

Session: L070  
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## **Airway Management of a Patient With Penetrating Neck Injury**

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### **Stem Case and Key Questions Content**

A 28-year-old man is brought to the emergency room (ER) after being stabbed in the neck with a knife and hit with a bat during an altercation. On arrival to the ER he is conscious but agitated (alcohol on breath). BP 130/90, HR 110, RR 34, SpO<sub>2</sub> 98% on room air. Examination of the neck shows a large entry wound on the left side of the neck extending to the midline with exposed blood vessels but no active bleeding. Trachea appears to be in the midline and no dysphonia is present. Patient is in handcuffs. He denies any significant medical or surgical history but admits cocaine use 4 hours ago. You are consulted for airway assessment.

- 1) What aspects of the physical exam would be most relevant for airway management?
- 2) How does mechanism of injury determine the likelihood of associated injuries?
- 3) What landmarks would you use to determine the anatomic zone of injury?
- 4) What factors will determine if the patient will go immediately to the operating room or undergo further workup?
- 5) What findings would prompt you to immediately secure the airway?

The patient has been scheduled for emergent neck exploration and you have decided to secure the airway. The surgeon requests your assistance to determine presence of laryngeal/tracheal injuries.

- 6) Discuss pros and cons of securing airway in the Emergency Room vs. O.R.
- 7) What would be the best initial intubation approach: Nasal, oral, or surgical?
- 8) Would you perform an awake or an asleep intubation?
- 9) If asleep: spontaneous breathing versus rapid sequence? What agents would you use?
- 10) Discuss devices to be used to secure the airway (conventional laryngoscopy vs. videolaryngoscopy vs. fiberoptic endoscopy)

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11) How will you establish the presence and location of an airway injury?

The patient's airway is now secured and the surgeon proceeds with a neck exploration. A tracheal injury is diagnosed and primarily repaired in a one-layer fashion with polyglycolic suture (no tracheostomy). Towards the end of the procedure the patient develops hypertension, tachycardia, and ST-segment elevation in ECG leads I and V5.

12) Likely etiology of ST segment elevation? Management?

Hypertension, tachycardia and ST segment changes resolved and surgery completed.

13) When and where would you extubate trachea? Any special precautions?

14) Will the patient require ICU admission? Why?

## **Model Discussion Content**

### **CLASSIFICATION OF INJURIES**

Penetrating neck injuries are usually described in terms of their location in one of three anatomic zones. Knowledge of the common consequences of each zone of injury gives some idea of the most likely injuries, the probability of urgent airway management problems, and any expected surgical intervention.

Zone I extends from the sternal notch and clavicles to the inferior border of the cricoid cartilage. Zone I injuries are the least frequent of penetrating neck injuries. Wounds in this region are associated with the highest mortality because they often involve great vessel or pulmonary injuries. For this reason, most of these patients require emergency airway management procedures.

Zone II is the area between the cricoid cartilage and the angle of the mandible. This area is the most common location for neck wounds. Airway compromise from laryngeal injury, hematoma formation, and subcutaneous emphysema is most likely to occur if the wound involves this area. One third of patients with zone II injuries require emergency airway management procedures. Most of the remaining patients will usually undergo surgical exploration of their wounds or endoscopic evaluation, so airway interventions will be performed in many of these patients.

Zone III comprises the area between the angle of the mandible and the base of the skull. Wounds in this region are most commonly associated with vascular and pharyngeal injuries. Patients with injuries in this area are less likely to require urgent airway management procedures or immediate surgical exploration.

In addition to the above classification, anesthesiologist should recognize that wounds in the anterior and lateral aspects of the neck compromise the airway more often than those in the posterior region (behind sternocleidomastoid) because of their proximity to the larynx, trachea, laryngeal nerves, and cervical vessels.

### **MECHANISMS OF PENETRATING NECK INJURY**

Most penetrating neck injuries are produced by knives and firearms. The severity of the injury increases progressively as the weapons change from knives to high-velocity missiles. The

greater kinetic energy of the bullet results in a temporary cavity that produces tissue damage beyond the missile tract (permanent cavity). Damage to surrounding tissue may also be increased by tumbling, mushrooming, bouncing, fragmentation, and embolization of bullets within the body.

Death after neck trauma is usually caused by airway obstruction, exsanguination, cervical spine injury, or cerebral ischemia due to carotid and occasionally vertebral artery injury. Late mortality has been attributed to sepsis, ARDS, and multiple organ dysfunction.

