Section 1

Operating Room General Conduct

Chapter 1

Trauma operating room

Kenji Inaba and Lisa L. Schlitzkus

Operating room

- A large operating room (OR) situated near the emergency department, elevators, and ICU should be designated as the Trauma OR to facilitate the logistics of patient flow and minimize transport. The room should be securable for high profile patients.
- A contingency plan for multiple simultaneous operations should be in place with the operating rooms in sufficient proximity to allow nursing and anesthesia cross-coverage and facilitate supervision of the surgical teams. Direct lines of communication between the OR and the resuscitation area, ICU, other ORs, blood bank, and laboratory should be in place.
- All rooms should have ample overhead lighting as well as access to portable headlamps.
- Multiple monitors to display imaging, vital signs, and laboratory data such as thromboelastometry should be in place.
- Hybrid operating and interventional radiology suites are ideal. Both the surgical and radiology teams should be familiar with operating in the hybrid room.
- A dedicated family waiting room should be identified, and all family should be directed to this area for the postoperative discussion.

Atlas of Surgical Techniques in Trauma, ed. Demetrios Demetriades, Kenji Inaba, and George Velmahos. Published by Cambridge University Press.

Fig. 1.1. Hybrid operating room setup.

Setup and equipment

- Nursing staff should be regularly in-serviced about the trauma room setup, supplies, and common practices such as massive transfusion to minimize problems due to service line cross-coverage.
- While all attempts should be made to count instruments and ensure a correct final count, this may be postponed in life-threatening or damage control situations. Radio-frequency ID device embedded laparotomy sponges are a useful adjunct to these emergency situations.

The following should be readily available:

- instrument trays including laparotomy, sternotomy with pneumatic sternal saw, thoracotomy, emergency airway, amputation, and peripheral vascular
- a wide selection of vascular shunts, catheters, vascular conduits, chest tubes, drains, staplers, local hemostatic agents, advanced thermal cutting devices, and temporary abdominal closure supplies
- standard suture tree including sternal closure wires, vascular sutures, and liver sutures
- adult and pediatric code cart
- high volume suction canister and device
- tourniquets
- endotracheal tube occluders
- rigid sigmoidoscope, bronchoscope, gastroscope
- portable fluoroscopy and personnel shielding devices should be immediately available for use in the OR
- an electrothermal bipolar vessel sealing system device (LigaSure device) is desirable.

Warming

- Due to the large surface area exposed, trauma patients are susceptible to hypothermia.
- The room should not be cold.
- Forced air blankets should be used.
- Warmed intravenous fluids should be available at all times.
- All irrigation fluids should be warmed.

Blood

- A type and screen should be sent immediately to the laboratory upon patient arrival to the emergency department.
- Emergency release products (uncross-matched O− or O+ packed red blood cells as well as thawed AB or low titer A plasma) should be readily available in the emergency department and in the operating room.
- A rapid transfusion device should be available.

Fig. 1.2. Emergency release blood products stored in a refrigerator in the emergency department or operating room available for immediate use. Can contain uncrossed matched O+ or O− packed red blood cells and AB or low titer A plasma.

Section 2 **Resuscitative Procedures in the Emergency Room**

Chapter 2

Cricothyrotomy

Peep Talving and Rondi Gelbard

Surgical anatomy

- The cricothyroid membrane lies between the cricoid and thyroid cartilage and is bordered laterally by the cricothyroid muscles. In adults it is about 1 cm in height and about 2–3 cm wide, including the area covered by the two cricothyroid muscles. The actual membrane between the two muscles is approximately 1 cm wide.
- The cricoid cartilage is the only complete ring in the trachea. It serves as a stent supporting the airway and is an important attachment point for muscles and ligaments.
- The vocal cords are attached to the internal anterior surface of the thyroid cartilage, about 1 cm from the upper border of the cricothyroid membrane.
- Localizing the cricothyroid membrane rapidly can be critical in managing the difficult airway. If soft tissue trauma or obesity prevents clear identification of the thyroid and cricoid cartilage, with the neck in neutral position, place the tip of the small finger of the extended hand in the suprasternal notch. The tip of the index finger will touch the cricothyroid membrane in the midline.

