle will remove the air. If an inflation needle is not available, the bladder can be broken and depressed with an 18-gauge needle.
6. Person B takes over in-line immobilization of the head. With 1 hand, person B grasps the patient’s mandible between the thumb and first 2 fingers while placing the other hand under the occiput. Person A places a thumb inside each ear hole of the helmet and curls the fingers along the bottom edge of the helmet. Some authors suggest that the helmet can be spread and eased off by pulling laterally and longitudinally in line with the head and neck.\textsuperscript{121} However, it has been suggested that this maneuver serves to tighten the helmet at the occiput and the forehead.\textsuperscript{3} The task force has recommended that the helmet be rotated off the head in a gentle fashion without pulling laterally.\textsuperscript{85}
7. The external shirt should be cut immediately on arrival to provide optimal exposure. The shoulder pads are removed by cutting the straps underneath the arms and the anterior straps holding the pads together. If a neck roll or roll restriction pad is present, it should be unfastened from the helmet and shoulder pads before removal. The shoulder pads and helmet should be removed simultaneously to prevent the head from falling into extension. If the shoulder pads cannot be removed simultaneously, the head must be stabilized in a neutral position during this procedure. The hands of person B can be moved superiorly as the helmet is being removed so that the thumb and first fingers grasp the maxilla at each side of the nose in the maxillary notch.
8. If the helmet cannot be removed and access to the chest area is required, the anterior half of the shoulder pads can be removed, leaving the posterior portion to maintain cervical position with the helmet in place.
9. A cervical collar can be placed after helmet removal, and in-line stabilization can be maintained.

Facemask Removal From a Football Helmet

1. Maintain neutral position of the head and neck.
2. Remove the athlete’s mouthpiece.
3. Maintain the chin strap and helmet cheek pads in place.
4. Cut through the 4 clips fastening the facemask to the helmet.
5. One member removes the facemask while another maintains head and neck stabilization.
6. Carefully clear the facemask of the clips, being especially cautious of any anterior remnants and extraneous cervical spine motion. Remove the facemask completely if possible.\textsuperscript{82,122}

Helmet/Equipment Design and Backboard Immobilization

Football helmet design differs from that of other helmets (Figure 5).\textsuperscript{15,71} The helmeted athlete with a potential cervical spine injury should be properly immobilized on a backboard, with the helmet taped to the backboard and facemask removed.\textsuperscript{76,152} Stabilization of the helmet will limit movement of the head within the helmet, which is necessary for spinal immobilization.\textsuperscript{76,184} Some investigators have questioned whether immobilization of loosely fitted helmets, such as those worn in hockey, will actually limit the amount of head movement within the helmet.\textsuperscript{126} The movement within a properly stabilized lacrosse, ice hockey, or football helmet has been shown to be minimal, although the actual amount of movement that is safe has not been established.\textsuperscript{104} The safety and emergency treatment protocols of helmets depend on proper equipment fitting, and clinicians should be aware that poorly fitting equipment might affect in-line immobilization techniques.\textsuperscript{3} The National Athletic Trainers’ Association protocol for helmet and shoulder pads removal (Table 3) has been shown to effectively limit motion of the cervical spine during equipment removal.\textsuperscript{120}

Because of neck hyperextension, helmet removal should be delayed until both the helmet and shoulder pads can be removed together.\textsuperscript{52,121,132,153,166} Although it has been suggested that a hard collar be placed around the helmeted neck during transport,\textsuperscript{111,131,172} achieving proper fit for cervical collars in these helmeted athletes is often difficult because the helmet and shoulder pads with attached neck roll/collar may interfere with proper positioning of the collar.\textsuperscript{190} In a study of cervical spine movement in asymptomatic helmeted football, lacrosse, and ice hockey players, cervical collars could not be properly placed because of other equipment restraints (Figure 6).\textsuperscript{184} This finding was recognized by the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete in its statement that the potentially injured helmeted spine can be stabilized with helmet and shoulder pads without a collar.\textsuperscript{85} Proper immobilization with commercially available

