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Emergency cricothyrotomy

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KEYWORDS
Emergency cricothyrotomy;
Failed intubation;
Cricothyroid membrane;
Tracheotomy;
Airway obstruction;
Failure to ventilate

Emergency cricothyrotomy is a potentially lifesaving procedure in a "failure to intubate, failure to ventilate" scenario. It should be performed in instances when other means of securing a definitive airway during an emergency have failed, and prolonged inability to maintain adequate patient ventilation may have disastrous consequences. This article describes two techniques (with illustrations) that are effective in rapidly accessing the trachea to provide ventilation when standard airway techniques have failed. Familiarity with these techniques can provide the practitioner with the ability to restore adequate ventilation to a patient who might otherwise suffer irreversible hypoxic injury or death.

Emergency cricothyrotomy is a potentially lifesaving procedure that has over time become less commonly performed both in the field and in the hospital setting.[1,2] The overall use of emergency cricothyrotomy has been declining as a result of the implementation of better airway management training, skills, and tools.[3] Nonetheless, the final pathway in the American Society of Anesthesiologist's difficult airway algorithm still advises the use of an invasive intervention in a "cannot intubate, cannot ventilate" scenario.[4] Therefore, this technique should continue to be understood and practiced for use in situations when other standard attempts at establishing a definitive airway, such as endotracheal intubation, have failed. Once a point in the airway management algorithm has been reached when there are no longer nonsurgical options and the decision to undertake an emergency cricothyrotomy is made, it should commence swiftly. Previous planning, including access to necessary equipment, must be in place in advance of attempting this procedure.

Emergency cricothyrotomy should be performed by those who can most rapidly and effectively identify the critical landmarks and perform the procedure. Although there are many potential approaches to accessing the trachea through the cricothyroid membrane,[5] the goal of this article is to outline and discuss 2 important methodologies: needle cricothyrotomy (catheter over needle) and surgical cricothyrotomy.

Indications

Emergency cricothyrotomy is indicated as a rapid means to definitively secure or rapidly circumvent obstruction of a patient's airway when inability to restore adequate oxygenation would have potentially catastrophic results. This may arise when a previously anticipated difficult airway exists during planned, elective intubations, but also may present initially as an unexpected complication in emergency situations, such as "code blues" or trauma. It should be stressed that adequate prior assessment and planning for a difficult airway may obviate the need for emergency techniques.

In many instances, there are a host of potential causes of failure to secure a definitive airway by less-invasive means. In a true emergency with loss of the airway and the inability to bag-mask ventilate, emergency cricothyrotomy should quickly be considered. There are few limitations to successful completion, even on first attempts, provided the practitioner has an understanding of anatomy and has had a chance to review and understand the technique.[6]

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Table 1 Contraindications to surgical cricothyrotomy[12]

Absolute contraindications
Endotracheal intubation can be accomplished easily and safely
Transection of trachea with retraction of distal end
Severely fractured laryngeal cartilages
Relative contraindications
Infant and toddlers (transtracheal jet ventilation preferred)
Bleeding diathesis
Massive neck edema or swelling
Acute laryngeal disease

General contraindications

Certain patients may not be amenable to cricothyrotomy, such as persons in whom it is difficult or technically not possible to determine anatomic landmarks (eg, severely obese patients). Surgical cricothyrotomy is, likewise, generally contraindicated in neonates and children younger than the age of 6 as well as any patient with a laryngeal fracture,[7] but needle cricothyrotomy may still be considered in small children when other methods have failed (Table 1).[8]

However, it is challenging to develop a list of absolute contraindications, especially if additional delays may result in patient death. If all other options have been considered, emergency cricothyrotomy may remain the last viable option to prevent long term morbidity or mortality. Cricothyrotomy generally does not provide an ideal airway for prolonged ventilation and, after patient stabilization, an elective tracheotomy should be performed.

