Three-Step Emergency Cricothyroidotomy

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Objective: Surgical cricothyroidotomy is the airway of choice in combat. It is too dangerous for combat medics to perform orotracheal intubation, because of the time needed to complete the procedure and the light signature from the intubation equipment, which provides an easy target for the enemy. The purpose of this article was to provide a modified approach for obtaining a surgical airway in complete darkness, with night-vision goggles. Methods: At our desert surgical skills training location at Nellis Air Force Base (Las Vegas, Nevada), Air Force para-rescue personnel received training in this technique using human cadavers. This training was provided during the fall and winter months of 2003-2006. Results: Through trial and error, we developed a "quick and easy" method of obtaining a surgical airway in complete darkness, using three steps. The steps involve the traditional skin and cricothyroid membrane incisions but add the use of an elastic bougie as a guide for endotracheal tube placement. We have discovered that the bougie not only provides an excellent guide for tube placement but also eliminates the use of additional equipment, such as tracheal hooks or dilators. Furthermore, the bevel of the endotracheal tube displaces the cricothyroid membrane laterally, which allows placement of larger tubes and yields a better tracheal seal. Conclusions: Combat medics can perform the three-step surgical cricothyroidotomy quickly and efficiently in complete darkness. An elastic bougie is required to place a larger endotracheal tube. No additional surgical equipment is needed.

Introduction

Military medics need to treat many different types of life-threatening injuries quickly and efficiently while in a combat zone. To increase survival rates, they attend Tactical Combat Casualty Care courses taught months before their deployment.1,2 There they learn how to treat the most common preventable causes of death seen on the battlefield, while engaging the enemy. For example, if the medic is being fired upon, he or she must first suppress enemy fire by returning fire. After the shooting ceases, the medic takes the casualty to cover and follows the triage mnemonic MARCH (Table 1).3 (1) Massive compressible hemorrhage is controlled with the use of pressure dressings, tourniquets, and hemothastic dressings. (2) The airway is assessed; if compromised, it is maintained through placement of a nasopharyngeal airway with a jaw-thrust maneuver. If the airway remains compromised, then the medic can place a Combitube (Tyco-Kendall, Mansfield, Massachusetts) or perform a cricothyroidotomy.4 (3) Respiratory emergencies such as tension pneumothorax can be decompressed with needle thoracostomy using a 10- to 14-gauge BD Angiocath Autoguard angiocatheter (BD Biociences, San Jose, California). A casualty with a sucking chest wound is covered with an Asherman chest seal or Vaseline gauze, and respiratory effort is monitored closely. (4) If the patient displays palpable radial pulses and normal mentation, then no intravenous fluids are given; if these features are diminished, then a controlled fluid bolus is infused.5, 6 (5) Hypothermia must be prevented. If necessary, the casualty may be placed in a body bag, to prevent evaporative heat loss, and given warm intravenous fluids. Once the casualties can be safely removed from the battlefield, they are transported to a forward surgical team if they are in unstable condition or are transported to a combat support hospital if they are in stable condition.

If the medic has to perform these lifesaving procedures in complete darkness, however, then considerable challenges can exist. Over the past 3 years at our desert medical training site at Nellis Air Force Base, we have developed and modified a technique for establishing a surgical airway while in complete darkness, with the use of night-vision goggles and an elastic bougie, as a guide for proper endotracheal tube placement.

Methods

The recommended equipment consists of a size 10 scalpel, an elastic bougie, a cuffed endotracheal tube (ranging in size from 6 to 8), and night-vision goggles (Fig. 1A). The three-step surgical airway procedure is outlined as follows.

Step 1: Skin Incision

Quickly cleanse the neck, and grasp the larynx with the nondominant hand. Use the index finger of the nondominant hand to identify the thyroid cartilage, cricothyroid membrane, and cricoid ring. Once the underlying structures have been identified, use the dominant hand to make a vertical incision over the cricothyroid membrane (Fig. 1B). Place the nondominant index finger into the vertical incision and move it side to side to clearly feel the cricothyroid membrane (Fig. 1C).