\textsuperscript{3}References 52, 62, 105-107, 125, 126, 147.
specialized binders (Figure 6), 184 sandbags, 111,182 and tapping 131,157 can be used. Although sandbags have lost favor in the prehospital management of unhelmeted trauma victims, 157 the weight and shape of the helmet may require greater stabilization to prevent lateral movement of the head and neck. 183 Sandbag placement for lateral cervical spine stabilization has been recommended to help secure the helmet in injured hockey players. 111 Lightweight foam pads or rolled-up towels may not be adequate alone for stabilization in the helmeted athlete. 49 If available, commercial backboards with specialized binders that firmly secure the helmet and neck may be the optimal choice of backboard immobilization (Figure 6). 184 A specialized cervical spine immobilizer that limits spinal range of motion while the helmeted athlete is immobilized and transported has been studied but is not in general use. 138

Shoulder pads with helmet in place elevate the torso to maintain a relatively neutral cervical spine position. 42,105,153,166 Unacceptable cervical motion can occur during motorcycle helmet removal if the shoulders are not properly elevated. 112 Both American football and ice hockey players wear protective shoulder pads as part of their standard equipment. The shoulder pads in football are larger in design and often include an attached collar roll to prevent neck hyperextension and rotational/lateral bending (Figure 7). No single piece of protective equipment will appreciably alter flexion, and attempts to alter shoulder pads and helmet design to prevent extremes of flexion have been studied with some success but are not in common use today. 6 In the transport of an athlete with a potential cervical spine injury, proper immobilization includes leaving both the helmet and shoulder pads in place. 35,185

Emergency medical service providers must take into account the method of removal of a player off the field because standard emergency medical service immobilization equipment may be inadequate for the large size of the athlete. 136 The location of rescue vehicles for transport and the safety of methods to transport the athlete to the rescue vehicle are all issues that need to be further discussed. 7 The contribution of shoulder pads to the mechanism of cervical spine injury in other sports such as lacrosse and rugby has not been well studied. 135

Facemask Removal

It is recommended that all facemasks be removed (Table 4) from football helmets (Figure 5A) before transport, regardless of current respiratory status. When facemask removal is required, the plastic clips attaching the facemask are cut. Safe techniques for facemask removal are well

---

**TABLE 5**

Radiography as Screening

<table>
<thead>
<tr>
<th>References</th>
<th>Subjects</th>
<th>Methods</th>
<th>Number of Subjects</th>
<th>Techniques</th>
<th>Limitations</th>
<th>Results</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davidson et al</td>
<td>Male volunteers</td>
<td>Radiographs</td>
<td>N = 20</td>
<td>2-view radiograph series with and without football helmet and pads</td>
<td>Poor visualization of C1-C3, C6-C7, C7-T1 interspace with helmet and pads</td>
<td>Guidelines for helmet and pads removal are needed before radiographs; helmet and shoulder pads are impediments to radiographic visualization</td>
<td></td>
</tr>
<tr>
<td>Veenema et al 176</td>
<td>Male volunteer</td>
<td>Radiographs</td>
<td>N = 1</td>
<td>Lateral scout film with no equipment; football and hockey helmets and pads</td>
<td>Radiographs (football) inadequate; radiographs (hockey) C7, C7-T1 inadequate</td>
<td>Football helmets should be removed before radiographs; hockey films may be adequate if C7, C7-T1 can be visualized</td>
<td></td>
</tr>
<tr>
<td>Waninger et al 186</td>
<td>Male volunteer</td>
<td>MRI</td>
<td>N = 1</td>
<td>MRI with helmet and shoulder pads in place</td>
<td>MRI films had sufficient field inhomogeneity and skew artifact to preclude adequate evaluation of the cervical structures</td>
<td>MRI plays only a limited role in the initial evaluation of the neck-injured helmeted athlete, with present-day MRI capability and equipment</td>
<td></td>
</tr>
<tr>
<td>Waninger et al 185</td>
<td>Male volunteers</td>
<td>CT</td>
<td>N = 5</td>
<td>CT with and without helmet and shoulder pads on</td>
<td>Quality of CT scans was adequate for evaluation of cervical spine structures</td>
<td>CT scans may play an important role in the initial evaluation of the neck-injured helmeted athlete</td>
<td></td>
</tr>
</tbody>
</table>

---

Vol. 32, No. 5, 2004 Helmeted Athlete With Cervical Spine Injury 1339
described.$^{35,83,94,140}$ With practice, the facemask of any helmet can be quickly and safely removed with minimal risk of extraneous movement of the cervical spine.$^{86}$

