CHAPTER 3

Surgical Airways: Tracheostomy and Cricothyroidotomy

Gregory J. Jurkovich and Darwin Noel Ang

Percutaneous Tracheostomy with the Ciaglia Blue Rhino

Clinical Anatomy

- The key landmarks to this surgery are the thyroid notch, cricothyroid cartilage, sternal notch, and median raphe. Structures to avoid are the anterior jugular veins and thyroid gland.

Preoperative Considerations

- Favorable anatomy
  - The patient's airway should accommodate a standard tracheal airway appliance. Short, fat, deep necks that would require extensive dissection or a modified tracheal appliance, such as an XLT extended-length tracheostomy tube, are not suited for percutaneous tracheostomy.
  - Ideally, the cricoid cartilage should be palpated at least a few centimeters above the sternal notch.
- Positioning of the patient
  - The patient should be in a supine position with hyperextension of the neck for maximal exposure of the trachea. A folded towel or blanket can be placed behind the patient's shoulder blades to help with extension of the neck.
  - If the patient has a cervical collar or neck injury, the anterior portion of the cervical collar can be removed; there should be minimal extension of the neck.
- Number of operators
  - There should be a minimum of two operators. One should be assigned to management of the airway and performance of bronchoscopy. The other individual should be in charge of the surgical technique and placement of the tracheostomy.
  - Ideally, a nurse and respiratory therapist should be present as bedside assistants.

- Precautions
  - Preparation is required for endotracheal intubation and open tracheostomy. Available equipment should include laryngoscope, extra endotracheal tube, rapid sequence induction agents, bag-mask apparatus, and tracheostomy surgical tray.

Operative Steps

- After landmarks are identified, local anesthetic is applied to the sterile operative field.
- We prefer a small vertical skin incision along the axis of the trachea over the second tracheal ring, about 1.5 cm in length, long enough to allow dissection and ease of passage of the blunt dissector and tracheostomy tube (Figure 3-1A).
- The pretracheal tissue is bluntly dissected with hemostats (Figure 3-1B). The median raphe is identified past the platysma, and the avascular plane leads directly to the pretracheal fascia. The second and third tracheal rings are then visualized. This may require retraction superiorly or inferiorly of the thyroid isthmus with a Cushing vein retractor. We rarely divide the isthmus.
- The bronchoscopist places the tip of the bronchoscope at the tip or just past the endotracheal tube.
- The bronchoscopist withdraws both the endotracheal tube and bronchoscope until the light source can be seen through the surgical wound.
- The tracheal lumen is then entered below the second tracheal ring with an introducer needle with plastic sheath. This needle and sheath are visualized by the bronchoscope. Care must be taken not to puncture the bronchoscope (Figure 3-1C).
- The needle is removed, the plastic sheath is left in place, and a guide wire is placed through the sheath. Again, this is done under direct visualization with the bronchoscope.
- The tracheal lumen is then serially dilated over a guide wire, first with the 14.0 French dilator, then followed by the Ciaglia Blue Rhino with EZ-Pass hydrophilic-coated percutaneous tracheostomy dilator. Keys to this step are to ensure full passage to the indicator mark on the large dilator (Figure 3-1D).
- The tracheostomy appliance is then placed into the tracheal lumen with the appropriately sized loading catheter tube advanced over the guide wire and under direct bronchoscopic vision. The loading catheter and guide wire are removed and the inner cannula of the tracheostomy is placed. The balloon is inflated. The ventilator is then connected to the tracheostomy appliance (Figure 3-1E).
- Placement is confirmed by both end-tidal CO_2 and direct visualization of the carina through the newly placed tracheostomy appliance. The tracheostomy is then secured with four separate sutures of 3-0 nylon (Figure 3-1FG).

Postoperative Care

- The ventilator settings should remain the same.
- It is rare to have postprocedure bleeding, but if it happens, it can be treated with packing.
- Obtain a postprocedure chest radiograph to exclude pneumothorax or pneumomediastinum.