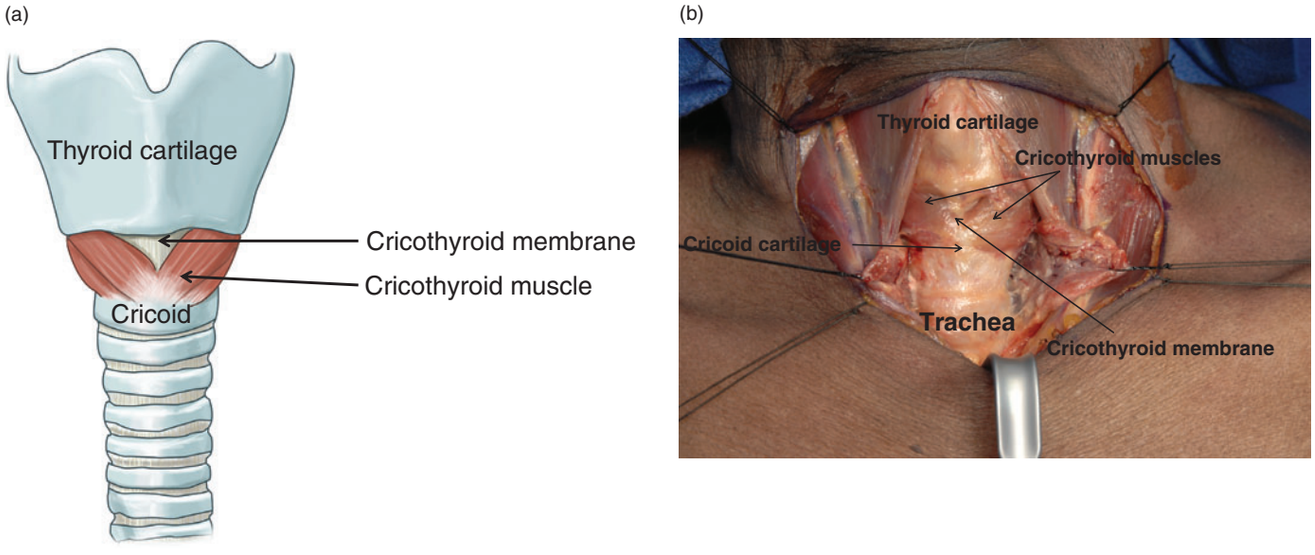

Fig. 2.1(a), (b). Anatomy of the cricothyroid space. The cricothyroid space includes the inferior border of the thyroid cartilage and the superior rim of the cricoid arch that are connected by the cricothyroid membrane, and are partially covered by the cricothyroid muscles.

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(a)

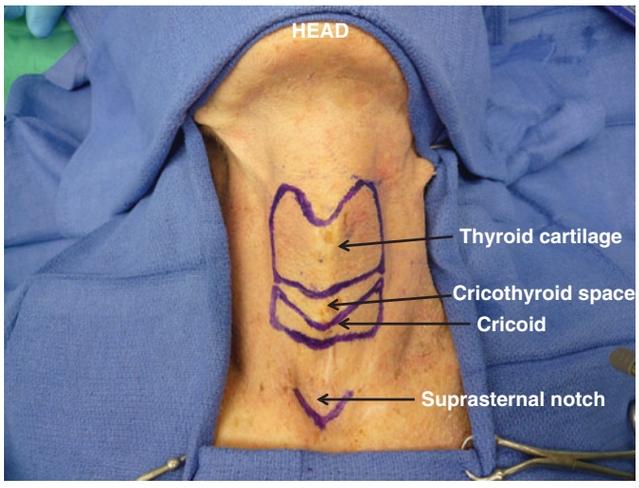


Fig. 2.2(a). Surface anatomy of the cricothyroid space. The cricothyroid space includes the inferior border of the thyroid cartilage and the superior rim of the cricoid arch. In adults the cricothyroid membrane is about 1 cm in height and about 2–3 cm wide.