There have been many tools (Figure 8) and methods (Table 6) studied for facemask removal.$^{143}$ The proper equipment to remove the facemask should be readily available, and the choice of equipment is less important than the expertise of the personnel with a particular tool.$^{146}$ (Table 7). Practice increases skills of facemask removal.$^{86}$

The new Riddell Revolution helmets have a new facemask clip design that cannot be cut using conventional measures and requires a screwdriver for removal (Figure 9E).$^{144}$ Consequently, athletic training and medical staff need to be familiar with the equipment used by the players under their care. A quick-release system that eliminates the need for any tools may be available in the future.$^{143}$

Note that ice hockey (Figure 5B) and lacrosse (Figure 5C) facemasks differ from football facemasks in that they consist of metal bars attached by screws to the superior aspect of the helmet. A plastic or cloth clip attaches the facemask to the helmet and must be cut to gain access to the facial structures. The facemask flips up easily but remains attached to the helmet by metal screws. Often, these helmets have rusted hardware that makes removal difficult. There are no established guidelines for removal of facemasks in ice hockey and lacrosse,$^{25}$ although removal with a screwdriver may be the preferred method if the screws are well maintained and not rusted. Metal cutters may be used to cut the facemask, but this maneuver may cause unacceptable torque and movement.

Helmet and Shoulder Pad Removal

The recommendation of both the NCAA$^{117}$ and the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete$^{25}$ is that only after radiographs have been
obtained and reviewed should the helmet and shoulder pads be removed. Equipment should be removed only by qualified trained medical personnel. These recommendations reflect the belief that maintaining spinal immobilization during removal of the football helmet and shoulder pads is quite difficult and requires training, practice, and multiple qualified personnel.  

Current guidelines on equipment removal represent a consensus of those with clinical expertise in the field rather than evidence-based medicine. The athlete should be stabilized on a backboard, facemask removed, with helmet and shoulder pads in place. If the athlete is face down or side lying, he/she should be moved into place as a unit via a coordinated logroll technique. The decision to remove an athlete’s equipment has been guided by the “all or nothing” principle: if it is determined that either the helmet or shoulder pads need to be removed, they both should be removed simultaneously. Simultaneous helmet and shoulder pad removal may be warranted in the following situations:  

1. The helmet is so loose that adequate spinal immobilization cannot be obtained with the helmet in place; that is, the helmet and chin strap do not hold the head securely.  
2. The design of the helmet and chin strap is such that even after removal of the facemask, the airway cannot be assessed or managed properly.  
3. The facemask or visor interferes with adequate airway management, and the facemask cannot be removed after a reasonable period of time.  
4. The helmet prevents immobilization for transport.  
5. There is evidence of a head injury requiring direct inspection.  
6. The patient has arrived at the emergency department, and initial radiographs or CT scans are normal or nondiagnostic.  

Studies show that proper immobilization of football, ice hockey, and lacrosse helmets does prevent movement of
Figure 9. Football helmet. Anterior view (A) and side view (B) of facemask loop straps that attach the facemask to the helmet (area to cut for quick removal indicated). The helmet cheek or jaw pads (C, labeled “chin pads”) can be removed by gently pry- ing the pads loose from their snap attachments with a reflex hammer handle or similar tool and then sliding the pads out. If the helmet has an internal air pad (C), it should be deflated by tapping it with an air pump needle or an 18-gauge needle before hel- met removal, as diagrammed in D. The new Riddell helmet has a clip design that cannot be cut off but requires the clip to be removed by a screwdriver (E). It also has cheek pads that are not removable and that require a puncture with an 18-gauge nee- dle to facilitate helmet removal.
### TABLE 6
Facemask Studies for American Football Helmets

