Laryngeal Trauma in Sport

Scott A. Paluska and Christopher D. Lansford
University of Illinois College of Medicine, Urbana, IL

PALUSKA, S.A., and C.D. LANSFORD. Laryngeal trauma in sport. Curr. Sports Med. Rep., Vol. 7, No. 1, pp. 16–21, 2008. The larynx and surrounding soft tissues are vulnerable to injury during athletics despite protective equipment and rule modifications. Laryngeal injuries are uncommon but potentially fatal conditions that pose risks to the voice, airway, and esophagus of athletes who sustain blunt or penetrating neck trauma. Common symptoms and signs of laryngeal trauma include hoarseness, dyspnea, hemoptysis, dysphonia, respiratory distress, anterior neck tenderness, subcutaneous emphysema, and loss of normal laryngeal architecture. Diagnostic evaluation includes plain radiographs, computed tomography, and fibroscopic endoscopy. Most athletes with laryngeal injuries will require surgical treatment to restore normal regional anatomy and vocal quality. Less severe injuries may be treated with close observation, serial endoscopy, medications, and vocal rest.

INTRODUCTION

Despite the development and implementation of rule modifications and safety equipment, occurrences of laryngotracheal injuries during sporting activities remain significant. Laryngeal injuries are less common than other head or neck injuries among athletes, but they pose risks to the voice, airway, and esophagus of affected individuals. Indeed, the mortality rates of laryngeal trauma can approach 40%, and even relatively minor injuries can lead to permanent phonic, neurological, swallowing, or respiratory difficulties (1,2). Identifying the full extent of an athletic laryngeal injury can be challenging, but a delayed or missed diagnosis can be life threatening (3,4). Moreover, laryngotracheal injuries often have subtle, confusing, and heterogeneous presentations, especially when present in conjunction with multiple areas of trauma (2). It is important for sports medicine clinicians to maintain a high index of suspicion and utilize a systematic approach during the evaluation of athletes with possible laryngotracheal injuries.

The trachea, larynx, and esophagus are relatively unprotected and vulnerable to injury during athletic events. Laryngeal injuries typically occur after blunt or penetrating contact with another athlete, environmental hazard, or fixed structure, such as a goal post, mat, hurdle, hockey board, or wall. Sporting equipment, such as pucks, sticks, bats, and balls, also may produce substantial laryngeal injuries. Low velocity trauma may cause soft tissue lacerations, abrasions, contusions, submucosal hemorrhage, and edema (5). Injuries that are more forceful may damage the intrinsic laryngeal muscles, the vocal folds, or the dual nerve supply to the larynx from the superior and recurrent laryngeal nerves (6). The hyoid bone, thyroid cartilage, arytenoid cartilage, and cricoid cartilage also are susceptible to direct injury during athletic participation. Forceful compression injuries of the chest with a closed glottis or rapid deceleration injuries can result in laryngeal fractures or mucosal disruption (7). The proximity of the larynx to the trachea and esophagus increases the likelihood of concomitant aerodigestive abnormalities, and esophageal injuries occur in up to 50% of individuals with a penetrating neck injury (2).

EPIDEMIOLOGY

Laryngeal injuries are uncommon, representing less than 1% of blunt and 7% of penetrating trauma cases seen in major medical centers (2,3,7–9). Recent studies have noted that the yearly rates of neck injuries have remained stable among several major sports (10). Although many sports have the potential to put participants at risk of laryngotracheal injuries, only 10% are due to athletic trauma (11).

The incidence of laryngeal injury varies depending upon the age and gender of the athlete. Children sustain fewer laryngeal injuries than adults because of their more elastic skeleton and higher proportion of subcutaneous fat (11,12). Increased participation in sporting activities among older
adults has resulted in relatively greater exposure to injuries in this age group. Notably, the population of adults aged 65 yr and older increased by 8% between 1990 and 1996, but sports-related injuries increased by 54% among this group (13). Moreover, athletic injuries among adults aged 33–54 yr increased by 33% between 1991 and 1998 (14). Males generally sustain a higher proportion (60%–88%) of face and neck injuries than females (3,12,13,15). As more women are involved in sporting activities at higher levels of competition, it is likely that the incidence of laryngotracheal injuries among female athletes will increase.