(b)

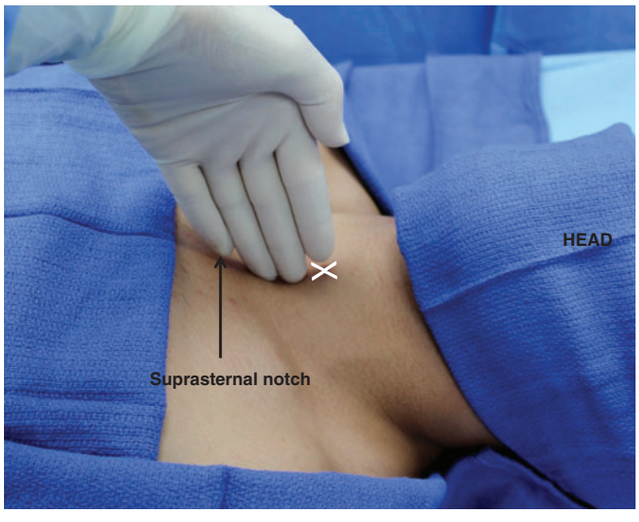


Fig. 2.2(b). Photograph demonstrating the four-finger technique for identifying the cricothyroid membrane. With the palm extended, the tip of the small finger is placed in the suprasternal notch. The tip of the index finger touches the cricothyroid membrane in the midline (x).

General principles

- Cricothyrotomy is indicated in patients requiring emergent airway management who cannot be intubated by the oral or nasal route, and cannot be oxygenated with alternative rescue techniques such as the Laryngeal mask airway, or Combitube. Severe maxillofacial trauma, or edema of the glottis are common conditions requiring cricothyrotomy.
- Cricothyrotomy is relatively contraindicated in patients under 8 years of age, because of the small size of the cricothyroid membrane and propensity to develop post-procedure stenosis. In these pediatric patients, needle jet insufflation should be considered. For patients with suspected tracheal transection, this procedure should also be avoided.
- There is no evidence to support routine conversion of a cricothyrotomy to a formal tracheostomy.

Special instruments

- The open cricothyrotomy instrument set should include endotracheal and tracheostomy tubes (size 6 French), scalpel, tracheal hook, Senn retractors, Kelly clamp, Metzenbaum scissors, and forceps.
- Suction with an endoluminal suction catheter attachment.
- Alternatively, commercially available percutaneous cricothyrotomy sets can also be used.
- End-tidal CO_2 detector should be available.
- Adequate lighting.

(a)

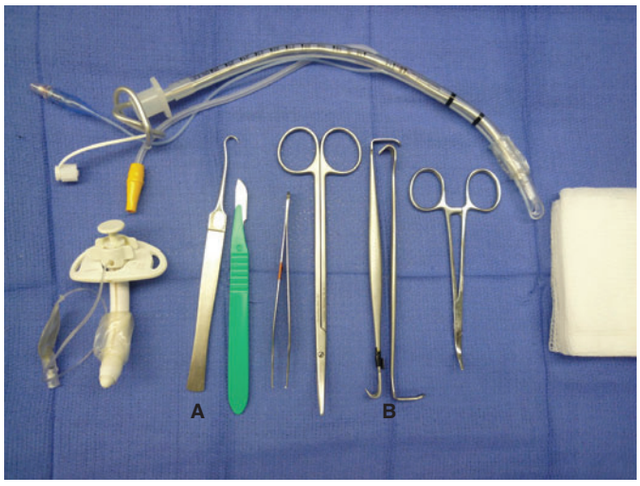


Fig. 2.3(a). Open cricothyrotomy instrument set should include endotracheal and tracheostomy tubes, scalpel, tracheal hook (A), Senn retractors (B), Kelly clamp, Metzenbaum scissors, and forceps.