<table>
<thead>
<tr>
<th>References</th>
<th>Study Variable</th>
<th>Tools</th>
<th>Problems</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almquist et al</td>
<td>Response time</td>
<td>TA, AP, PVC, SD</td>
<td>Abstract only</td>
<td>Carrying tools for facemask removal improves response time</td>
</tr>
<tr>
<td>Angotti et al</td>
<td>Time needed to cut facemask straps using 3 techniques</td>
<td>FME</td>
<td>Abstract only</td>
<td>FME has 3 technique options for facemask removal</td>
</tr>
<tr>
<td>Block et al</td>
<td>Time needed to cut facemask straps and retract mask</td>
<td>TA, AP</td>
<td>Abstract only; student ATCs</td>
<td>Differences in amount of time and amount of movement with different tools and facemask straps</td>
</tr>
<tr>
<td>Brown et al</td>
<td>Hand placement patterns of removal tools</td>
<td>TA, AP, FME, PVC</td>
<td>Abstract only</td>
<td>Various hand positions are used during helmet removal; FME and AP allowed subjects to perform removal with 1 hand</td>
</tr>
<tr>
<td>Ensch et al</td>
<td>Evaluate whether transfer of learning occurs with respect to time needed to cut facemask straps and retract facemask</td>
<td>FME, TA, AP</td>
<td>Abstract only; subjects had no prior experience in facemask removal</td>
<td>Practicing a specific tool improves performance with tool, but improvement will not transfer to other tools</td>
</tr>
<tr>
<td>Fuchs et al</td>
<td>Time needed to cut facemask straps and retract mask</td>
<td>AP, PSD, TA, SD</td>
<td>Abstract only</td>
<td>Differences in amount of time and amount of movement with different tools and facemask straps</td>
</tr>
<tr>
<td>Hall et al</td>
<td>Time needed to cut facemask straps and retract mask</td>
<td>FME, TA, PVC, AP</td>
<td>Abstract only</td>
<td>FME most effective; FME and TA required fewest number of cuts to remove facemask</td>
</tr>
<tr>
<td>Hoenshel et al</td>
<td>Time needed to cut facemask straps and retract mask</td>
<td>FME, TA, AP</td>
<td>Abstract only</td>
<td>Greater satisfaction with FME, AP faster than FME or TA</td>
</tr>
<tr>
<td>Hoenshel et al</td>
<td>Evaluation of 3 methods of FME use</td>
<td>FME</td>
<td>Abstract only</td>
<td>Recommend use of tool technique that is most practiced and at which trainers have most skill</td>
</tr>
<tr>
<td>Jenkins et al</td>
<td>Time and torque needed to cut facemask straps and retract mask measured via force platform</td>
<td>FME, TA, PSD, QRS</td>
<td>FME most effective; FME and TA required fewest number of cuts to remove facemask</td>
<td>Removal of plastic clips via QRS or PSD faster with less force and torque than TA or FME</td>
</tr>
<tr>
<td>Kleiner et al</td>
<td>Time needed to cut facemask straps and retract mask</td>
<td>TA, AP</td>
<td>Abstract only</td>
<td>Practice decreases time and increases efficiency of facemask removal</td>
</tr>
<tr>
<td>Kleiner</td>
<td>Facemask removal vs retraction, amount of movement of spine</td>
<td>TA, AP</td>
<td>AP more effective than TA cutting straps, satisfaction</td>
<td>Complete extraction of face mask vs retraction results in less extraneous cervical spine movement; recommend to practice skill of facemask removal</td>
</tr>
<tr>
<td>Kleiner and Knox</td>
<td>Facemask removal techniques</td>
<td>TA, KN, SD, other</td>
<td>Abstract only; survey</td>
<td>Recommend practice skill of facemask removal; suggest skill be made ATC competency requirement</td>
</tr>
<tr>
<td>Kleiner and Greenwood</td>
<td>Hand size and grip strength</td>
<td>TA, AP</td>
<td>Abstract only; healthy controls</td>
<td>Unable to attribute differences in male and female study subjects to hand size or grip strength</td>
</tr>
<tr>
<td>Kleiner and Knox</td>
<td>Evaluate technique with TA</td>
<td>TA</td>
<td>Abstract only; healthy controls; observational study; not well controlled</td>
<td>The skill of facemask removal should be included as a competency requirement for ATCs</td>
</tr>
<tr>
<td>Kleiner and Sonnenberg</td>
<td>Temperature</td>
<td>TA, AP</td>
<td>Abstract only; healthy controls</td>
<td>Differences in time and satisfaction related to temperature; increased difficulty in facemask removal in cold environments</td>
</tr>
</tbody>
</table>