Pearls and Pitfalls

- Finding the avascular plane will avoid injury to any bridging veins from the anterior jugular.
- If the thyroid is encountered, it is usually not necessary to divide its isthmus. Instead, dissect the isthmus off the trachea; this will allow it to be retracted superiorly (preferred) or inferiorly for maximal exposure of the trachea.

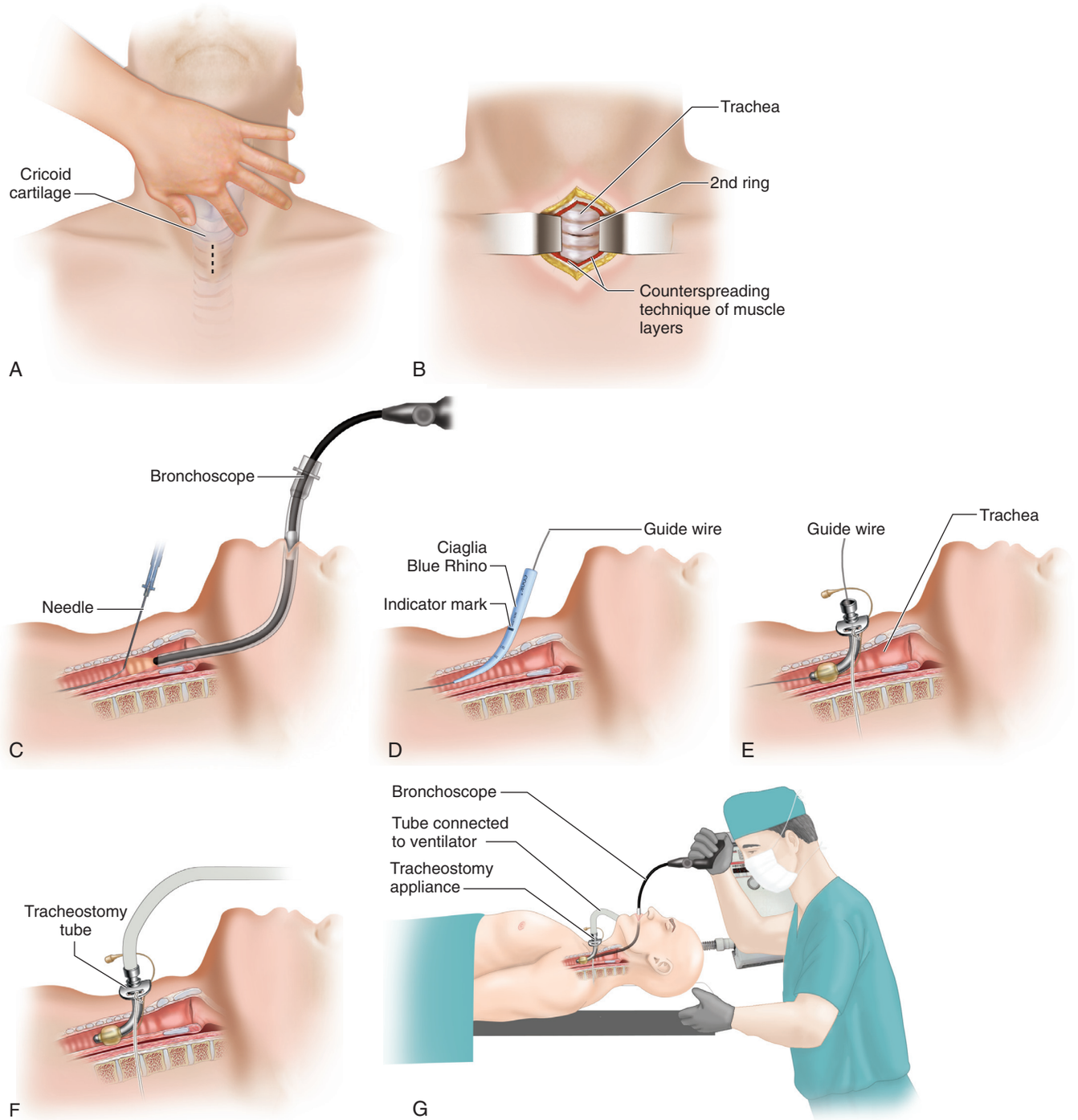

Figure 3-1

- It is important that the operator of the bronchoscope withdraw both endotracheal tube and bronchoscope simultaneously. If this responsibility is shared by two people, coordination of withdrawal can be mistimed, and the risk of airway loss is increased.
- If the airway is lost, manually ventilate the patient with an Ambu bag and reestablish the airway by means of endotracheal tube. The procedure can be repeated if there is minimal decompensation.

Open Tracheostomy

Clinical Anatomy

- The key landmarks to this surgery are the cricothyroid cartilage, sternal notch, and median raphe. Structures to avoid are the anterior jugular veins and thyroid.

Preoperative Considerations

- Tracheostomies are reserved for those for whom attempts at extubation have failed secondary to either pulmonary or neurologic compromise and for those with extensive maxillofacial injuries precluding oral or nasotracheal intubation.
- Positioning of the patient
  - The patient should be in a supine position with hyperextension of the neck for maximal exposure of the trachea. A folded towel or blanket can be placed behind the patient's shoulder blades to help with extension of the neck.
  - If the patient has a cervical collar or neck injury, the anterior portion of the cervical collar can be removed with minimal extension of the neck.
- Planning for life-threatening loss of the airway
  - Discuss a plan with the anesthesiologist should loss of airway occur. Reintubation of the patient is the most logical step; however, with an inexperienced team, this may be overlooked.

Operative Steps

- After landmarks are identified, local anesthetic with epinephrine is applied to the sterile operative field.
- We prefer a small vertical skin incision along the axis of the trachea over the cricothyroid cartilage extending inferiorly about two or three tracheal rings. Alternatively, a transverse incision in a semilunar fashion also two fingerbreadths above the sternal notch may be employed. A transverse incision approximately two fingerbreadths above the sternal notch is the incision most frequently used (Figure 3-2A).
- Midline dissection down to the pretracheal tissue can be done bluntly by a counterspreading technique with hemostats or with electrocautery. For this step to remain relatively avascular, it is essential that the median raphe be identified past the platysma and the avascular plane followed to the pretracheal fascia. The second and third tracheal rings are then visualized (Figure 3-2B).