Cricothyrotomy versus tracheotomy

In the adult patient, with few exceptions (Table 1), cricothyrotomy is preferred over tracheotomy for definitive management of an emergency airway situation in which endotracheal intubation is impossible. The emergent or "slash" tracheotomy typically is considered only when the patient is in extremis, which is when a cricothyrotomy should be performed.[9] The incidence of complications in emergency tracheotomies may be up to 5 times that found in elective procedures.[10]

A tracheotomy, even in experienced hands, is a more complex and time-consuming surgical procedure. The decreased incidence of complications with cricothyrotomy as compared with emergent tracheotomy is in part the result of anatomical considerations.[11] Less encroachment on mediastinal structures occur with cricothyrotomy because the cricothyroid membrane is located more cephalad. Thus, early complications such as pneumothorax and mediastinal perforation occur less often. The tracheal cartilage is absent posteriorly (unlike the laryngeal and cricoid cartilages). Thus, the chance of damage to the posterior tracheal wall and esophagus is more likely in a tracheotomy than in a cricothyrotomy.[12]

Surgical anatomy

In all cases, it is imperative that the practitioner be able to appropriately identify landmarks before undertaking the procedure. The sternal notch, thyroid, and the cricoid cartilage usually can be easily palpated through the skin. The cricoid, described as a reverse signet ring just inferior to the thyroid cartilage, can be found by using either the sternal notch below or the thyroid cartilage above as reference points. The cricothyroid membrane stretches between the thyroid and cricoid cartilages and can be identified by palpating a slight indentation in the skin inferior to the laryngeal prominence (Figure 1).[13] The advantage of this space is that the cricothyroid membrane is easily identifiable between these 2 structures, and its fibrous nature contains minimal vasculature.

Subsequent cannulation of the cricothyroid membrane allows for restoration of ventilation either by transtracheal jet ventilation or by direct insertion of an endotracheal tube. There appears to be an overall low long-term complication rate for this procedure if the thyroid cartilage and cricoid ring are not damaged during the procedure.[14]

Techniques

Needle cricothyrotomy (catheter over needle)

Advantages

The catheter over needle technique uses basic landmarks along with simple technique and equipment to provide access to the trachea to provide for transtracheal jet ventilation.[15] Studies indicate that this can accomplished on average of 30 seconds or less even by inexperienced practitioners.[16] Because a relatively small needle is used in lieu of an incision, there is less incidence of unanticipated airway trauma or bleeding than with other cricothyrotomy techniques. In certain situations, this technique may be preferred over others secondary to aberrant anatomy.[17] Because a relatively small needle is used in lieu of an incision, there is less incidence of unanticipated airway trauma or

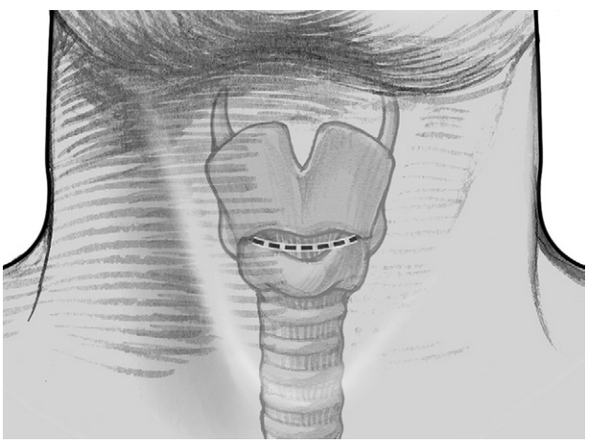

Figure 1 The cricothyroid membrane is palpated through the skin using the thyroid notch and cricoid cartilage as reference points.

bleeding than with other cricothyrotomy techniques. Furthermore, with a successful catheter in situ, additional techniques can be planned and used, such as retrograde wire intubation, after the patient has been stabilized.[18]

Disadvantages

This technique creates only a small opening in the cricothyroid membrane, allowing for intermittent high-velocity (jet) ventilation. There will need to be a high-flow oxygen delivery system (50 psi) to delivery intermittent ôpulseö ventilations. Without a high-pressure source, it is difficult to impossible to adequately ventilate a patient with low-pressure ventilation. A large cannula must be available and used to ensure adequate oxygen delivery. At a minimum, a plastic catheter on top of a large bore, at least 14-gauge or 9-Fr, needle should be used. Additionally, if the upper airway is unclear, or there is blood, debris, stomach contents, or other foreign matter already in the trachea, the transtracheal ventilation technique will not allow the ability to clear this matter from the airway and may force such matter further into the airway. Furthermore, a significant upper-airway obstruction above the insertion site may not allow sufficient time for the evacuation of expiratory gasses between breaths. If any of these obstacles are foreseen or are noticed during the conducting of the catheter over needle technique, needle cricothyrotomy should be abandoned for the surgical technique. If this is noted after the trachea has been successfully cannulated using the catheter over needle technique, the in situ catheter can serve as a landmark for the subsequent procedure.

