

The Bougie-Aided Cricothyrotomy

Darren Braude, MD, EMT-P^{1,2,3} Heather Webb, MD,^{1,2} Jennifer Stafford, RN,⁴ Paula Stulce, RN, EMT-P,⁴ Lauri Montanez, RN, MSN,^{2,4} George Kennedy, MD,^{1,4} and David Grimsley, EMT-P⁵

Surgical cricothyroidotomy is considered a critical skill in emergency airway management, though it is rarely used and fraught with complications. A variety of approaches are taught, including both the standard and rapid four-step techniques. We report a case in which an air medical crew used a gum-elastic bougie (endotracheal tube introducer), a common device in many airway kits, to facilitate surgical cricothyroidotomy in a 58-year-old patient with a pharyngeal mass, respiratory failure, and failed rapid sequence induction. We believe this technique may decrease the time until ventilation, minimize complications compared with other cricothyroidotomy techniques, and allow insertion of a larger-diameter endotracheal tube compared with other techniques.

Case

A fixed-wing flight crew was called to transport a 58-year-old male patient from a small rural hospital secondary to a pharyngeal mass complicated by alcohol withdrawal. The radiologist interpreted the image seen on a computed tomography scan as a 6 cm by 6 cm by 6 cm mass at the base of tongue and left tonsillar area with pharyngeal displacement and distortion of normal neck anatomy. On arrival, the crew found an emaciated patient in respiratory failure with supraclavicular and intercostal retractions and with altered mental status; he opened his eyes only to deep painful stimuli. His vital signs revealed a temperature of 101.4°F rectally, saturation of 95% with an oxygen-powered albuterol nebulizer at 15 L/min, a regular heart rate of 144 beats/min, a respiratory rate of 26 to 40 breaths/min, and a blood pressure of 120/70 mmHg. The patient had received Solu-

Medrol, Ativan, and Romazicon before arrival. Although a difficult airway was anticipated, it was determined that the patient would require definitive airway control before the 2-hour transport. This small facility has no otolaryngologist availability, and the certified registered nurse anesthetist on call had yet to arrive, with no known estimated time of arrival. While simultaneously preparing for a surgical airway, the patient was positioned optimally and rapid sequence intubation initiated with etomidate and rocuronium. The flight nurse attempted direct laryngoscopy with a #4 Macintosh blade, without success. Frank blood was suctioned from the oropharynx, and the best view was Lehane and Cormack Class IV. It was then decided to perform a surgical cricothyroidotomy. Bag-valve mask ventilation was required to maintain the oxygen saturation above 90% while preparing for and during this procedure. The flight nurse made a vertical incision over the cricothyroid membrane, followed by a horizontal incision into the membrane. They placed a 6.0 cuffed endotracheal tube into the incision directed distally; however, during positive-pressure ventilation, gurgling sounds were heard from the patient's mouth, and there were no audible breath sounds. A gum-elastic bougie was then introduced into the incision. Tracheal position was confirmed with "hold-up," and a 6.0 endotracheal tube was introduced into the opening over the bougie. Breath sounds were equal bilaterally, and tube placement then was re-verified with capnography. The tube was secured and the patient placed on the transport ventilator. The remainder of the transport was uneventful. The cricothyrotomy was eventually converted to a tracheostomy without any noted complication from the initial procedure. The patient was diagnosed with a squamous cell carcinoma of the tongue and ultimately transferred to hospice.

Discussion

Ideally, patients with significant anatomic airway obstructions would only be managed by anesthesiologists and otolaryngologists in a controlled operating room setting. In reality, flight crews may encounter such patients in settings where no such expertise is available. Rapid-sequence intubation (RSI) is relatively contraindicated in such patients and should be avoided when possible. In this case, the patient's respiratory failure, altered level of consciousness, and prolonged transport did not permit watchful waiting or alternatives such as noninvasive positive-pressure ventilation. Once deemed necessary, options for managing an anatomically obstructed upper airway include RSI with simultaneous preparation for a surgical airway, that is, a "double set-up," awake intubation with or without fiberoptic adjuncts, retrograde intubation, and primary cricothyroidotomy. In this case, awake

1. Department of Emergency Medicine, University of New Mexico, Albuquerque, NM

2. Airway911 Training Program, University of New Mexico, Albuquerque, NM

3. PHI Air Medical

4. Lifeguard Air Emergency Services, University of New Mexico, Albuquerque, NM

5. Pegasus Flight Operations, University of Virginia, Charlottesville, VA

Address for correspondence:

Darren Alan Braude, MD, Department of Emergency Medicine, MSC10-5560, 1 University of New Mexico, Albuquerque, NM 87131-0001; dbaude@salud.unm.edu

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Figure 1. Prepare and drape as time allows



Figure 3. Horizontal incision through the cricothyroid membrane



Figure 5. Immediate placement of bougie with coude tip directed toward the feet



intubation and retrograde intubation were not available, and it seemed reasonable to attempt RSI because a surgical airway appeared feasible as a backup. Such an approach is relatively contraindicated in the setting of known distorted airway anatomy and is not without serious potential risks. The primary purpose of this case is to present the bougie-aided approach to the surgical airway.

