Thoracic and Cardiovascular Surgery

Upper Airway Injury and Its Management

Michael G. Corneille, MD, Ronald M. Stewart, MD, and Stephen M. Cohn, MD

Injuries to the upper airways are rare, but carry a significant morbidity and mortality. The degree of injury and presentation varies; thus recognition often requires a high index of suspicion based on mechanism. Effective management of laryngotracheal injuries begins with immediate control of the airway whether by orotracheal and surgical route. Definitive management of upper airway injuries relies on an understanding of the anatomy of the larynx, trachea and surrounding structures. Associated injuries are common and must be addressed concomitantly. Postoperative complications are frequent, requiring perioperative vigilance and long-term follow-up to ensure best outcome.
Semin Thorac Cardiovasc Surg 20:8-12

KEYWORDS trachea, larynx, trauma, injury, neck injury, laryngotracheal injury

Although uncommon, upper airway injuries pose a range of diagnostic and management challenges to surgeons. Because of the airway compromise associated with severe laryngotracheal trauma, victims typically expire at the scene of injury before treatment.[1] The exact frequency of these injuries is uncertain, but at our trauma center, approximately eight injuries occur per 100,000 patients each year. This rate of less than 0.1% of patients admitted to our regional trauma center is consistent with rates reported in surveys of other registries.[2] The mechanism of injury depends on the clinical setting: in series from violent urban or wartime settings, penetrating injuries predominate; in series from most civilian settings, blunt injuries predominate.[3] This review will describe the management of upper airway injuries affecting the region from the larynx to the carina.

The adult trachea is approximately 12 cm long with 18 to 22 rings. It is most anterior at the level of the larynx and courses posteriorly along its entire course to the carina. The cricoid cartilage is a complete ring that anchors the trachea and prevents the collapse of the remaining incomplete rings. Both the larynx and the trachea consist of a cartilaginous skeleton lined with mucosa. Disruption of this mucosa and exposure of the cartilage beneath leads to the formation of granulation tissue, which may in turn lead to stenosis and airway compromise. The segmental and tenuous blood supply precludes circumferential dissection of more than one tracheal ring. Extensive mobilization of the trachea may disrupt the blood supply and lead to stenosis or anastomotic failure. The trachea is simple but dynamic in design, changing position with both respiration and motion of the neck. When the neck is flexed, the cricoid is at the level of the sternal notch; however, when the neck is extended, as much as an additional 5 cm is revealed from the thorax. The larynx is anatomically and physiologically complex, participating in phonation, airway protection, and swallowing.

The rarity of upper airway injury is probably due to the protection afforded by the mandible and the sternum anteriorly, the sternocleidomastoid (SCM) muscles laterally, and the spine posteriorly. Blunt injuries are caused by direct blows, rupture (when intrathoracic pressure is high and the glottis is closed), and shear forces associated with deceleration. Common injury patterns are most likely related to a combination of these forces. Frequent blunt mechanisms include motor vehicle crashes, striking a wire while riding a snowmobile or an all-terrain vehicle, and direct blows to the larynx and trachea.[4] Gunshot wounds, knife stab wounds, or slash wounds account for the penetrating injuries. Tracheal injuries should always prompt a complete search for other associated injuries to the neck or thorax.

Initial Evaluation

Airway Management

The initial evaluation of any patient with suspected airway injury includes measures for protecting and securing the airway. Diagnosing upper airway injuries may be difficult. Patients with obtunded reflexes and those in clear respiratory distress because of airway injury require immediate intuba-

Department of Surgery, University of Texas Health Science Center at San Antonio, San Antonio, Texas.
Address reprint requests to Michael G. Corneille, MD, Department of Surgery, University of Texas Health Science Center at San Antonio, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900. E-mail: corneille@uthscsa.edu

1043-0679/08/$-see front matter
doi:10.1053/j.semtcvs.2008.02.003

tion. The remainder of patients with an airway injury will exhibit signs and symptoms that may sometimes be subtle. A delay in diagnosis may permit airway edema to progress to the point of obstruction, worsening hypoxia, and need for an urgent surgical airway. Common presenting symptoms include voice changes, difficulty in swallowing, hoarseness, and neck pain. Physical examination findings range from minor neck bruising or abrasions to substantial hematomas and subcutaneous emphysema. More obvious signs of injury include massive subcutaneous emphysema, inability to phonate, air bubbles from a neck wound, deformity of the thyroid cartilage, and large open wounds.[5] A history consistent with neck injury or the presence of substantial trauma to the face, the head, or both should also alert the clinician to the possibility of an airway injury.