Needle cricothyrotomy technique

The items are prepared by connecting the ventilation control device directly to the 50 psi outlet (Figure 2). A small amount of sterile saline is draw into the syringe and connected to the 14-gauge catheter-needle combination. The cricothyroid membrane is identified as demonstrated previously. The syringe-catheter, with 3 to 5 mL of sterile saline, is advanced at a 30-degrees-toward-caudad angle in the midline while withdrawing on the syringe to create a vacuum within the chamber (Figure 3). Once the presence of the trachea is identified, by the appearance of bubbles in the saline within the syringe, the needle-catheter-syringe unit is advanced approximately 5 mm further.

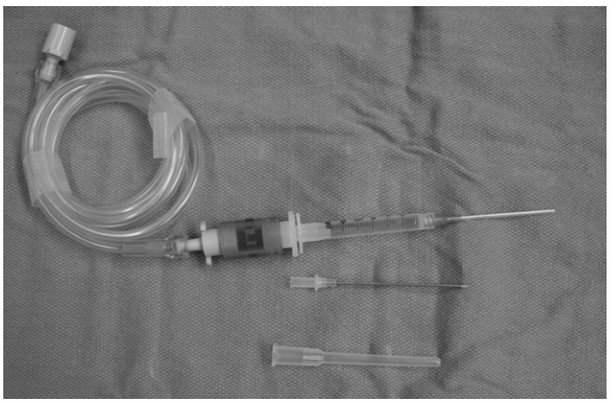

Figure 2 Flow-regulation device, 10-mL syringe, and large-bore (14-gauge) catheter-over-needle.

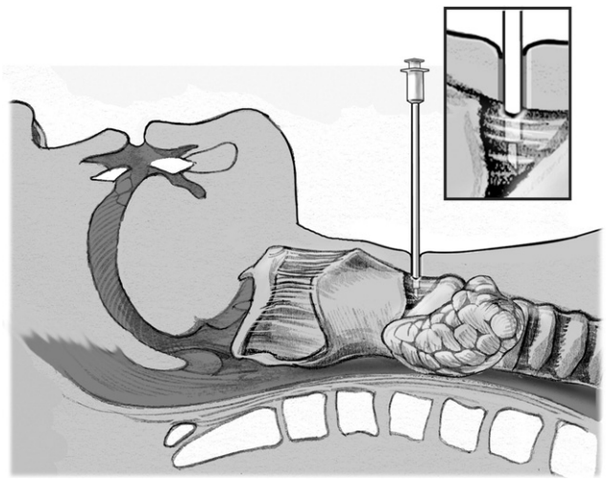

Figure 3 The cricothyroid membrane with syringe-catheter in the midline Needle-catheter-syringe combination inserted at 30-degree caudad angle.

The plastic catheter is then advanced forward while withdrawing the needle-syringe unit. The needle is removed from the syringe and discarded. The syringe is then emptied of saline. A full 10 mL of air is withdrawn into the catheter. The syringe is reconnected to the catheter in the patient's neck, and the air is plunged through the syringe-catheter. Be careful to note any resistance or appearance of subcutaneous blebbing, which would indicate that the catheter has been advanced too far into the posterior side of the trachea or is located subcutaneously. This additional confirmatory step will only use a few extra seconds but may prevent the accidental administration of a great volume of high pressure into an unintended space.

Once the catheter position has been confirmed, secure it in place and use the high-pressure wall system to deliver breaths in a 1:4 inspiratory-to-expiratory ratio (Figure 4). If possible, position the patient in the lateral recovery position to facilitate clearance of any debris in the airway above the insertion point.