(continued)
TABLE 6

<table>
<thead>
<tr>
<th>References</th>
<th>Study Variable</th>
<th>Tools</th>
<th>Problems</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knox and Kleiner²⁷</td>
<td>Qualifications; satisfaction; efficiency with tools; time to removal; amount of head movement</td>
<td>SD, TA, AP, KN</td>
<td>KN removed because of causing injury to staff; healthy controls</td>
<td>No difference in time; movement highest with TA; satisfaction greatest with AP; ATCs need to practice skill of facemask removal</td>
</tr>
<tr>
<td>Knox and Kleiner³⁶</td>
<td>Comparison of time to remove and retract facemask using S</td>
<td>S</td>
<td>Abstract only; healthy controls; ATCs and EMTs served as subjects</td>
<td>EMT shears are not the ideal tools to remove facemasks</td>
</tr>
<tr>
<td>O'Sullivan et al¹²²</td>
<td>Comparison of time to remove vs retract facemask</td>
<td>FME, TA, PVC, AP</td>
<td>Abstract only; healthy controls</td>
<td>Removal faster than retraction for all tools; supports removal of facemasks; removal time for PVC longest</td>
</tr>
<tr>
<td>Pearson et al¹²⁷</td>
<td>Facemask removal time</td>
<td>PVC, AP</td>
<td>Abstract only; healthy controls</td>
<td>No gender differences, but significant differences dependent on experience; AP faster than PVC</td>
</tr>
<tr>
<td>Pearson et al¹²⁸</td>
<td>Ease and speed of removal of 2 brands of facemask loop straps</td>
<td>TA, AP</td>
<td>Abstract only; healthy controls</td>
<td>Loop straps are made of different consistencies; tool efficiency differs with loop-strap brands</td>
</tr>
<tr>
<td>Putnam¹³³</td>
<td>Feasibility of alternative facemask removal tools</td>
<td>PSD, SD, WC, WC</td>
<td>Demonstration, not real study</td>
<td>Several alternative methods are available for facemask removal; bolt cutters needed for older facemasks</td>
</tr>
<tr>
<td>Ray et al¹⁴⁰</td>
<td>Cervical spine motion measured via video motion analysis</td>
<td>PM, SD</td>
<td>Healthy controls</td>
<td>PM insertion techniques allow quicker insertion and initiation of rescue breathing; cervical spine displacement not significant; PM can be used without facemask removal</td>
</tr>
<tr>
<td>Ray et al¹⁴¹</td>
<td>Qualifications; efficiency with tools; time to removal; amount of head movement</td>
<td>SD, PSD, TA, PM</td>
<td>Healthy controls</td>
<td>PM insertion techniques allow quicker insertion and initiation of rescue breathing; TA more extraneous motion; PM can be used without facemask removal</td>
</tr>
<tr>
<td>Redden et al¹⁴²</td>
<td>Gender and grip strength on time needed to cut facemask straps</td>
<td>TA, AP</td>
<td>Abstract only; healthy controls</td>
<td>Differences in time to cut and in satisfaction between TA and AP</td>
</tr>
<tr>
<td>Sanville et al¹⁴⁸</td>
<td>Age (sharpness) of the removal tools</td>
<td>TA, AP</td>
<td>Abstract only; healthy controls</td>
<td>AP preferred over TA; both less effective when dull compared to sharp</td>
</tr>
<tr>
<td>Surace et al¹⁶²</td>
<td>Facemask removal time and head motion during removal</td>
<td>AP, TA, SD</td>
<td>Abstract only; healthy controls</td>
<td>SD most effective, less head motion</td>
</tr>
<tr>
<td>Swartz et al¹⁶³</td>
<td>Facemask removal time and head motion during removal using video motion analysis</td>
<td>AP, TA, SD, FME</td>
<td>Healthy controls</td>
<td>AP quickest; FME least amount of movement</td>
</tr>
<tr>
<td>Swartz et al¹⁶⁵</td>
<td>Facemask removal time and head motion during removal using video motion analysis</td>
<td>AP, TA, PVC, FME</td>
<td>Healthy controls</td>
<td>FME increased performance in time, satisfaction, rating, efficiency; FME increased amount of movement but needs further study</td>
</tr>
<tr>
<td>Zeal et al¹³²</td>
<td>Facemask removal time and satisfaction using various loop straps (single, double)</td>
<td>AP, TA, FME</td>
<td>Healthy controls</td>
<td>Modifying the standard single loop straps adversely affects the ability to remove facemask</td>
</tr>
</tbody>
</table>