Blood aspiration is common in patients with airway injuries. A significant volume of inhaled blood can cause severe airway obstruction and resultant hypoxia, but does not cause long-term pulmonary injury. The effects of blood aspiration usually resolve within 6 to 12 hours.

## AIRWAY INJURIES

Penetrating injury of the larynx and the cervical trachea is rare compared to injuries to other structures of the neck. One explanation is that the majority (70%-80%) of victims who sustain airway injuries die before reaching medical care. Of those patients who do survive to reach tertiary care, 21% die during the first 2 hours after admission.

Airway obstruction after penetrating trauma can occur by several mechanisms: direct injury to the larynx or trachea; hematoma causing external pressure; displacement of soft tissue into the airway; aspiration of blood, gastric contents, or foreign bodies; and bilateral severance of the vagus, recurrent laryngeal, superior laryngeal and/or hypoglossal nerves (producing obstruction either by facilitating aspiration or by causing abductor paralysis of the vocal cords).

A sucking neck wound and progressive hypoxemia are pathognomonic for major laryngotracheal laceration and avulsion. Dyspnea and subcutaneous emphysema are present in almost all penetrating laryngotracheal injuries. Dysphonia may occur in patients with recurrent laryngeal nerve injury, vocal cord injury or partial tracheal avulsion. Dysphonia, however, is not a sensitive sign of injury since it may be absent in up to two-thirds of the patients. Loss of palpable landmarks in the thyroid or cricoid cartilage is a very specific finding for airway injury, although normal palpation certainly does not rule out significant injury. Mild to moderate hemoptysis immediately after trauma usually stops if the injury is limited to the larynx or trachea but continues in the presence of associated vascular injuries. Although penetrating injuries to the airway are frequently obvious and dramatic in their presentation, the entrance wounds and the presenting symptoms are poor predictors of the extent of injury.

Chest and neck imaging studies provide valuable information and are obtained in the majority of stable patients. Flexible laryngoscopy and bronchoscopy may be the single most accurate technique for the overall diagnosis of airway injury. Ideally, endoscopic examination should be performed in all patients with suspected airway injury before attempting intubation.

## VASCULAR INJURIES

All cervical vessels are vulnerable to penetrating trauma, but the jugular and subclavian vessels are injured more frequently. Carotid and less frequently vertebral artery injuries can compromise cerebral blood flow resulting in brain ischemia, infarction, and post-ischemic cerebral edema. Neck venous injuries have the risk of air embolism, especially in the hypovolemic patient with airway obstruction. Exsanguination hemorrhage is the most prominent risk of zone I injuries.

Knowledge of the location of any vascular injury should guide placement of intravascular catheters.

Diagnosis of vascular injury in the presence of specific physical findings, such as hematoma, external or internal hemorrhage, and distal pulse or blood pressure deficit, is usually obvious. Although a large hematoma with asymmetry of the neck is a reliable indicator of significant vascular injury and airway compression, its absence does not exclude the possibility of airway compromise. If a hematoma is present, early tracheal intubation is carried out prophylactically in order to avoid possible airway compromise by an expanding hematoma. Significant bleeding at the wound site should be managed by application of direct pressure.

Angiography has been considered an important diagnostic test, especially for injuries located in Zones I and III. More recently, computed tomographic angiography (CTA) has become the diagnostic test of choice in the evaluation of vascular injuries after penetrating neck trauma.

## NEUROLOGIC INJURIES

The spinal cord, phrenic nerve, brachial plexus, and autonomic nerves may be injured individually or in combination. Cervical spine injury is usually the result of gunshot wounds and is uncommon after stab wounds. Prehospital cervical spine immobilization does not appear to prevent progression of neurologic injury in these cases. Neurologic recovery in the patients with complete lesions is uncommon.

## ESOPHAGEAL INJURIES

Delays in the diagnosis and management of esophageal injuries after penetrating neck trauma are associated with increased morbidity and mortality. Mediastinitis is a devastating complication of undetected esophageal perforation. The signs and symptoms of esophageal perforation are non-diagnostic and a high index of suspicion must be maintained to avoid missing an injury.