(b)

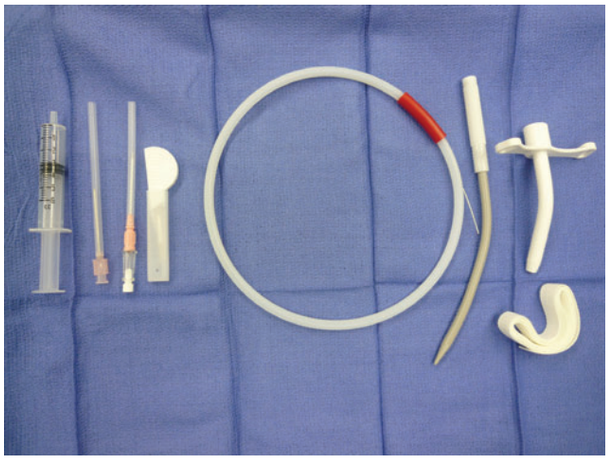


Fig. 2.3(b). Commercial percutaneous cricothyrotomy set.

Patient positioning

- Supine, with the neck in neutral position if the cervical spine has not been cleared. If cleared, the neck should be extended to facilitate this procedure.

Fig. 2.4. The neck is in neutral or slightly extended position. The trachea is immobilized between the thumb and middle finger of the non-dominant hand to prevent lateral movement of the trachea during the procedure. The index finger may be used to palpate the cricothyroid space.

Technique

Percutaneous cricothyrotomy

- Begin with a 5 mm long vertical skin incision. In patients with a short and thick neck it may be difficult to palpate the cricothyroid membrane. The "four-fingers technique" as described above can help identify the cricothyroid space. This will localize the area where the initial skin incision should be made. Once the skin incision is made, re-examine the anatomy. Once the skin is breached, the underlying structures will become easier to localize. The skin incision must be sufficiently large to allow entry of the tube. Insufficient incision length is a common pitfall.
- Stabilize the thyroid cartilage between the thumb and the middle finger of the non-dominant hand to facilitate palpation of the anatomical landmarks and immobilize the airway during the procedure.
- With the dominant hand, insert the needle into the cricothyroid membrane directed caudally at a 45° angle. If time is available, the needle can be attached to a syringe that is filled with normal saline to visualize entry into the airway.
- As the needle is advanced, apply negative pressure to the syringe.
- Advance the needle until it traverses the membrane and enters the trachea, signaled by a distinct pop and aspiration of air. If saline was placed in the syringe, bubbles will be seen.
- Remove the needle and syringe, leaving the catheter in place. Advance the guide wire through the catheter. The catheter can then be removed.
- Place the dilator into the airway catheter, and insert both the dilator and catheter together over the guidewire, ensuring that guidewire is not advancing with the cannula/dilator complex.
- Remove both the dilator and the guidewire once the airway tube is secured in the trachea.
- Secure the tube in place.