Once an airway injury has been identified, the approach to airway management for a patient with a suspected injury to the larynx or trachea is less than clear. Although all authors agree that appropriate airway management is essential, there is no unanimous agreement as to the best method of securing an airway. Some advocate a primary surgical airway, specifically tracheostomy, for avoiding further endolaryngeal and endotracheal injury or completion of a partial laceration.[1,6] When a substantial neck hematoma exists, early endotracheal intubation should be performed so that the airway will not be lost with expansion of the hematoma. We believe that the choice of airway control should be based on the patient's presentation. A patient with a nondisplaced laryngeal injury requires only close monitoring, whereas a patient with a destroyed larynx requires immediate tracheostomy.[7] Patients whose injuries range in severity between these two extremes will require a variety of approaches to the airway.

Any patient with respiratory distress or stridor after trauma requires placement of a definitive airway. Options include orotracheal placement, nasotracheal placement, cricothyroidotomy, and tracheostomy; each has utility in certain clinical situations. Laryngeal mask airways should not be used because their effectiveness is decreased when the anatomy is distorted, and they may worsen the injury. If the patient is awake and ventilating (even with a compromised airway), neuromuscular blockade should be avoided until the airway is secure. This approach allows greater flexibility and usually a more controlled approach to the airway. In all cases of upper airway injury, the airway should be secured by the most experienced airway managers, usually an anesthesiologist, a surgeon, or an emergency medicine physician.

Blind nasotracheal intubation should not be attempted if an upper airway injury is suspected, because this procedure may exacerbate the injury. Other contraindications to this procedure are facial and basilar skull fractures and coagulopathy. Controlled fiberoptic nasotracheal intubation with topical anesthesia is an option, but this technique should be performed only by someone skilled and practiced in this approach. Fiberoptic nasotracheal intubation allows complete inspection of the airway while the patient is awake and ventilating; thus, for certain patients, this may be the preferred technique for airway control.

Orotracheal intubation is usually the most expeditious and reliable means of establishing a secure airway. In their series, Bhojani and colleagues accomplished oral endotracheal intubation for 34 of 39 patients with laryngotracheal injuries.[8] Orotracheal intubation requires little equipment, all of which is available in virtually every modern emergency department. Most emergency department personnel have been trained to perform this procedure and have experience in performing it. Direct laryngoscopy allows for visualization of the vocal cords and arytenoids and assessment of the degree of airway swelling and hematoma. The size of the endotracheal tube can be best judged by directly visualizing the vocal cords, and the tube can be passed through the cords under direct vision. The disadvantages of orotracheal intubation include the need for extension of the neck or for advanced airway management skills in the use of a flexible bronchoscope or fiberoptic wand. The neck must be held with in-line stabilization while the patient is intubated with minimal neck extension. Orotracheal intubation also usually requires sedation and sometimes neuromuscular blockade. Thus, the technique may impair the airway of a patient who was previously breathing spontaneously. If, after careful consideration, the use of neuromuscular blockers is deemed necessary, a surgical airway may be preferable. We favor an attempt with topical anesthesia and the patient awake, unless the airway has already been lost. Videolaryngoscopy is becoming widely available; with this procedure, the airway is visible to all members of the team and the view of the airway is usually better than that provided by other techniques.[9]

Cricothyroidotomy

Many patients present with an isolated laryngotracheal injury; however, for a patient with associated facial injuries, signs of substantial neck trauma, or a destroyed larynx, a cricothyroidotomy may provide the most expeditious airway. Because cricothyroidotomy is simpler and quicker than a formal tracheostomy, it is the best choice for an emergency surgical airway in adults. Although we have used both vertical and horizontal incisions for emergency airway access, we now prefer to use a vertical incision because this technique avoids the anterior jugular veins and allows greater airway exposure with extension of the incision.[10] We normally use a 10 or 15 blade and take extra care to avoid an uncontrolled entry through the cricothyroid membrane.

Tracheostomy

For children, or for adults for whom endotracheal intubation is not an option, tracheostomy is the emergent surgical airway of choice. This procedure is best performed in the operating room, although this setting is not always available. For emergency settings, we favor a vertical incision carried directly down to the anterior trachea. A single vertical incision through the second and third tracheal rings may decrease the frequency of future stenosis and is the simplest approach for an emergency airway. The risk of a tracheal fire prohibits the use of electrocautery for entry into the trachea. When the wounding agent has already created an anterior tracheostomy, it makes sense to use this wound as the access to the