The incidence of laryngeal injury also differs depending upon the activity or sport. Worldwide, soccer and rugby account for the majority of traumatic head and neck injuries (3). Most often laryngotracheal injuries in these sports result from contact between players or during aerial challenges for the ball (16,17). In the United States, football and soccer are associated with the greatest number of catastrophic head and neck injuries (16). Football rule changes that prohibited the use of the head as an initial point of contact during blocking or tackling have played a critical role in reducing head and neck injuries (20). Cheerleading, with its increasingly demanding stunts and maneuvers, accounts for the greatest overall number of laryngotracheal injuries experienced by female athletes (18). Fatal laryngeal injuries due to collapsed tracheae have been reported among baseball players, and “clothesline” injuries during snowmobiling, skiing, and motorcycling may occur (4,21,22).

REGIONAL ANATOMY AND PHYSIOLOGY

The complex laryngeal anatomy provides three distinct and important functions: 1) an airway, 2) a mechanism for phonation and speech, and 3) a sphincter during swallowing. Deterioration of any of these functions after an anterior neck injury indicates underlying laryngotracheal trauma. At the inferior base of the larynx lies the cricoid cartilage, which forms a complete ring around the airway. The posterior aspect of the cricoid supports the paired arytenoid cartilages that rotate to adduct and abduct the attached true vocal cords. These vocal cords consist of the thyroarytenoid muscles and ligaments that span from the arytenoid cartilages to the thyroid cartilage anteriorly and contribute to tension and vibratory characteristics of the vocal cords. The thyroid cartilage forms the “Adam’s apple” and shields the laryngeal airway anteriorly. The supraglottis, including the arytenoids and the epiglottis, is superior to the true vocal cords and normally covers the laryngeal airway during swallowing. The hyoid bone sits at the uppermost aspect of the larynx and is connected by the thyrohyoid membrane to the thyroid cartilage.

Laryngotracheal injuries may produce obstructive edema, submucosal hematomas, cartilaginous framework fractures, mucosal tears, or complete laryngotracheal separation (Fig. 1). The larynx is partially protected from trauma anteriorly by the mandible and posteriorly by the spine. Objects forcefully striking the mid- to lower neck may, however, crush the laryngeal skeleton against the vertebral column (23). Thyroid cartilage fractures may shorten and destabilize the thyroarytenoid tendon and jeopardize the airway. The glottis, defined by the true vocal cords and the space between them, constitutes the narrowest portion of the airway after the nose. Hoarseness due to a glottis injury may be the first clue to obstructing airway edema and should not be overlooked. Fractures of the cricoid cartilage ring with an associated loss of the subglottic airway also may compromise the athlete’s airway.

Less forceful blows to the neck are more frequently associated with soft tissue injuries due to rotation of the larynx around its fixed attachments or to ligamentous tears. These soft tissue injuries include endolaryngeal mucosal tears, mucosal edema, and submucosal hematomas. A rupture of the thyroepiglottic ligament may allow the pre-epiglottic space to expand and herniate into the endolaryngeal airway (24). Cricotracheal separation is a particular risk with a clothesline injury and is frequently associated with bilateral recurrent laryngeal nerve injury (24).

The larynx of a child is situated higher in the neck, affording even more protection by the mandible. Younger athletes are predisposed to more soft tissue injuries and fewer cartilaginous fractures because of the elasticity of their regional cartilage, loose attachment of the mucous membrane, and lack of fibrous support. However, the decreased...
cross-sectional laryngeal area makes them especially susceptible to respiratory distress even when no fractures are present.