Step 2: Incision of Cricothyroid Membrane

Remove the nondominant index finger from the cricothyroid membrane, and make a 5-mm horizontal incision through the cricothyroid membrane (Fig. 2A). Watch the depth of incision, to avoid injury to the underlying esophagus. Place the elastic bougie into the defect, and advance it until resistance is appreciated (Fig. 2, B and C). This indicates entry into the right main stem bronchus.

Step 3: Endotracheal Tube Placement

Advance the preselected cuffed endotracheal tube over the elastic bougie (Fig. 3), up to the cricothyroid membrane. En-
TABLE I
MARCH TRIAGE MNEMONIC USED IN COMBAT

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<thead>
<tr>
<th>M</th>
<th>Massive hemorrhage</th>
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<tr>
<td>A</td>
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<td>R</td>
<td>Respiration</td>
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<td>C</td>
<td>Circulation</td>
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Fig. 1. (A) Surgical airway procedure being performed with night-vision goggles. (B) Vertical skin incision superficial to the cricothyroid membrane. (C) Nondominant index finger placed into the vertical skin incision, to palpate the cricothyroid membrane.

Fig. 2. (A) Horizontal incision through the cricothyroid membrane. (B) Placement of an elastic bougie through the cricothyroid membrane. (C) Placement of an elastic bougie through the cricothyroid membrane with night-vision goggles.
Fig. 3. Placement of an endotracheal tube over the elastic bougie.

Discussion

There are many benefits of using the three-step approach described above to obtain a surgical airway. First, a medic can perform this procedure quickly and safely, without the burden of any additional equipment (such as a Trousseau dilator or a tracheal hook). This three-step airway procedure requires only three items, namely, a scalpel, an endotracheal tube, and an elastic bougie. Second, the cricothyroid membrane is displaced laterally as the bevel of the endotracheal tube is advanced into the trachea. This lateral dilation not only reduces the resistance involved in advancing the endotracheal tube into the trachea but also enables the medic to place a tube larger than a standard 6-mm tube. The traditional teaching is to place a 6-mm endotracheal tube, rather than a ≥7-mm tube, because of the ease of insertion into the narrow orifice. A larger endotracheal tube can form a better seal and decrease airway leaks, both critical issues when dealing with higher peak airway pressures caused by blast injuries to the lungs. Third, the lateral dilation eliminates the need to use the back end of the scalpel to increase the diameter of the opening, which could increase the chance of an inadvertent airway injury, esophageal injury, or hand injury.

The potential drawbacks of the three-step airway procedure include those associated with the visual challenges of working in the dark. The use of infrared night-vision goggles enables the medic to see in complete darkness, but there is a “learning curve.” For example, there is loss of normal multidimensional sight, with visual acuity confined to the color spectrum of green and black, which would make it difficult to see active bleeding or to identify the typical skin color of a hypoxic patient. However, one can still readily visualize the neck, important landmarks, and one’s hand placement throughout the procedure. This reduces the chance of injury from the most dangerous part of the procedure, that is, using the scalpel to make the skin incision and to divide the cricothyroid membrane. We recommend using a safety scalpel, to keep the blade covered when bringing the scalpel up to the patient’s neck. The safety cover can then be retracted to expose the blade and to incise the skin; the same holds true for division of the cricothyroid membrane.

Conclusions

An efficient easy means of obtaining a surgical airway via cricothyroidotomy is critical in combat. We propose a modification to the traditional cricothyroidotomy with the following three-step airway procedure. Step 1 is the identification of landmark structures and skin incision. Step 2 is cricothyroid membrane incision and insertion of a bougie. Step 3 is insertion of an endotracheal tube and removal of the bougie.

The speed, ease, and efficiency of obtaining a surgical airway, in addition to the larger airway provided (compared with traditional cricothyroidotomy), have made the three-step airway procedure a key tool for combat emergency personnel. We expect it to be just as significant and useful in the civilian setting.

References
