Operational Consideration for Definitive Airway Management in the Austere Setting

A Case Report

Jean-Baptiste Morvan, MD[1]; Jean Cotte, MD[2]; Marc Danguy des Deserts, MD[3]; Tamara Worlton, MD[4]; William Menini[5]; Olivier Cathelinaud, MD[6]; Pierre Pasquier, MD[7]*

ABSTRACT

In modern and asymmetric conflicts, traumatic airway obstruction caused by penetrating injury to the face and neck anatomy is the second leading cause of preventable mortality. Definitive airway management in the emergency setting is most commonly accomplished by endotracheal intubation. When this fails or is not possible, a surgical airway, usually cricothyrotomy, is indicated. The clinical choice for establishing a definitive airway in the austere setting is impacted by operational factors such as a mass casualty incident or availability and type of casualty evacuation. This is a case report of a patient with severe cervicofacial injuries with imminent airway compromise in the setting of a mass casualty incident, without possibility of sedation and mechanical ventilation during his evacuation. The authors seek to highlight the considerations and lessons learned for emergency cricothyrotomy.

Keywords: *Tactical Combat Casualty Care; cricothyrotomy; airway; mass casualties; medical evacuation*

Introduction

In modern and asymmetric conflicts, traumatic airway obstruction caused by penetrating injury to the face and neck is still the second leading cause of preventable mortality.[1,2] Definitive airway management in the resource-rich emergency setting is most commonly accomplished by endotracheal intubation. However, when this fails or is not feasible, a surgical airway, usually cricothyrotomy, is indicated. This is a case report of a unique situation where endotracheal intubation was not indicated and immediate surgical airway was needed in an austere setting.

Military operations of the French Armed Forces in the most austere combat settings may require the deployment of the Surgical Life-Saving Module (SLM).[3] SLM is a rapidly deployable (operational in 45 minutes) and highly mobile forward surgical asset. The SLM team consists of a general trauma surgeon (visceral or thoracic surgeon), a head and neck trauma surgeon (oral and maxillofacial surgeon, otolaryngologist or neurosurgeon), an anesthesiologist-intensivist, and two specialized nurses (one operating room nurse and one nurse anesthetist). In its standard format, SLM is stored in eight sealed containers with a total volume of 4m^3 and a weight ranging between 650 kg and 1 ton. The SLM capacity is intended to stabilize one or two severe combat casualties with the primary role of resuscitation and damage control surgery. In our recent experience, the SLM has been called upon to care for many more casualties that originally intended. In such situations, triage had to be performed, and adaptation of personnel and equipment were required.

Case Presentation

In 2016, SLM was deployed to provide surgical support of allied forces with no forward surgical capabilities available. The host nation military command asked the coalition forces, including the SLM, to provide forward surgical teams as intermediate medical treatment facilities between the front line and the geographically distant local hospitals. Casualties were immediately transported by host nation ambulance to the SLM, approximately at 15 minutes from the frontline. The SLM received combat casualties with no notification. Some arrived with only tenuous peripheral intravenous access and hemostatic dressings. The ambulance staff were not able to perform tube thoracostomy or definitive airway management. Additionally, they did not apply tourniquets. The SLM performed triage, emergency lifesaving surgical intervention, and ensured rapid medical evacuation to host nation facilities. The host nation facilities, which routinely dealt with war injuries, were at least a 2-hour drive from the front line. Helicopter evacuation was possible in thirty minutes. Ambulances and helicopters were equipped with oxygen and staffed by a nurse and, more rarely, by a local physician. The ability to transfer a mechanically ventilated or sedated patient was determined by the SLM anesthesiologist-intensivist depending on tactical considerations and the patient's condition.

During a mass casualty incident (40 casualties in 2 hours, 60 total casualties), the SLM received a 28-year-old Allied soldier, wounded by an improvised explosive device on the frontline. He presented with a compromised airway, due to active hemorrhage precipitated by a large (15-cm) foreign body in the left mandibular angle (Figure 1).