## SURGICAL STRATEGIES FOR NECK EXPLORATION

Patients with obvious signs and symptoms suggestive of major vascular or aerodigestive injury (“hard findings”) should be taken promptly to the operating room. “Hard findings” include airway compromise, shock or active bleeding, pulsatile hematoma, or extensive subcutaneous emphysema. High-velocity penetrating injuries also dictate operative intervention. Patients with subtle (“soft”) signs of injury are selected to undergo further evaluation and observation. “Soft findings” include dysphagia, dysphonia, hemoptysis, or wide mediastinum. Selecting the most appropriate evaluation in these patients depends on injury mechanism, clinical status and facility resources. CTA is the initial study of choice for evaluating vascular structures in hemodynamically stable patients. Evaluation of the aerodigestive tract includes flexible endoscopy and contrast esophography. If injury is present or suspected the patient will then undergo operative intervention.

An observational approach has been advocated in patients with no signs and symptoms suggestive of injury.

## AIRWAY MANAGEMENT

As with any other form of trauma, airway management remains the first priority of resuscitation. Patients arriving with or developing airway obstruction require rapid establishment of the airway.

Other indications for tracheal intubation include respiratory failure, prevention of aspiration of blood, airway protection in the unconscious patient, and hemodynamic instability.

There is no uniform agreement as of the preferred method of airway management in patients with penetrating neck injuries. The small number of patients included in most series, the prolonged periods over which large series were reviewed, and the diverse nature of these injuries precludes formulating a single method of choice. Most authors agree that blind intubation methods (e.g., blind nasotracheal intubation) should not be used in these patients because further injury or complete airway obstruction may be induced.

At the Ryder Trauma Center patients with penetrating neck injuries that require airway intervention undergo endotracheal intubation by one of the following methods:

- A) Awake fiberoptic intubation
- B) "Rapid-sequence" fiberoptic intubation
- C) Rapid-sequence induction
- D) Awake orotracheal intubation
- E) Surgical airway (rare)

Factors that determine which one of the above methods is selected for a particular patient include urgency of the situation, likelihood of airway injury, patient cooperation, type of injury, and the presence of significant bleeding or airway obstruction.

Awake fiberoptic intubation is the safest method for most patients and should be considered in all cooperative patients with suspected airway injury. This method allows evaluation of injuries at or below the glottis and positioning of an endotracheal tube distal to the injury. However, awake fiberoptic intubation is usually not possible in combative patients or when immediate airway access is required (e.g., in the moribund patient).

A "rapid-sequence" fiberoptic intubation technique may be used in combative patients who otherwise do not appear "difficult to intubate". In this technique a rapid sequence anesthetic induction is followed by standard laryngoscopy and insertion of a bronchoscope through the larynx to rapidly evaluate for the presence of injury or blood below the vocal cords. The bronchoscope tip is placed distal to the injury and the endotracheal tube is then introduced over the endoscope. The cuff of the endotracheal tube should be positioned below the injury to prevent air leak and enlargement of the laceration.

A standard rapid sequence induction is used for patients that have normal anatomy, minimal risk for airway injury (e.g., "slash injury" behind sternocleidomastoid), and high risk for bleeding if coughing or straining occurs.

An awake orotracheal intubation is the most expeditious approach when immediate control of the airway is required in a moribund or apneic patient or in cases of massive upper airway bleeding.

We recommend that the trachea and cricothyroid membrane be located before attempting intubation, and that qualified personnel be at the bedside to rapidly establish an emergency surgical airway with the necessary instruments. This is particularly important if the anesthesiologist selects an anesthetic induction for intubation.

The airway should be secured using cervical spine protection measures until the integrity of the spine is assured. Cricoid pressure is contraindicated in cases of suspected laryngotracheal injury because complete airway separation could result. The risk of aspiration is less significant than the potential loss of airway patency in this situation.

If any of the above intubation methods fails a surgical airway should be immediately established. The surgical airway of choice in a true emergency setting is a cricothyroidotomy. However, this procedure may result in complete disruption of the airway in cases of laryngotracheal dissociation. Tracheostomy will often be chosen in such cases. Finally, patients with an overt airway injury communicating with the skin can also undergo intubation through the open wound.

## SUMMARY

Airway control in most patients with penetrating trauma can be safely achieved under direct vision by a variety of methods. Fiberoptic bronchoscopy is a valuable aid for both evaluation and intubation in such cases. Factors that determine which method is selected to secure the airway include urgency of the situation, likelihood of airway injury, patient cooperation, type of injury, and the presence of significant bleeding or airway obstruction.

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