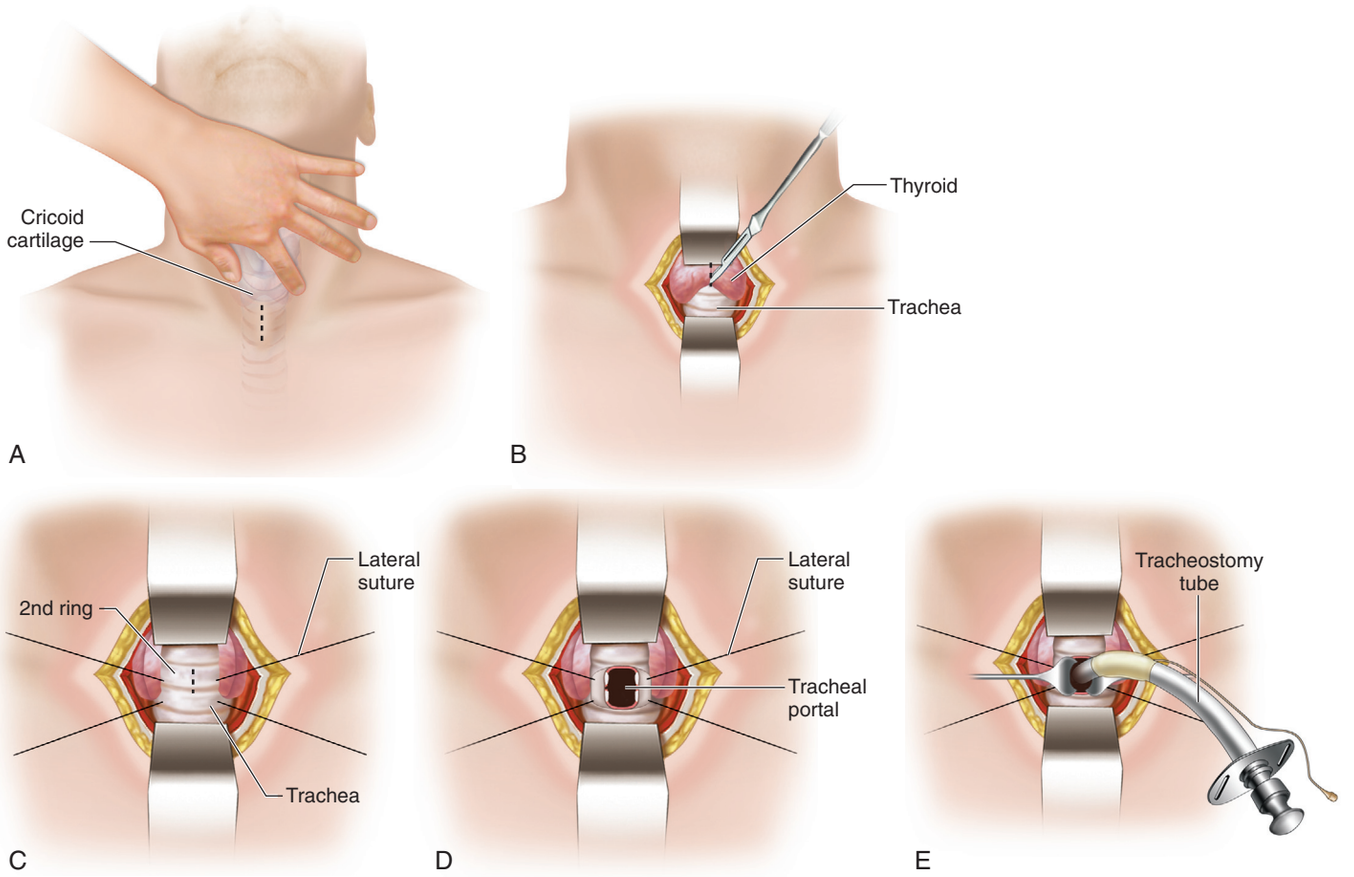

Figure 3-2

- If the isthmus of the thyroid is identified, it can be bluntly dissected off the trachea and retracted superiorly for exposure of the second through fifth tracheal rings. A Cushing vein retractor is useful, or alternatively a Kittner dissector may also be employed. If this is not possible, the isthmus is divided with electrocautery and retracted to expose the trachea.
- Two stay sutures are then placed laterally on either side of the midbody of the exposed trachea. A 2-0 polypropylene suture on a small curved but stout noncutting needle is ideal, passed just behind the second ring without entering the tracheal lumen to serve as traction sutures (Figure 3-2C).
- Creating the tracheal defect
  - Many techniques are described. We prefer a simple vertical incision along the axis of the trachea across two tracheal rings, with or without a T between tracheal rings as an extension. Once the stay sutures are pulled up, there is a good-sized defect for the tracheal appliance to be placed safely. An alternative is a cruciate incision between the second and third tracheal rings (Figure 3-2D).
- A tracheal hook is applied firmly to the cricothyroid cartilage (first tracheal ring) to elevate the trachea and provide excellent security for the next steps.
- The anesthesiologist withdraws the endotracheal tube with the balloon slightly deflated. When the tip of the endotracheal tube is superior to the defect, the tracheostomy tube is quickly placed into the trachea. This is generally facilitated with a two-pronged Trousseau or three-pronged Laborde tracheal dilator along with the aforementioned tracheal hook (Figure 3-2E).
- Gentle retraction on the tracheal stay sutures is maintained. The retractors are removed. The inner cannula is substituted for the tracheal introducer. The balloon is then inflated. The patient is then ventilated through the new tracheostomy tube.
- Placement is confirmed by both end-tidal CO_2 and equal chest wall movement. Direct visualization of the carina through the newly placed tracheostomy appliance is optimal if a bronchoscope is available. The tracheostomy is then secured.