*Correspondence to jbmorvan@hotmail.com

[1]**LCL Jean-Baptiste Morvan** and [6]**COL Olivier Cathelinaud** are physicians in the Department of Otorhinolaryngology and Head and Neck Surgery, Sainte Anne Military Training Hospital, Toulon, France. [2]**LCL Jean Cotte** is a physician and [5]**CWO William Menini** is affiliated with the Intensive Care Unit, Sainte Anne Training Military Hospital, Toulon, France. [3]**LCL Marc Danguy des Deserts** is affiliated with the Intensive Care Unit, Clermont Tonnerre Training Military Hospital, Brest, France. [4]**CDR Tamara Worlton** is a physician in the Department of Surgery, Uniformed Services University of the Health Sciences, Bethesda, MD. [7]**COL Pierre Pasquier** is a physician in the Intensive Care Unit, Percy Military Training Hospital, Clamart, France and is affiliated with the Ecole du Val de Grâce, French Military Medical Academy, Paris, France.

FIGURE 1 *Obstructed airway conditions, due to an active hemorrhagic wound in the left mandibular angle with a facial metal foreign body.*

Patient's photograph.

This was further compounded by a right lateral zone III wound, a comminuted fracture of the anterior mandible, fractured teeth, and active bleeding in the mouth (Figure 2). He was dyspneic on presentation with an open right chest wound but did not appear to have tension pneumothorax physiology (Figure 2). The Glasgow Coma Scale score was 13 (eye 4, verbal 4, motor 5). He was confused, agitated and diaphoretic. His heart rate was 140 beats per minute with a systolic blood pressure of 120mmHg, in Class 3 shock. Oxygen saturation was 91%. The casualty was previously equipped at the frontline with a peripheral venous line and an oxygen mask, hardly accepted by the patient. The otolaryngologist and nurse anesthetist managed the casualty at his arrival to the SLM, while other members of the team were dealing with other simultaneous casualties. In an effort to maintain a patent airway, they removed the foreign body, suctioned the mouth, and attempted hemorrhage control. With the inability to compress the facial injuries to stop hemorrhage, concern for upper airway and possibly tracheal injury, and worsening mental status, the decision was made to perform an emergent surgical airway.

While it may have been physically possible to do an endotracheal intubation, there were several operational factors that made this a poor option. First, the SLM was still receiving urgent casualties and it was thought to be quicker to do a surgical airway then to attempt direct laryngoscopy with the ongoing oral bleeding. Second, a helicopter medical evacuation was available in 15 minutes. The helicopter did not have the capability of ventilator support nor monitoring for a sedated patient. It was the opinion of the surgical team that the patient would be able to maintain his own airway if the bleeding was stopped and the potential airway injury was bypassed. Indeed, the SLM team performed an emergency cricothyrotomy procedure to ensure surgical definitive airway management before facial bleeding control. Due to concerns about oversedation, which would have precluded his evacuation and required ongoing monitoring during a mass casualty incident, the SLM team elected to use light procedural anesthesia. The patient received by intravenous injection 2mg of midazolam and 80mg of ketamine. No local anesthesia was performed according to French military guidelines. The otolaryngologist conducted a bedside surgical technique employing a "scalpel-bougie-tube" method, in about 3 minutes, with no immediate complication.[4] An endotracheal tube was cut to a smaller length and carefully secured in place before medical evacuation.

FIGURE 2 *Hemorrhagic cervical wound and nonblowing, nonhemorrhagic chest wound.*

Patient's photograph.

Bleeding control was ensured by a cervical compressive packing with QuikClot Combat Gauze (https://quikclot.com/) and a facial dressing to close the mandibular symphysis fracture (Figure 3). As he desaturated before the cricothyrotomy, a needle thoracostomy was performed and found to be negative for tension pneumothorax. After the cricothyrotomy, oxygen saturation was 96% and an extended-focused assessment with sonography for trauma (E-FAST) was performed and showed no hemopneumothorax. A three-sided occlusive chest bandage was placed on the thoracic wound (Figure 3). The medical evacuation team reported no complications en route and the patient was alive 2 days later.

FIGURE 3 *Damage control management with emergency cricothyrotomy, needle thoracostomy, three-sided occlusive chest bandage, and cervicofacial compressive packing.*

Patient's photograph.

