Three-Step Emergency Cricothyroidotomy

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Abstract

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 enaotracheal 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 hemostatic 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 three 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).

TABLE 1
MARCH, TRIAGE MNEMONIC USED IN COMBAT

M	Massive hemorrhage
A	Airway
R	Respiration
C	Circulation
H	Head injury/hypothermia

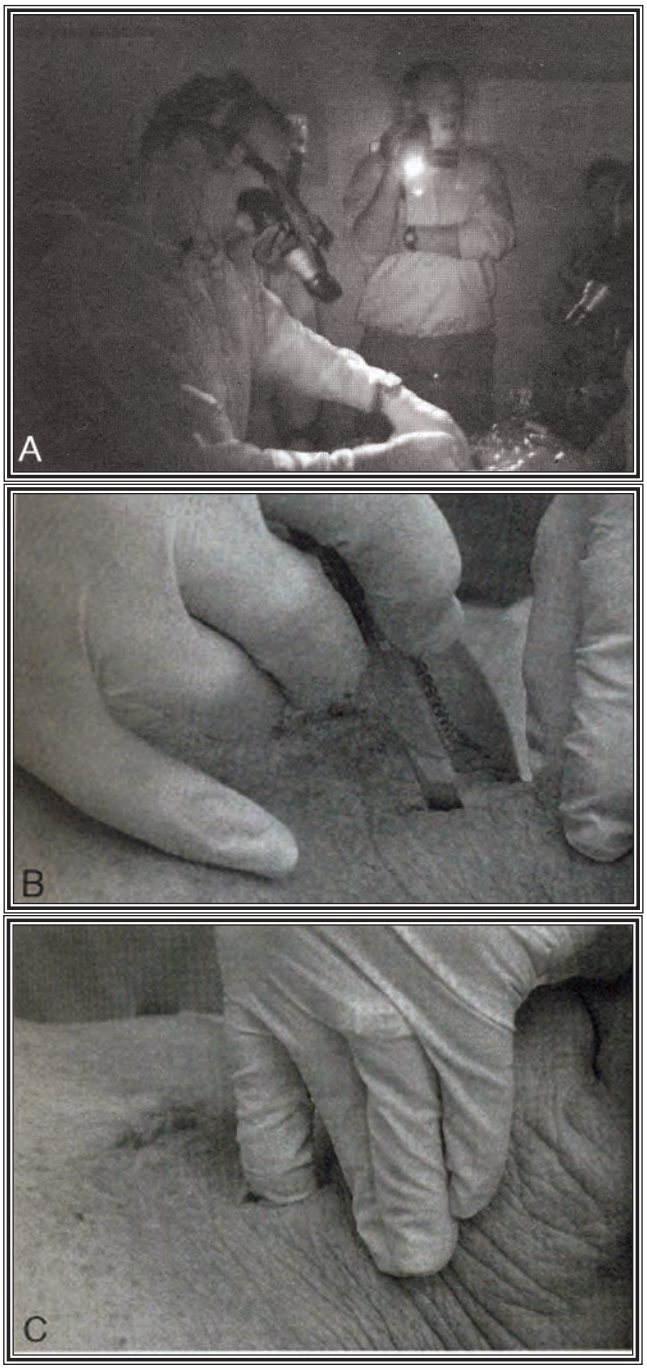

Fig. 1. (A) Surgical airway procedure being performed with night-vision goggles. (B)Vertical skin incision superficial to the cricothyroid membrane. (C)Nondominant index finger placed into the vertical skin incision, to palpate the cricothyroid membrane.