**DIAGNOSIS**

As noted, athletic laryngotracheal injuries may present with manifestations ranging from subtle to obvious. The Table lists the common symptoms and signs of laryngeal trauma, with hoarseness, dyspnea, and subcutaneous emphysema being the most common initial findings (8). All athletes with laryngeal injuries should be thoroughly evaluated for cervical spine injuries with plain radiographs after initial stabilization (19). Hyoid bone elevation suggesting cricotracheal separation also may be apparent on plain radiographs (2). Computed tomography (CT) plays an essential role in the initial work-up of suspected laryngeal trauma if no obvious fractures or lacerations are identified during the physical examination, and the results often help guide surgical planning (2,8,25). Fibroscopic endoscopy also should be considered to determine the extent of the laryngeal damage or presence of additional mucosal injuries (7,21).

Clinicians must remain mindful of concomitant non-laryngeal trauma, such as esophageal tears, cervical spine fractures, and vascular injuries. Hemoptysis suggests an injury to the upper aerodigestive system, although this type of injury is often difficult to differentiate from bleeding caused by associated facial or vascular trauma (26). The presence of subcutaneous emphysema indicates a disruption within the upper aerodigestive tracts (27).

**MANAGEMENT**

**Acute and On-the-Field Treatment**

There have been various attempts to standardize the initial evaluation and treatment of blunt and penetrating laryngotracheal trauma among athletes. Figure 2 depicts one

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**TABLE.** Common symptoms and signs of laryngeal trauma.

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
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<tbody>
<tr>
<td>Hoarseness</td>
<td>Subcutaneous emphysema</td>
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<tr>
<td>Dyspnea</td>
<td>Drooling</td>
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<tr>
<td>Dysphagia</td>
<td>Laryngeal tenderness</td>
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<tr>
<td>Odynophagia</td>
<td>Anterior neck tenderness</td>
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<tr>
<td>Hemorrhage</td>
<td>Cervical ecchymosis and edema</td>
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<tr>
<td>Hemoptysis</td>
<td>Loss of normal laryngeal prominence</td>
</tr>
<tr>
<td>Dysphagia</td>
<td>Air leaks through neck wound</td>
</tr>
<tr>
<td>Aphonica</td>
<td>Respiratory distress</td>
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<tr>
<td>Nonproductive cough</td>
<td>Atelectasis</td>
</tr>
<tr>
<td>Stridor</td>
<td>Pneumothorax</td>
</tr>
<tr>
<td>Neck pain</td>
<td>Tracheal deviation</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>Abrasions or lacerations</td>
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</tbody>
</table>

Figure 2. An approach to the initial evaluation and management of an athlete with laryngotracheal trauma. §Flexible Fiberoptic Laryngoscopy is performed by the otolaryngologist in the emergency department. †Performed urgently or emergently on the field, in the emergency room, or operating room.
such approach. Unfortunately, no clear correlation usually exists between the presenting symptoms and signs of an athlete who has sustained a laryngeal injury and the true extent of his or her injury (7,9,25). Nonetheless, the initial and most important goal is to establish a secure, patent airway. As with any trauma, one should follow evidence-based guidelines, such as the Advanced Trauma Life Support, when possible (28).

Gentle palpation for cervical spine tenderness or bony step-offs should be undertaken. Because anterior neck trauma may be a distracting injury, it may be impossible to evaluate fully the cervical spine on the field (28). Until evaluation for a cervical spine injury has been performed, the athlete's neck should be secured in a neutral position while supine. Obvious soft deformities should not be reduced, and the neck position should not be altered if doing so incurs pain. If helmet removal is needed, hold the neck in neutral position while providing in-line manual immobilization from below while expanding the helmet laterally and removing it from above the head. A helmet cutter, trainer's angel, or cast cutter may be used if necessary (28).

If the airway is unstable, a tracheostomy under local anesthesia is the procedure of choice to secure an athlete's airway (2,4). Because children often tolerate awake procedures poorly, obtaining a new airway may require mask anesthesia followed by operative rigid bronchoscopy and tracheotomy (29). Fiberoptic nasotracheal intubation may be the safest approach in athletes if a tracheostomy is not necessary (7). Routine orotracheal intubation is hazardous (23). Based on the initial survey, the otolaryngologist will then recommend immediate surgical therapy, close observation, humidified air, and head of the bed elevation (11,25). However, deterioration of the athlete's clinical status usually signals the need for surgical treatment (23). Common indications for surgery include an initially high global injury severity, airway instability, or lack of spontaneous resolution with conservative therapy. Surgical interventions range from tracheotomy to open reduction and internal fixation of the cartilaginous framework with or without luminal stenting.