Discussion

This case report illustrates the complexity and rapidity of tactical decision making in an operational environment and highlights the operation indications for emergent cricothyrotomy in patients with severe cervicofacial injury. In this case, the main reason for the emergent airway was to avoid further management of a patient who required sedation and mechanical ventilation in the context of a mass casualty event and poor medical resources/capabilities during evacuation. During the Afghanistan and Iraq conflicts (2001–2011), traumatic airway obstruction was responsible for 8% of fatalities caused by penetrating injury to the face and neck anatomy; it was the second leading cause of preventable mortality.[1,2] These findings are similar, but slightly greater than that previously reported for airway obstruction mortality (1–2%).[5] Historically, airway obstruction is the third leading cause of potentially

preventable death on the battlefield, behind compressible hemorrhage and tension pneumothorax.[1,5–7] SLM was designed to address these three leading causes of battlefield mortality with a small surgical team as close to the frontline as possible.[3] The SLM has a smaller footprint than the French role 2 or 3 and can be deployed for small-scale military operations with fewer personnel involved, such as the Special Operations Forces.[8–10] The SLM is comparable to the US surgical resuscitation teams (SRTs) and forward surgical teams (FSTs).[11,12] Trauma surgical support is flexible and rapidly mobile.

Airway management is critical to conduct damage control strategies. Definitive airway management in the emergency setting is most commonly accomplished by endotracheal intubation. When endotracheal intubation fails or is not possible because of traumatic injury to the face, neck, or upper airway, a surgical airway, usually cricothyrotomy, is indicated.[13,14] In certain situations, the medical intervention of choice is a definitive airway with tracheal intubation. However, rapid sequence intubation (RSI) is not practical in all situations for one individual to acutely manage, such as with multiple trauma patients, or if RSI medications are not available.[15] In the case of anatomical superficial neck landmark identification failure, the otolaryngologist used a vertical, midline skin incision to optimize visualization and palpation of the cricothyroid membrane and surrounding anatomy.[16] Since location of the cricothyroid membrane could be particularly compromised in case of cervical injuries or burns, the help of at least one other person is necessary to maintain adequate head and body position.[4,17] As in our case, the patient with maxillofacial trauma presents serious challenges.[18] The first challenge is to secure the airway for sufficient and effective breathing and/or ventilation. When planning to secure the airway, the physician has to consider the nature of the trauma and its effect on the airway, possible trauma of the cervical spine, and the risk of regurgitation and significant bleeding that may cause circulatory deterioration and aspiration. The time available for deciding on and then performing the cricothyrotomy is often short because the patient's condition can deteriorate quickly.

In the combat setting, awake cricothyrotomy represents an alternative of choice to orotracheal intubation and ensures a fast and efficient definitive airway. However being simple to execute, even in austere settings, it requires a regular refresher training for both use of material and procedures.[19] Awareness of this technique allows clinicians to save precious time establishing a definitive airway, especially in mass casualty incidents. It allows spontaneous ventilation and facilitates the evacuation of an injured person in case of transport without ventilation capability. Orotracheal intubation would have been possible and preferable in other tactical circumstances.[18]

Use of local anesthesia and ketamine significantly reduces the risks associated with traditional RSI (hypotension during induction and loss of respiratory effort with full neuromuscular blockade). A dosage more consistent with the Tactical Combat Casualties Care (TCCC) guidelines near 200mg intramuscular (IM) ketamine or even the newer guideline of 300mg IM ketamine would have allowed the patient to maintain their airway.[14] Local anesthesia could have spared the patient the additional discomfort and should be used if operational situations allow. The ease of this procedure would have been improved without compromising the transport of the patient. The French military guidelines currently do not recommend the use of local anesthesia due to the theoretical risk of obscuring the anatomic landmarks. However, this case report highlights the pitfalls of this approach. A critical appraisal of the evidence on this subject should form the basis of a new version of those guidelines.

Conclusion

Definitive airway technique in the austere setting can be impacted by imminent incoming casualties and the capability of further medical evacuation. Emergency cricothyrotomy should be a comfortable capability of forward surgical teams such as French SLM. This case report illustrates these challenges and highlights lessons learned such as the use of local anesthesia and higher dose of ketamine for patient comfort. Further expert consensus on how and when to perform an emergent cricothyrotomy in the austere setting is still needed.

Author Contributions

JBM, JC, and PP conceived the study concept. JBM and WM coordinated and collected the data, and JC and OC analyzed the data. JC, MDD, TW, and PP revised the manuscript. JBM wrote the first draft, and all authors read and approved the final manuscript.

Disclosure

The authors have indicated they have no financial relationships relevant to this article to disclose.

Disclaimer

The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the Department of Defense, the Uniformed Services University of the Health Sciences, or any other agency of the US Government.