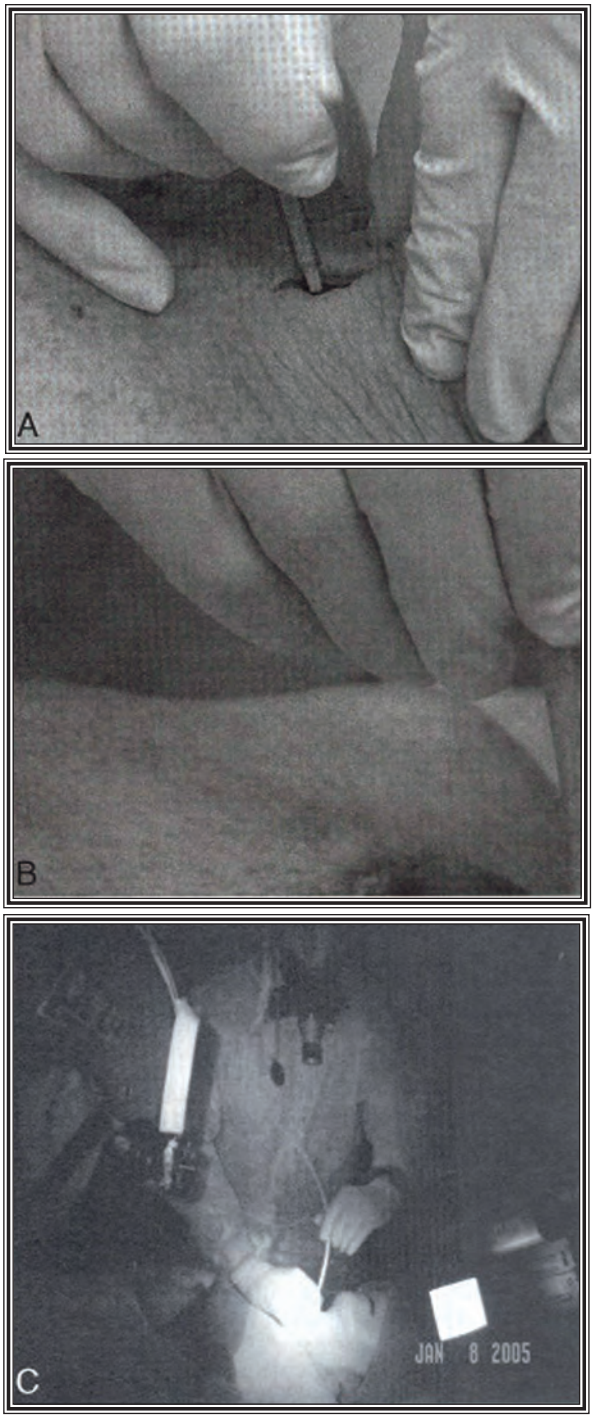

Fig. 2. (A)Horizontal incision through the cricothyroid membrane. (B)Placement of an elastic bougie through the cricothyroid membrane. (C) Placement of an elastic bougie through the cricothyroid membrane with night-vision goggles.

Step 2: Incision of Cricothyroid Membrane

Remove the nondominant index finger from the cricothyroid membrane and make a 5mm horizontal incision through the cricothyroid membrane (Fig.2 A). 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. Ensure that the bevel of the endotracheal tube is lined up with the horizontal incision of the cricothyroid membrane before advancing further. Apply gentle pressure while advancing the endotracheal tube through the divided cricothyroid membrane. As the bevel of the endotracheal tube is passing through the membrane, it will push the cricothyroid membrane laterally. This will open the defect, allowing placement of the larger endotracheal tube. Once the endotracheal tube cuff has entered the trachea, stop advancing. Remove the elastic bougie, and inflate the endotracheal tube cuff.

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 6mm tube. The traditional teaching is to place a 6mm endotracheal tube, rather than a ≥7mm tube, because of the ease of insertion into the narrow orifice.[7] 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.

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Picture This...

Rusty Rowe, MD

During day two of a fourteen-day recon mission in the Tal-Afar region of Iraq, you notice one of your team members limping. He saw a provider on the FOB three days ago and was diagnosed with a spider bite on his left ankle. He was prescribed Keflex 500mg BID for suspected secondary cellulitis. He complains of worsening pain and swelling and notes a small amount of yellowish discharge on his sock. He states that he had a similar appearing nodule on his right thigh about three weeks ago that ruptured and then healed on its own. Otherwise, he is healthy without fever or malaise.