Emergency surgical cricothyroidotomy is a potentially life-saving airway intervention that may be performed out-of-hospital, in the emergency department, or in the hospital. Indications include the “cannot intubate—cannot ventilate”

Figure 2. Identify the correct cricothyroid membrane. Use vertical incision if necessary



Figure 4. Blunt dilation of opening with finger



Figure 6. Confirm tracheal placement with palpation of clicks or hold-up



scenario, either after RSI or for providers not authorized to perform RSI, massive facial trauma, and airway obstruction; these indications have been reviewed elsewhere.^{1,2} Unfortunately, these procedures are rarely performed until a critical situation arises, which increases the risk of delays and complications. Complications of surgical airways include time delays, bleeding, creation of a false passage, esophageal placement, and others.²⁻¹³ The complication rate for air medical cricothyrotomy has been reported to be as high as 55%.¹⁴ In this case, the major complication was retrograde placement of the endotracheal tube, which has rarely been reported.¹⁵

Figure 7. Pass 6-mm endotracheal tube or tracheostomy tube over bougie. A 5.5-mm tube may be used in smaller adults



Figure 8. Ensure proper placement of tube



Figure 9. Withdraw bougie



The “standard” technique for surgical cricothyroidotomy involves an initial vertical incision, a horizontal incision through the cricothyroid membrane, use of a tracheal hook and dilator, then placement of a 5.0-mm or greater endotracheal tube.^{2,16-18} The “rapid four-step technique” involves palpation, incision, inferior traction, and tube insertion. This approach permits the operator to be positioned at the patient’s head with hand positions similar to that for direct laryngoscopy and endotracheal intubation.^{19,20} It also eliminates the vertical incision if the membrane can be palpated and eliminates the dilator. Although the four-step approach has been shown to be faster than the standard technique in cadaver studies,²⁰⁻²² both of these approaches require special equipment and are prone to many of these complications.^{23,24} The complication rate with the rapid four-step technique has been higher than that with the standard technique in some studies.^{20,21}

The ideal approach to the surgical airway would require no additional equipment than that found in a standard airway kit except a scalpel, would allow immediate confirmation of endotracheal placement before tube insertion, and would maintain the location of the incision even if hands must be released. In addition, this approach would facilitate placement even in the setting of heavy bleeding and would accommodate insertion of a 6-0 tube in average-size adults. Most importantly, the technique should be simple enough that skill retention can be maintained with minimal retraining. The bougie-aided approach accomplishes all of these goals. This technique has been previously described as the “three-step cricothyroidotomy.”²⁵ Only one previous case has been reported.²⁶

The bougie-aided cricothyroidotomy begins with identification of preparing and draping the patient if time permits (Fig. 1). The next step is identification of the cricothyroid membrane (Fig. 2). A vertical midline incision, followed by blunt dissection if necessary, may be used to assist in locating the membrane if it is

obscured by edema, trauma, or obesity. Once identified, a horizontal incision is made through the membrane with a scalpel (Fig. 3). The sharp should be safely discarded, a finger immediately placed into the incision, and the opening bluntly dilated (Fig. 4). The coude tip of the bougie is then placed into the expanded incision directed toward the patient’s feet (Fig. 5). The bougie should initially advance without resistance until resistance is met at the level of the carina or bronchus. This is called “hold-up.” Vibrations also may be felt through the bougie as the coude tip passes over each cartilaginous ring of the trachea (Fig. 6). If both of these confirmatory signs are present, the operator can be confident that the bougie is within the trachea rather than a false passage. If only hold-up is present (ie, the rings are not appreciated), there is a small chance of placement in peritracheal soft tissues, although in our experience using a cadaver model such placement results in a very different “feel.”

Once tracheal placement of the bougie is confirmed, an endotracheal tube or tracheostomy tube may be passed over the bougie into the trachea (Figs. 7, 8). All commercially available adult bougies will accommodate a 6-0 mm tube; some brands allow passage of a smaller 5.5-mm tube with lubrication. Pediatric bougies will accommodate a 4-0 mm tube. If using an endotracheal tube, the operator should be careful to only advance the tube until the cuff has passed into the trachea. The bougie may now be withdrawn (Fig. 9), and tracheal placement must be additionally confirmed using capnography; an esophageal detector device may be used if the patient is in cardiac arrest or no capnography is available.

The bougie-aided cricothyroidotomy combines the best of both the “rapid four-step” surgical approach and the Seldinger techniques, without using any special equipment except a gum-elastic bougie. The gum-elastic bougie, or endotracheal tube introducer, is commonly recommended to be included in any airway kit^{27,28} because of the substantial body of evidence supporting their utility in endotracheal intubations²⁹⁻³⁴; as such, they are now widely

available in many ambulances, air medical aircraft, emergency departments, intensive care units, and operating suites. Operators that have Trousseau dilators, curved forceps, and tracheal hooks immediately available and are facile in their use may incorporate them into this technique, although they are not required.

Conclusion

We report a case in which a gum-elastic bougie was used by an air medical crew to facilitate surgical cricothyroidotomy in a patient with an oropharyngeal mass and failed RSI. We believe the bougie-aided cricothyroidotomy, also known as the three-step cricothyroidotomy, is simpler, easier to learn and retain, and potentially safer than alternative techniques, because it reduces the risk of a misplaced cricothyrotomy. Further validation and comparison between techniques is warranted.

Further detailed video instruction in the bougie-aided cricothyrotomy is available on-line at: www.airway911.com.

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