References

1. **Eastridge BJ, Mabry RL, Seguin P, et al.** Death on the battlefield (2001-2011): implications for the future of combat casualty care. *J Trauma Acute Care Surg*. 2012;73(6 Suppl 5):S431–437.
2. **Pasquier P, de Rudnicki S, Donat N, et al.** [Epidemiology of war injuries, about two conflicts: Iraq and Afghanistan]. *Ann Fr Anesth Reanim*. 2011;30(11):819–827. doi:10.1016/j.annfar.2011.05.018
3. **Malgras B, Aoun O, Pauleau G, et al.** Deployment of the Surgical Life-saving Module (SLM) in 2017: Lessons learned in setting up and training operational surgical units. *Injury*. 2019;50(5):1133–1137.
4. **Langvad S, Hyldmo PK, Nakstad AR, et al.** Emergency cricothyrotomy: a systematic review. *Scand J Trauma Resusc Emerg Med*. 2013;21:43.
5. **Bellamy RF, Maningas PA, Vayer JS.** Epidemiology of trauma: military experience. *Ann Emerg Med*. 1986;15(12):1384–1388.
6. **Mabry RL, Edens JW, Pearse L, et al.** Fatal airway injuries during Operation Enduring Freedom and Operation Iraqi Freedom. *Prehosp Emerg Care*. 2010;14(2):272–277.
7. **Kotwal RS, Montgomery HR, Kotwal BM, et al.** Eliminating preventable death on the battlefield. *Arch Surg*. 2011;146(12):1350–1358.
8. **Malgras B, Barbier O, Petit L, et al.** Surgical challenges in a new theater of modern warfare: the French role 2 in Gao, Mali. *Injury*. 2016;47(1):99–103.
9. **Barbier O, Pasquier P, Racle M, et al.** Dynamic Insights on surgical activity in a new modern warfare: the French Role 2 in Bangui, Central African Republic. *Mil Med*. 2017;182(3):e1756–e1761.
10. **Luft A, Pasquier P, Soucanye de Landevoisin E, et al.** The damage control resuscitation and surgical team: the new French paradigm for management of combat casualties. *Mil Med*. Published online November 26, 2020:usaa322.

11. **Remick KN.** The Surgical Resuscitation Team: surgical trauma support for U.S. Army Special Operations Forces. *J Spec Oper Med*. 2009;9(4):20–25.
12. **DuBose JJ, Martens D, Frament C, et al.** Experience with prehospital damage control capability in modern conflict: results from surgical resuscitation team use. *J Spec Oper Med*. 2017;17(4): 68–71.
13. **Schauer SG, Bellamy MA, Mabry RL, Bebarta VS.** A comparison of the incidence of cricothyrotomy in the deployed setting to the emergency department at a level 1 military trauma center: a descriptive analysis. *Mil Med*. 2015;180(3 Suppl):60–63.
14. **Dye C, Keenan S, Carius BM, et al.** Airway management in prolonged field care. *J Spec Oper Med*. 2020;20(3):141–156.
15. **Mabry RL.** An analysis of battlefield cricothyrotomy in Iraq and Afghanistan. *J Spec Oper Med*. 2012;12(1):17–23.
16. **Hessert MJ, Bennett BL.** Optimizing emergent surgical cricothyrotomy for use in austere environments. *Wilderness Environ Med*. 2013;24(1):53–66.
17. **Palmer LE.** Concepts of prehospital advanced airway management in the operational K9: a focus on cricothyrotomy. *J Spec Oper Med*. 2019;19(1):99–106.
18. **Combes X, Jabre P, Jbeili C, et al.** Prehospital standardization of medical airway management: incidence and risk factors of difficult airway. *Acad Emerg Med*. 2006;13(8):828–834.
19. **Bennett BL, Cailteux-Zevallos B, Kotora J.** Cricothyroidotomy bottom-up training review: battlefield lessons learned. *Mil Med*. 2011;176(11):1311–1319.

The Special Operations Medical Association's Official Journal

JSOM

Fall 2022
Volume 22, Edition 3

JOURNAL *of* SPECIAL OPERATIONS MEDICINE™

THE JOURNAL FOR OPERATIONAL MEDICINE AND TACTICAL CASUALTY CARE

Inside this Issue:

Dedicated to the Indomitable Spirit, Lessons Learned & Sacrifices of the SOF Medic

A Peer Reviewed Journal That Brings Together The Global Interests of Special Operations' First Responders