After he removes his boot, you see the lesion noted in the photo that is tender to palpation. Pressure on the lesion expresses only a small droplet of purulent material from the central necrotic area.

Using the primary lesion definitions outlined in your SOF medical handbook, how would you describe the morphology of this lesion?

What is your differential diagnosis for a painful, warm, erythematous nodule on the extremity of a deployed Soldier?

Photo 1

ANSWER:

Morphology: Enlarging painful erythematous nodule. May eventually develop overlying pustule, vesico-bullae, or spontaneously rupture purulent material. Surrounding erythema and induration are common.

Differential Diagnosis: Furuncle (deeper/soft tissue infections), Hidradenitis suppurativa (this typically is found in the axilla, buttock, and groin; chronic and recurrent; may need wound culture to differentiate), dissecting cellulitis of the scalp (only found on the occiput of the scalp; more common in blacks), deep fungal infections (often on leg/foot; chronic; seen in central and south America or Caribbean), brown recluse spider bite (not common; dusky erythema progressing to a necrotic expanding ulceration with pain)

COMMUNITY ACQUIRED METHICILLIN RESISTANT *STAPHYLOCOCCUS AUREUS* SKIN INFECTIONS

Staphylococcus infections of the skin, commonly caused by methicillin resistant *Staphylococcus aureus* (MRSA), are an increasing problem in the military populations. Poor hygiene, shared contaminated equipment, and close quarters living promote disease transmission in deployed personnel and military recruits. Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA), which typically presents as a skin infection, has emerged as a highly virulent bacterium that can cause significant morbidity. Skin infections with MRSA commonly present as a painful abscess that is poorly responsive to antibiotic therapy. Incision and drainage is the treatment of choice, but patients are often additionally treated with antibiotics. Despite preventive medicine strategies such as hand washing, skin infections with CA-MRSA have increased in prevalence and represent a considerable cause of morbidity in military personnel.

MRSA infections were first described in hospitalized patients in 1961, but community-acquired strains were not reported until 1993.[1,2] Now CA-MRSA infections are increasingly reported world-wide. Hospital-acquired and community-acquired MRSA differ in genetic makeup, pathogenicity, and susceptibility to antibiotic treatment.[3] However, CA-MRSA vs HA-MRSA is more likely to affect younger patients and present with skin manifestations. Risk factors that encourage development of CA-MRSA infections include close contact, poor hygiene, sharing of contaminated equipment, breaks in the skin barrier, and/or immuno-suppresion. Populations at risk for contacting CA-MRSA infections include athletes, Native Americans, Pacific Islanders, military personnel, prisoner inmates, the homeless, IV drug users, men who have sex with men, and children in day care centers.[4] Accurate prevalence rates for MRSA infection in the deployed Soldier are unknown at this time. Methicillin-sensitive *S aureus* (MSSA) bacteria colonize approximately 25 to 30% of the asymptomatic civilian population in the United States. Typical colonization sites include the nasal passages, fingernails, and folds of the body (axilla, groin, and perineum). Studies have also demonstrated a 1 to 3% rate of MRSA nasal colonization in pooled pediatric and adult patients visiting outpatient clinics for unrelated appointments.[3,5]

Clinically, CA-MRSA infections typically begin as an insignificant folliculitis or pustule that progresses to a painful abscess. In actuality, the strongest predictor of a CA-MRSA infection on presentation to an emergency room was the initial presentation as a furuncle in one study.[6] The individual may initially complain of an infected pimple or insect bite that enlarges and swells. In actuality, many patients and healthcare providers mistakenly diagnose a MRSA skin infection as a spider bite. The early lesion may become more painful and develop a surrounding cellulitis. Redness, warmth, and swelling are typically found at the infected site upon initial exam (see figure 1). Patients often are afebrile, but may have associated lymphadenopathy in the draining nodal basin. If treatment is delayed or if the patient is immuno-suppressed, sepsis can ensue.