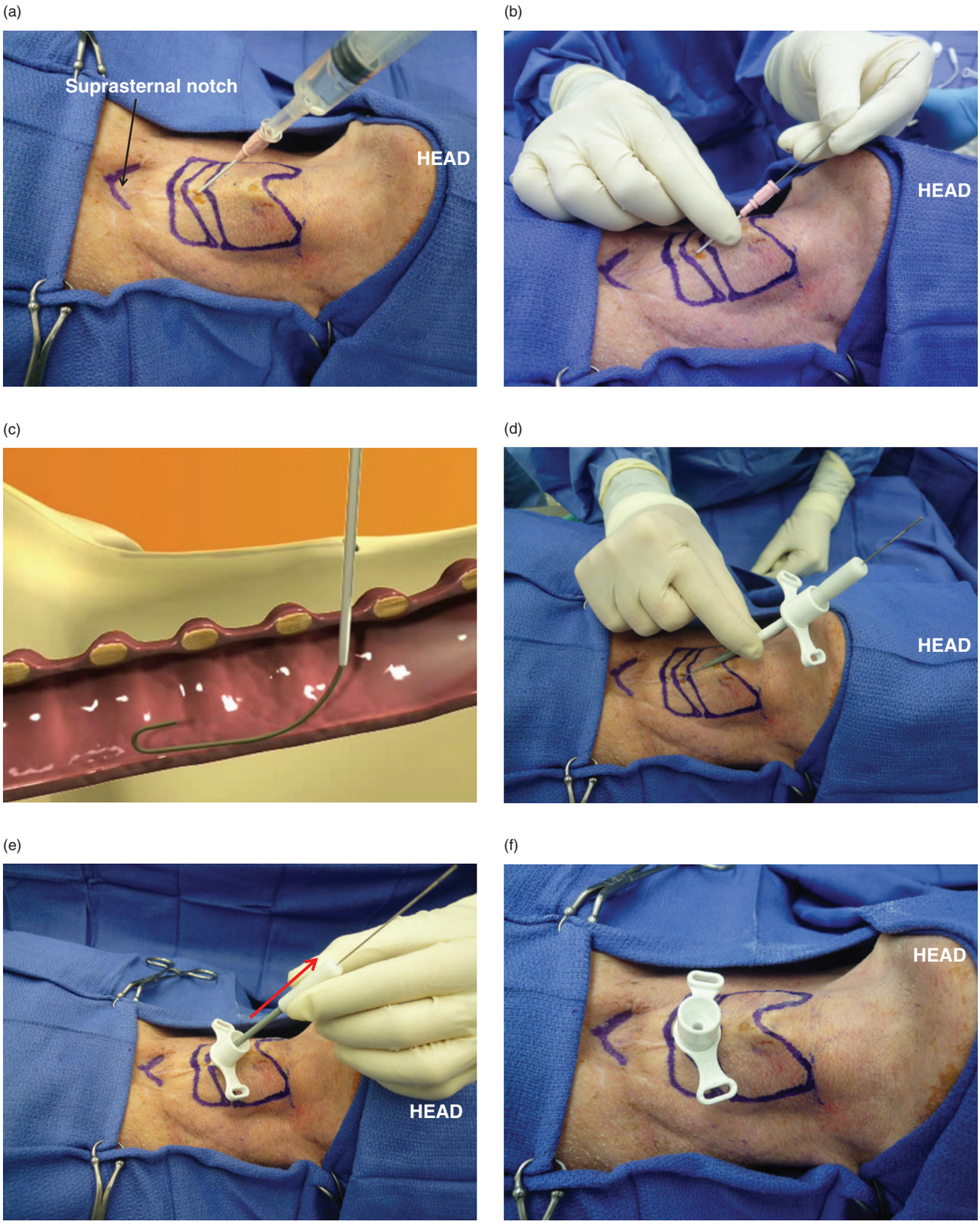


Fig. 2.5(a)–(f). Technique of percutaneous cricothyrotomy. The finder needle attached to a saline-filled syringe is inserted into the cricothyroid membrane, directed caudally at a 45° angle to avoid puncturing the posterior wall of the trachea. The needle and syringe are removed, leaving the small catheter in place. The guidewire is advanced through the catheter, and the catheter is removed once the guidewire is in place (b) and (c). The assembled dilator and airway catheter are inserted together, over the guidewire, into the trachea (d); the guidewire and dilator are removed once the airway tube has been secured (e); airway cannula in place (f).

Open cricothyrotomy

- With the non-dominant hand, stabilize the thyroid cartilage between the thumb and index finger.
- With the dominant hand, make a 3 cm midline vertical incision over the cricothyroid membrane. A transverse incision is an acceptable option, but a vertical incision is preferred because there is a decreased risk of bleeding from the anterior jugular veins and the incision is more versatile as it can easily be extended.
- Utilize the thumb and index finger of the non-dominant hand that is stabilizing the cartilage to retract the skin, exposing the cricothyroid membrane. Senn retractors can be utilized for exposure if an assistant is available.
- Make a horizontal stab incision through the cricothyroid membrane.
- If practical, perform the incision in the lower half of the cricothyroid membrane, along the superior border of the cricoid cartilage, in order to avoid injuring the cricothyroid artery which courses through the superior half of the cricothyroid membrane.
- Insert the tracheal hook at the superior end of the cricothyroid incision and retract the thyroid cartilage cephalad.

(a)

Fig. 2.6(a). Technique of open cricothyrotomy. The trachea is immobilized with the non-dominant hand. A 3-cm midline vertical skin incision is performed over the cricothyroid membrane.