Postoperative Care

- The ventilator settings should remain the same.
- It is rare to have postprocedure bleeding, but if it happens, it can be treated with packing.
- Obtain a postprocedure chest radiograph.

Pearls and Pitfalls

- Identify and confine dissection to the midline.
- If bleeding occurs, pressure is the preferred method of control.
- If the thyroid isthmus must be divided, go slowly with the electrocautery. Alternatively, the isthmus may be divided after the use of right-angle Jackson clamps and suture ligated with horizontal mattress sutures.
- Do not use electrocautery once the trachea has been opened. A spark can ignite the oxygenated field.
- If the patient has a deep neck or the trachea descends at a steep angle away from the sternum, a tracheal hook is helpful in exposure. Use the hook to grasp the cricoid cartilage and pull in a cephalad and outward direction.
- A false track occurs most commonly when there is mismatched anatomy to tracheostomy appliance. Always have different-sized tracheostomy appliances if the patient appears to have abnormal or deep neck anatomy.

Cricothyroidotomy

Clinical Anatomy

- The key landmarks to this surgery are the thyroid notch, larynx, cricothyroid ring and space, and sternal notch. Structures to avoid are the recurrent laryngeal nerves, anterior jugular veins, and thyroid. This technique is contraindicated in pediatric patients younger than 12 years.

Preoperative Considerations

- Indication
  - This is an emergent airway procedure and should be used only if an oral endotracheal airway cannot be achieved.
- Instruments
  - Tracheostomy tray
  - No. 10 blade scalpel
  - Curved hemostat, preferably Halsted mosquito clamps
  - Tracheal hook

Operative Steps

- Using the nondominant hand, palpate the thyroid and cricoid cartilages. Use the thumb and middle finger to stabilize the thyroid cartilage, with the elbow pointing toward the patient's head (Figure 3-3A).
- Use the index finger to identify the cricothyroid membrane above the cricoid cartilage.
- Make an incision over the membrane. A vertical incision will avoid transection of the cricoid cartilage, which may happen with vertical incisions, especially in inexperienced hands, resulting in catastrophic consequences (Figure 3-3B).
- Dissect down through the pretracheal tissue with the No. 10 blade. Use a hemostat or a Halsted mosquito clamp to counterspread once over the membrane.
- Make a horizontal incision over the cricothyroid membrane. Gently dilate the cricothyroid membrane longitudinally and horizontally with the Halsted mosquito clamps. Insert the tracheal hook into the defect and pull up and out (Figure 3-3C).
- Insert the tracheostomy appliance or endotracheal tube. Inflate the cuff and ventilate the patient. Watch for end-tidal CO_2 and listen for bilateral breath sounds (Figure 3-3D).

Postoperative Care

- This airway is not permanent and should be converted to a formal tracheostomy after 72 hours.
- Pack all bleeding with gauze.
- Obtain a postprocedure chest radiograph.
- Be aware that pneumothoraces may develop from forceful ventilations, including bilateral pneumothoraces.

Pearls and Pitfalls

- If an endotracheal tube is used, usually 5 cm is a safe distance for insertion.
- Do not forget to move your fingers out of the way when making the horizontal incision.