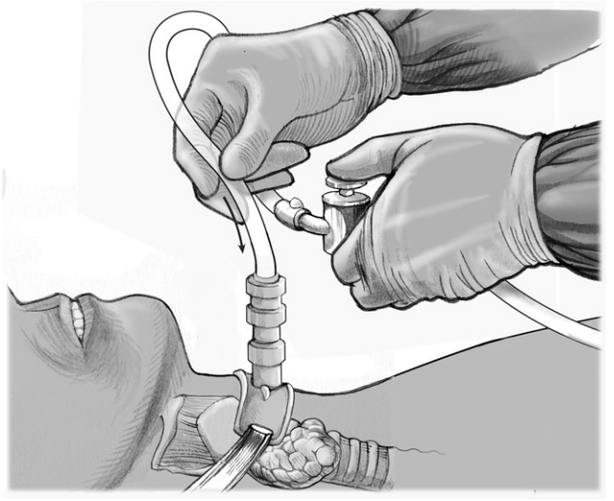

Figure 4 Device for administering high-pressure ventilation through a translaryngeal catheter (needle cricothyrotomy).

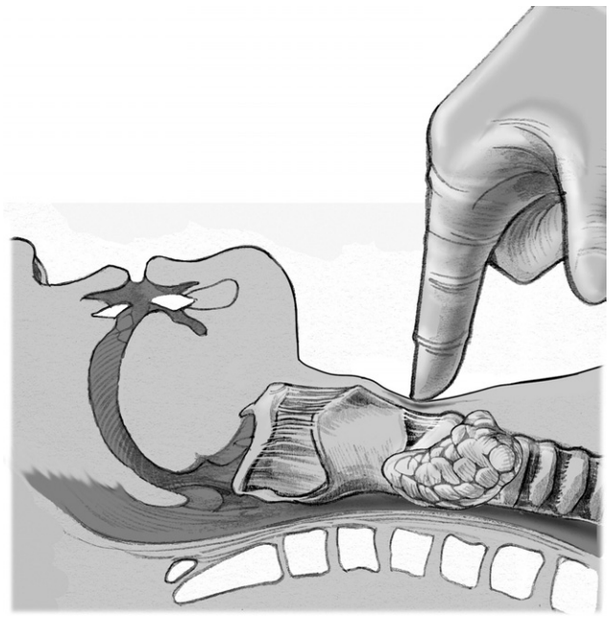

Figure 5 The cricothyroid membrane is located and palpated.

Surgical cricothyrotomy

Advantages

Surgical cricothyrotomy allows for the definitive securing of the airway by placement of a large cuffed endotracheal tube into the trachea through an insertion point at the cricothyroid membrane. This allows for low-pressure ventilation. Likewise, the tube can be more easily secured allowing for longer-term ventilation through this entrance point in the trachea. Additionally, the tube, once placed, allows for suctioning of the airway.

Disadvantages

The disadvantages center on the longer set-up time and time to complete the procedure required and a longer time until first ventilation of the patient[19] which may be significant if the patient has had a prolonged interval of nonventilation before the procedure commences. Likewise, there may be insufficient time to adequately anesthetize the area being operated on. It is important to realize that cricothyrotomy does not constitute an adequate airway for long-term ventilation and after patient stabilization a traditional elective tracheotomy should be performed to facilitate long term ventilatory support.

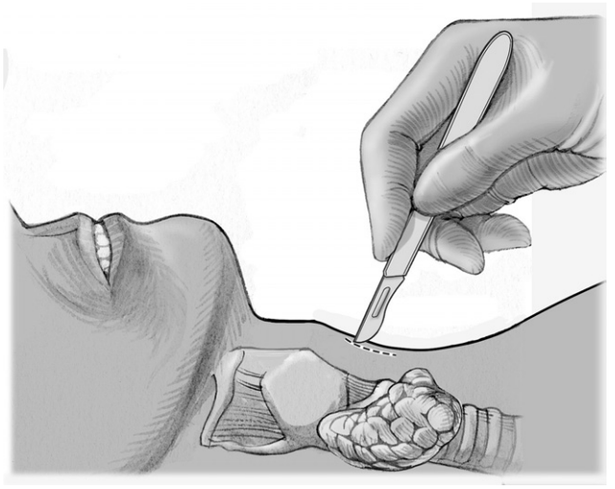

Figure 6 Using a scalpel, a midline incision approximately 1 to 1.5 cm long directly over the cricoid and thyroid cartilages. The incision should cut through the skin and subcutaneous tissues.