The primary treatment for CA-MRSA is incision and drainage (I&D) when an abscess is present. Failure to I&D skin abscesses can have catastrophic consequences even when appropriate antibiotics are prescribed. Exudates should be cultured for species identification and to determine antibiotic sensitivities. Although drainage alone will resolve most infections, antibiotic therapy is often initiated by healthcare providers despite strong evidence demonstrating little benefit. This may help prevent spread, re-infection, or clear superficial follicular infections that are not large enough for I&D.

Selection of antibiotic therapy will depend on local resistance rates, but these may not be known in the deployed setting where lab capabilities are non-existent. Most strains of CA-MRSA, although not sensitive to b-lactam antibiotics, are often susceptible to other antibiotic classes. Sulfa and tetracycline classes of antibiotics represent safe, typically effective empiric choices. CA-MRSA resistance to these antibiotic classes is uncommon at this time. Clindamycin may also be an effective treatment; however, fears of inducible resistance have made this treatment choice less favorable. Rifampin can be used in conjunction with other antibiotics, but should never be used as a solitary antibiotic therapy for MRSA infections.

Fluoroquinolone antibiotics may provide coverage for CA-MRSA, although rapid emergence of resistance in *Staphylococcal* isolates is well documented.[7] For the patient who is acutely ill, fails to respond to appropriate oral antibiotic therapy, or worsens despite I&D, evacuation to a higher level of care may be required.

PREVENTION

Preventing CA-MRSA skin and soft tissue infections is challenging; especially in patients with frequent recurrences. Colonization of the nares and skin are common reservoirs for re-infection. Close contact with other individuals colonized or infected with CA-MRSA are a common source of bacterial infections. In actuality, it is common for Soldiers who share the same combat housing unit to spread infection to their roommates. One overlooked source of re-infection is fomites. A recent study of prison inmates in Missouri showed significantly higher rates among inmates who shared personal hygiene products such as cosmetic items, lotion, bedding, toothpaste, headphones, especially nail clippers and shampoo. There was a 13% greater risk of disease spread when inmates shared shampoo or nail clippers. Furthermore, rates of infection were higher with inmates who showered and washed their hands less when compared to uninfected fellow prisoners.[8] Good personal hygiene and sanitation of equipment appears to be the best defense against re-infection or the spread of CA-MRSA. Many dermatologist advocate 4% Chlorhexidine Gluconate (Betasept® / Hibicleans®) as the deployment antiseptic surgical scrub of choice because it clears HA-MRSC and CR-MRSA carrier states.

The unique environment of the deployed Soldiers places them at increased risk of contracting CA-MRSA skin infections. Most infections present as a painful abscess that may respond to incision and drainage alone. Additionally sulfa and tetracycline antibiotics may be required to resolve or prevent recurrent skin infections. Hand washing and appropriate personal hygiene with 4% Chlorhexidine Gluconate (Betasept® / Hibicleans®), sanitization of shared equipment, and improved recognition / treatment of CA-MRSA infections by healthcare providers will decrease the incidence and morbidity of CA-MRSA.

If you are DEPLOYED and have concerns about a puzzling skin condition, you can email your clinical photos, a concise morphologic description of the lesion to our Operational Teledermatology site at derm.consult@us.army.mil or to Daniel.Schissel@us.army.mil. The lesion you describe just may make its way to the next edition of **Picture This… Thanks for all you do.**

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COL Daniel Schissel originated "Picture This" for the Med Quiz. He is a 1993 graduate of the Uniformed Service University of the Health Sciences and completed his internship with the family practice department at Fort Bragg in 1994. He then served as the 2/10th Special Forces Group (Airborne) Surgeon and followed on as the 10th SFG(A) Group Surgeon. He completed his residency training in dermatology at the Brooke Army Medical Center in 1999. COL Schissel is presently stationed in Heidelberg, Germany as a staff physician and the European Regional Medical Command Dermatology Consultant. He has been selected as the U.S. Army OTSG Dermatology Consultant. COL Schissel has authored the dermatology section of the new SOF manual, serves on the USSOCOM Medical Curriculum and Examinations Board, and is the U.S. Army Aviation Dermatology Consultant.