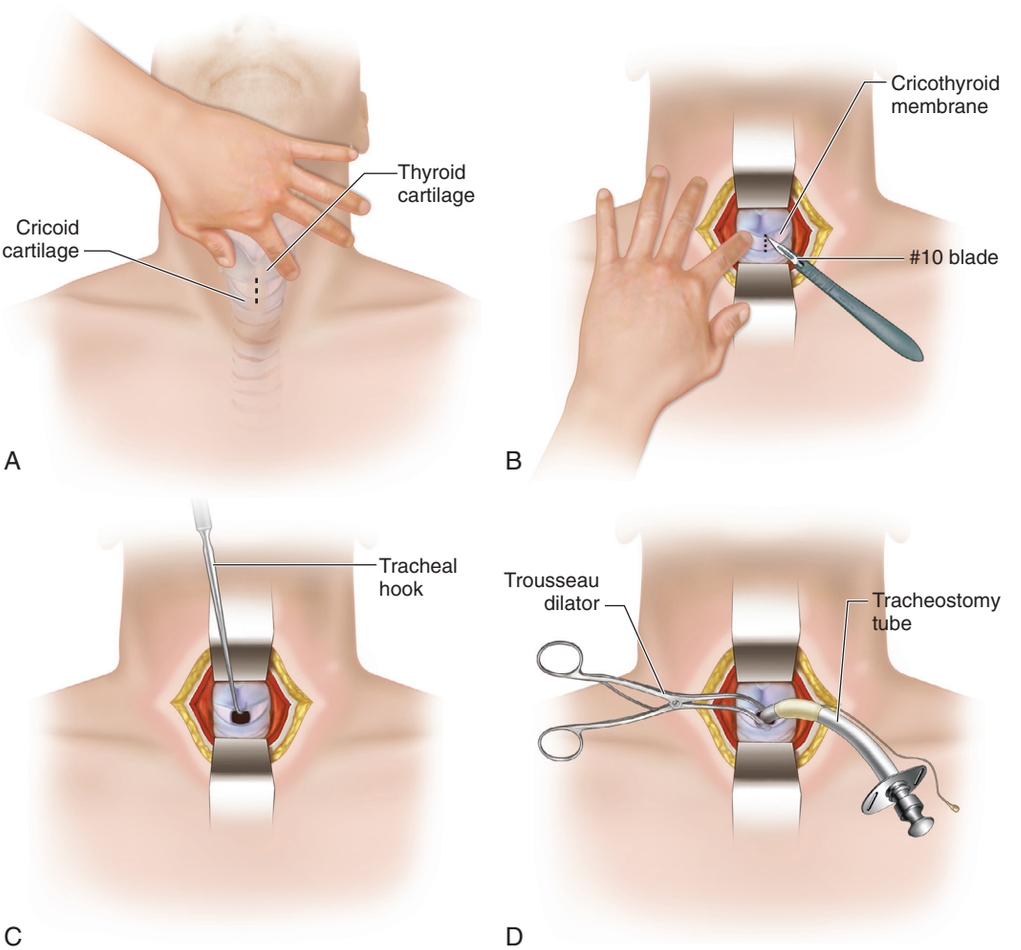

Figure 3-3

Needle Cricothyroidotomy

Clinical Anatomy

- The key landmarks to this surgery are the thyroid notch, larynx, cricothyroid ring and space, and sternal notch. Structures to avoid are the recurrent laryngeal nerves, anterior jugular veins, and thyroid.

Preoperative Considerations

- Indication
  - This is the last of all airways to consider. It is reserved as a temporizing measure. This airway is more effective in small children than it is in adults.
- This airway is effective in sustaining life for approximately 30 minutes.
- Instruments
  - 14-gauge angiocatheter with needle
  - 10-mL syringe half filled with water
  - Jet ventilation system or 3-mL syringe connected to bag-valve-mask by an endotracheal tube adapter for manual ventilation

Operative Steps

- Using the nondominant hand, palpate the thyroid and cricothyroid cartilages. Use the thumb and middle finger to stabilize the thyroid cartilage, with the elbow pointing toward the patient's head (Figure 3-4A).
- Use the index finger to identify the cricoid membrane below the thyroid cartilage.
- Insert the 14-gauge angiocatheter attached to the 10-mL syringe at a 45-degree angle into the cricothyroid membrane. Aspirate until air bubbles are present and then advance the angiocatheter (Figure 3-4B).
- Connect the jet ventilation for mechanical ventilation or attach the modified bag-valve-mask for manual ventilation (Figure 3-4C).
- Watch for end-tidal CO_2 or watch for expansion of the chest.