Long-term treatment goals include restoration of regional anatomical architecture, airway patency, and vocal quality (2,4,21). Some athletes may require speech therapy to avoid disturbed or restricted phonation (1). Attempts to address vocal cord scarring surgically should be delayed at least 3 months from the initial injury (35). Collagen, hyaluronan, or fat injections may be used to ameliorate the symptoms due to vocal cord scarring (36).

COMPLICATIONS

Potential complications of athletic laryngotracheal trauma can range from minor to severe. Notably, complication rates dramatically increase when the correct diagnosis or treatment is delayed (8,37). Dysphonia in association with hoarseness, voice fatigue, and poor vocal control remains the most common long-term complication of laryngeal trauma (2). Cases also have been reported of unilateral or bilateral vocal cord paralysis due to recurrent laryngeal nerve injury (4,6). Traumatic epiglottitis, laryngeal infections, vocal cord polyps, and laryngeal scarring, resulting from the initial injury or attempts to secure the airway, may cause permanent phonic disorders (35,38). Mucosal disruptions or concomitant aerodigestive injuries may lead to the formation of laryngoesophageal fistulae.
although the incidence of fistulae decreases with surgical interposition of a vascularized muscle flap between the esophagus and trachea at the time of initial surgical repair (4,7). Other long-term sequelae of laryngotracheal injury may include laryngeal chondritis, webs, or stenosis (30,39).

CONCLUSION

Laryngeal trauma is a rare but potentially life-threatening problem. Clinicians caring for athletes with blunt or penetrating injuries to the upper chest, neck, or head should maintain a high index of suspicion for laryngotracheal injuries. A systematic approach during the initial assessment and stabilization of an injured athlete remains paramount (25). Little external evidence of the injury’s true severity may initially be apparent, and maximal damage may not become manifest for up to 48 h (2,5,34). Suspicion of laryngeal trauma is often based on clinical detection of symptoms and signs indicated in the Table. Notably, early identification and treatment of laryngotracheal injuries improves outcomes for injuries of all severities (9).

Primary prevention and appropriate safety equipment are the most effective means of reducing significant laryngeal trauma. Well-maintained safety equipment and enforcement of existing athletic regulations also are important mechanisms to reducing the incidence of laryngeal injuries (13–15,17,18). Helmets, face masks, neck guards, and other protective athletic equipment reduce head and neck fractures and injuries in other sports (10,12). Proper conditioning, warm-up, and technique play a role in preventing laryngeal injuries in sport (22). Football players and coaches need to be particularly mindful that adhering to proper blocking and tackling techniques decreases the likelihood of head and neck injuries (20).

Athletic venues should have qualified personnel on site and a written emergency procedure plan in place to respond quickly to laryngotracheal injuries. The initial treatment of a suspected injury includes airway maintenance, breathing assessment, cardiac evaluation, cervical spine stabilization, and bleeding control (37,39). Any athlete noted to have a laryngotracheal injury should be transported urgently for a comprehensive evaluation at a qualified center. More than 80% of laryngeal injuries will require surgical treatment to restore normal regional anatomy and vocal quality (2,7). Nevertheless, an athlete who sustained a laryngeal injury with minimal submucosal hemorrhage, mild edema, no exposed cartilage, and a stable airway may be treated non-operatively with close observation, serial endoscopy, corticosteroids, antibiotics, humidified air, and vocal rest (2,21,39). Athletes treated conservatively should refrain from participation until symptoms and clinical findings have resolved. It is prudent to send all athletes who have had laryngotracheal injuries for a phonic and speech therapy evaluation (1). Fortunately, many athletes with laryngeal trauma regain normal speaking and swallowing and are ultimately able to return safely to athletic activities.

References