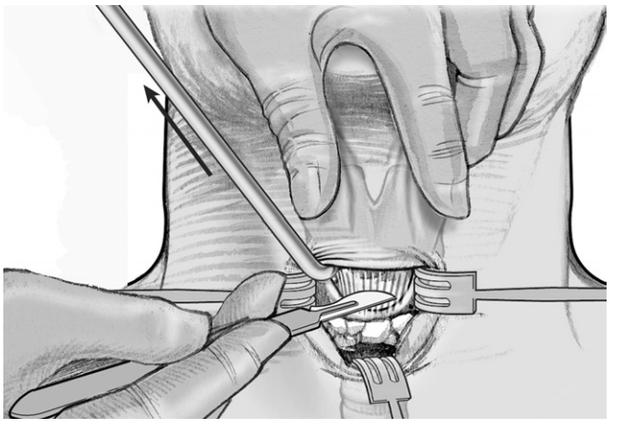

Figure 7 A horizontal incision is made through the cricothyroid membrane. A tracheal hook may be used to elevate the thyroid cartilage to provide greater exposure.

Surgical cricothyrotomy technique

Secure necessary equipment, that is, a no. 15 scalpel, hemostats, small tracheotomy tube or endotracheal tube (5.0, 5.5, or 6.0 in an adult), tracheal hook, scissors, and tracheal dilator (Trousseau) should be readily available if possible. The cricothyroid membrane is located and palpated (Figure 5). The nondominant hand becomes "fixed" and will not move until the procedure is completed and the airway controlled.[20]

A no. 15 scalpel is used to make a longitudinal midline incision approximately 1 to 1.5 cm long directly over the cricoid and thyroid cartilages (Figure 6). The incision is meant to be full thickness, which is cutting through the skin and subcutaneous tissues down to the cartilages. This is ideally accomplished in a single swipe.

The fingers of the stabilizing hand can now apply a slight increase in downward pressure, which will help draw the skin edges apart and allow visualization of the cricothyroid membrane. The scalpel is then used to make a transverse stab incision through the cricothyroid membrane into the airway (Figure 7).

The handle of the scalpel is next introduced into this membrane opening and rotated or the scalpel can be used to incise the membranes in the sagittal plane. Laying the scalpel aside, a tracheotomy or endotracheal tube is introduced into the trachea with the bevel of the tube pointed caudally (Figure 8). The balloon is then inflated and the tube is secured with umbilical tape around the neck.

Discussion

With the advent of newer airway devices, the emergency cricothyrotomy method is fortunately no longer commonly

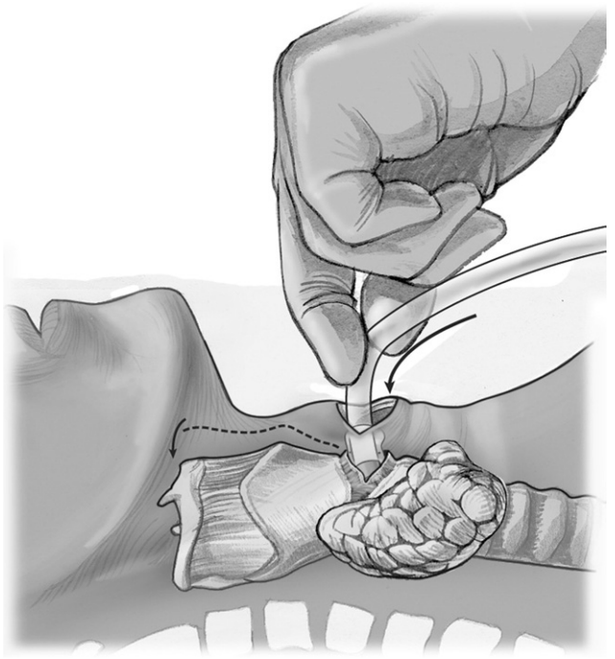

Figure 8 The tracheotomy tube is inserted through the cricothyroid membrane. The tracheal hook can be redirected to facilitate entry of the tracheotomy tube into position.

necessitated. Interestingly, this fact presents a unique challenge in maintaining adequate competency with this technique, as there may be few, if any, instances during a practitioner's career during which this technique will be necessitated. It is recommended that practitioner's who wish to make this a part of their treatment arsenal find means to practice this technique on mannequins, cadavers, or suitable animal models. As a last resort, this technique does have the ability to avert catastrophe in the patient for whom no other airway means of adequate ventilation or oxygenation can be secured.

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