¹⁴⁰ TA, Trainer's Angel; AP, anvil pruner; PVC, polyvinyl chloride pipe cutters; SD, manual screwdriver; FME, facemask extractor tool; ATC, certified athletic trainer; PSD, power screwdriver; QRS, quick-release system; KN, utility knife; S, emergency medical technician scissors/shears; WC, wire cutters; PM, pocket mask insertion technique.
the head inside the immobilized helmet. However, if the equipment is a liability during immobilization or radiographic evaluation, it must be removed. The shape of the human head and the design of a football helmet allow for a tight custom fit. The head is shaped like a cone, widest at the crown and narrow toward the chin. The helmet, on the other hand, is nearly spherical. Pads are used to secure the helmet tightly at the player’s cheekbones, and an air bladder is inflated within the helmet to fill any remaining space. In preparation for helmet removal, the pads need to be removed, and the air bladder needs to be deflated. Holes in the helmet at the ears allow examination of the ears without helmet removal. It is recommended that the chin strap not be removed during transport until the helmet is ready to be removed (Table 4). The procedure for removal of helmet and shoulder pads is at least a 2-person process (Table 8). An alternative method of motorcycle helmet removal by bivalving the helmet in the coronal plane has been investigated in a cadaveric model, but no studies looking at alternate methods of football helmet removal have been examined (see Appendix 6 for helmet studies of interest, available in the online version of this article at www.ajsm.org).

CONCLUSIONS

The approach to the neck-injured player on the field has been well reviewed, and conservative, literature-based algorithms for on-field sideline evaluations of neck pain have been published. The unique characteristics of the well-fitted football helmet allow safe access to airway management, and helmets and shoulder pads should not be removed in the prehospital management of the football player with a potential cervical spine injury unless absolutely necessary. Prehospital and emergency department personnel must be trained in the proper removal of the football helmet, shoulder pads, and facemask. If required, both helmet and shoulder pads should be

<table>
<thead>
<tr>
<th>Tool</th>
<th>Positives</th>
<th>Negatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick-Release system</td>
<td>Easy system with minimal practice; no tools involved; user-friendly</td>
<td>Still in testing phase, not available; testing on prototype only, new versions not well studied</td>
</tr>
<tr>
<td>Facemaks Extractor</td>
<td>Ability to resist slipping while requiring minimal grip strength</td>
<td>High cost; ergonomics often require 2-handed procedure; testing on prototype only; new versions not well studied</td>
</tr>
<tr>
<td>Trainer’s Angel</td>
<td>One sharp edge; cuts by squeezing the clip between the sharp edge and the opposing buttress</td>
<td>May have problems with hard clips; medium cost</td>
</tr>
<tr>
<td>Anvil pruner</td>
<td>Ratchet mechanism best model; may cut harder clips; easy availability; low cost</td>
<td>May have slipping problems with some helmet clips</td>
</tr>
<tr>
<td>Electric screwdrivers</td>
<td>Battery-powered units are convenient; user-friendly; less movement; faster times; remove entire clip instead of cutting</td>
<td>Require continuous maintenance to combat screw damage and rust; not reliable; high failure rate</td>
</tr>
<tr>
<td>Manual screwdrivers</td>
<td>Easy availability; user-friendly; less movement; faster times; remove entire clip instead of cutting</td>
<td>May cause torque; require continuous maintenance to combat screw damage and rust; not reliable; high failure rate</td>
</tr>
<tr>
<td>PVC pipe cutters</td>
<td>Easy availability; low cost</td>
<td>May have problems with hard clips</td>
</tr>
<tr>
<td>Bolt cutters</td>
<td>Cut facemask or clips; needed for older facemasks that attach directly to helmet without clips</td>
<td>Torque/rebound effect; not recommended</td>
</tr>
<tr>
<td>High-speed rotary tool (with metal cutting blades)</td>
<td>Effective in cutting thicker facemask fastening systems found on lacrosse and hockey helmets; battery-powered units are convenient</td>
<td>Not recommended; may throw shavings into face; may melt plastic clips; bad odor; load noise; need to monitor battery power</td>
</tr>
<tr>
<td>Emergency medical technician scissors</td>
<td>Easy availability; low cost</td>
<td>Not effective; not recommended</td>
</tr>
<tr>
<td>Utility knife</td>
<td>Easy availability; low cost</td>
<td>Dangerous to user; not effective; not recommended</td>
</tr>
</tbody>
</table>
TABLE 8
Guidelines of the Inter-Association Task Force for Appropriate Care of the Spine-Injured Athlete