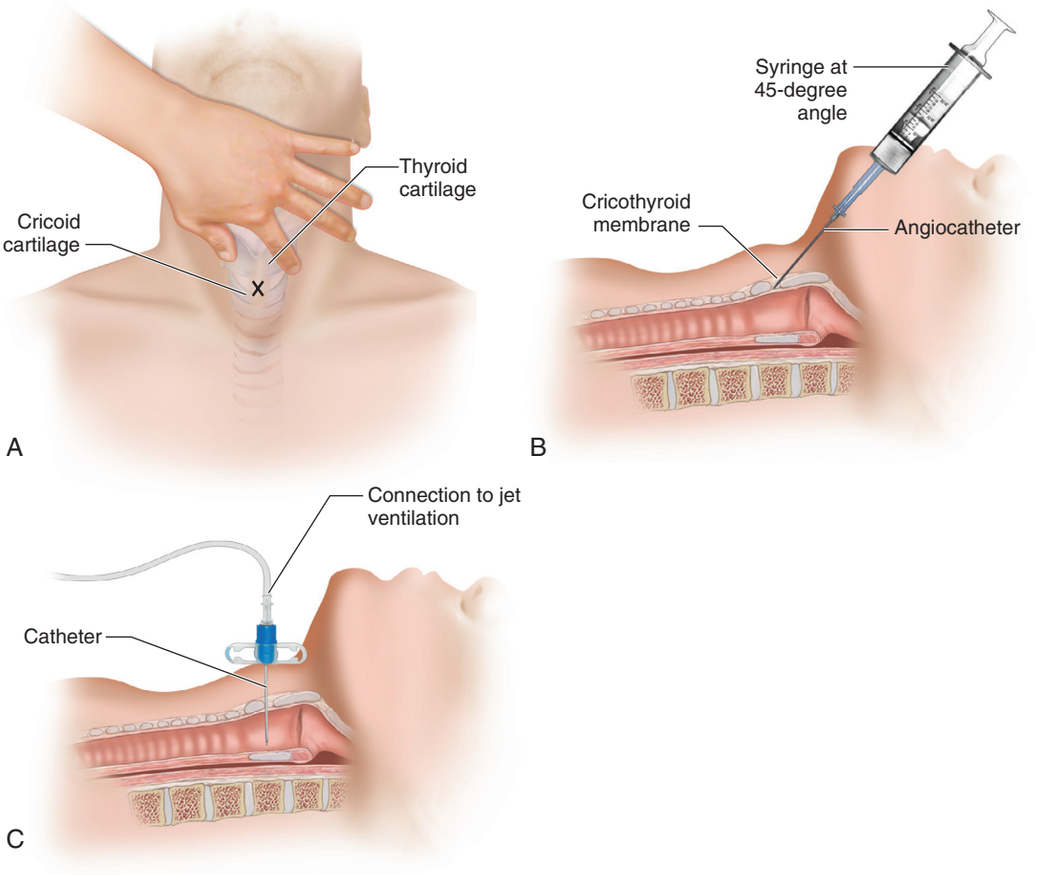

Figure 3-4

Postoperative Care

- Because this is a temporary airway, a more durable airway, such as a formal tracheostomy, must be established immediately in the operating room.

Pearls and Pitfalls

- The angiocatheter will bend easily. Any sudden movement will lose the airway.
- Remember, there is no way to secure this airway to the patient. There must be a person who is responsible for keeping the airway attached to the patient.

Selected Readings

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