General guidelines
1. Manage the athlete suspected of having a spinal injury as though a spinal injury exists.
2. Activate emergency medical service.
3. Assess the athlete’s airway, breathing and circulation, neurologic status, and level of consciousness.
4. Do not move the athlete unless absolutely essential to maintain airway, breathing, and circulation.
5. If the athlete must be moved to maintain airway, breathing, and circulation, place him/her in a supine position while maintaining spinal immobilization.
6. If moving a suspected spine-injured athlete, move the head and trunk as a unit (an accepted technique is to manually splint the head to the trunk).

Facemask removal
1. Remove the facemask before transport, regardless of current respiratory status.
2. Have the tools for facemask removal readily available.

Football helmet removal
Remove the athletic helmet and chin strap only . . .
1. If the helmet and chin strap do not hold the head securely, such that immobilization of the helmet does not also immobilize the head.
2. If the helmet and chin strap design prevent airway control or the provision of ventilation even after removal of the facemask.
3. If the facemask cannot be removed after a reasonable period of time.
4. If the helmet prevents immobilization in an appropriate position for transport.

Helmet removal
Maintain spinal immobilization while removing the helmet.
1. Helmet removal should be practiced frequently under proper supervision.
2. In most circumstances, it may prove helpful to remove cheek padding and/or deflate air padding before helmet removal.

Equipment
Maintain appropriate spinal alignment.
1. The helmet and shoulder pads elevate an athlete’s trunk when in the supine position.
2. Should either the helmet or shoulder pads be removed or if only 1 is present, appropriate spinal alignment must be maintained.
3. Open the front of the shoulder pads to allow access for cardiopulmonary resuscitation and defibrillation.

removed simultaneously. The strength of the evidence is relatively circumstantial and somewhat anecdotal, but the few related studies have shown that there may be a risk to helmet removal. However, no injuries have been reported from the policy of keeping the equipment in place. In this clinical scenario, it is best to do no harm. There is a need

for greater communication between sports medicine and local emergency providers regarding management of the helmeted athlete. Prehospital and sports medicine teams should formulate a plan in advance to prepare for unexpected clinical scenarios such as cervical spine injuries, and skills such as facemask and helmet removal should be practiced. All health care specialties that treat these injuries need to be aware of the guidelines for managing helmeted athletes. Whether these thoughts can be extrapolated to other helmet designs has yet to be established.

If, with equipment in place, adequate radiographic visualization of the cervical spine is not possible, then existing protocols that recommend initial radiographs in these patients may need to be revised. Initial triage may be justified to bypass radiographs and go directly to CT evaluation. If immediate CT scanning is not available, then equipment may need to be removed in the emergency department before radiographic clearance. The MRI presently plays a limited role in the initial clearance of the injured spine before equipment removal. Because this is the standard of care, emergency department personnel should become familiar with helmet and shoulder pad removal procedures.

Some studies advocate helmet removal without differentiating among types of helmets. Adequate data evaluating lacrosse, equestrian, baseball/softball, kayak, or bicycle helmets are not available, and results from studies evaluating motorcycle, ice hockey, and football helmets may not be applicable to other helmet designs. Organized football programs requiring helmets as part of the standard equipment also involve the pediatric and female populations. These conclusions, based on studies performed on college-aged male athletes, cannot necessarily be extrapolated to a younger or female population without further study.

ACKNOWLEDGMENT

The author thanks the Library Staff and the Media Productions Department at Saint Luke’s Hospital for their assistance; Michael Heller, MD, for his guidance in the preparation; and Douglas Kleiner, ATC, PhD, and Joseph Torg, MD, for their review of this article.

REFERENCES

53. Godwin SA, Kleiner DM, Norton CE. The ability of physicians to perform endotracheal intubation with a football helmet, face mask, and chin strap. 2003 Southeastern Regional Meeting of the Society for Academic Emergency Medicine, April 11-13, 2003; Jacksonville Beach, Fla.