(b)

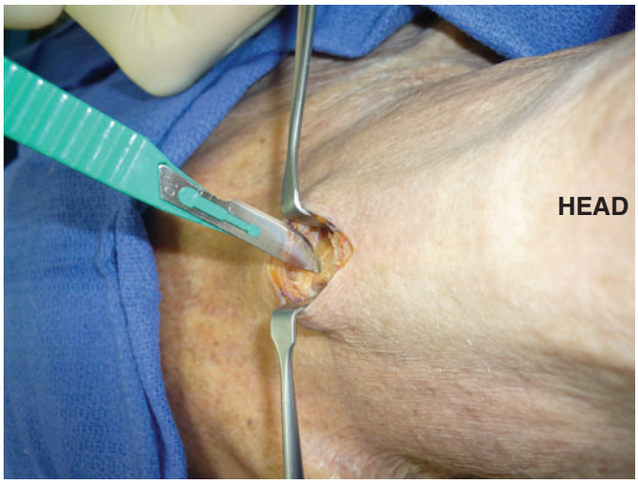
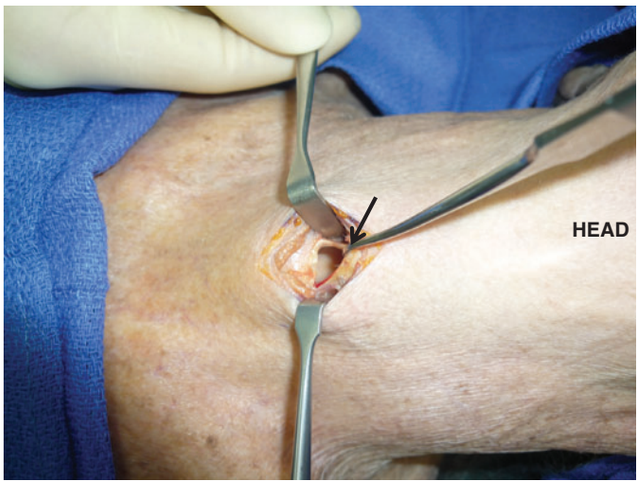


Fig. 2.6(b). A horizontal incision is made through the cricothyroid membrane to enter the trachea. This incision should be made in the lower half of the cricothyroid membrane, along the superior border of the cricoid cartilage, in order to avoid injuring the cricothyroid artery.

(c)



(d)

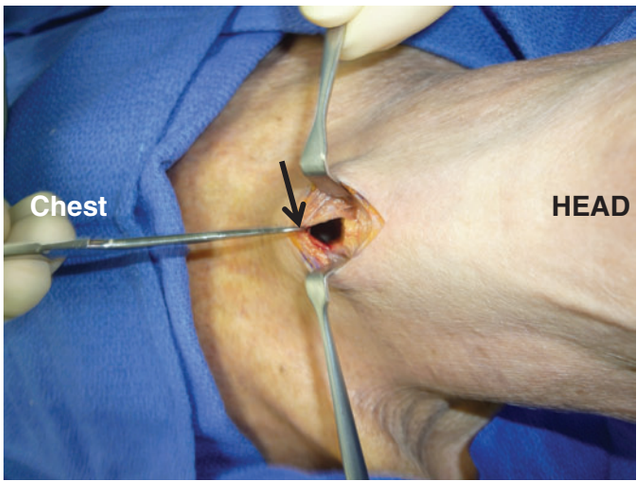


Fig. 2.6(c), (d). Following entry into the trachea, a tracheal hook is placed at the edge of the thyroid cartilage (arrow), and firm retraction is applied upward and toward the head (c). Alternatively, the tracheal hook may be placed inferiorly, on the cricoid ring with traction toward the patient's chest (d). The skin incision is retracted laterally, with Senn retractors.

- With the dominant hand, insert the cricothyrotomy tube into the trachea.
- Having the obturator in place will aid in this process. Once seated in the airway, the obturator is removed and the inner cannula can be inserted.
- Inflate the balloon with 5–10 mL of air, and confirm placement with observation of chest rise, auscultation, and assessment of end-tidal CO_2.
- Secure the tube in place and clear the airway of blood and secretions by suctioning through the cricothyrotomy tube.

(e)

(f)

Fig. 2.6(e), (f). Insertion of the airway cannula in a caudal direction. Airway access is obtained, and appropriate location of the airway cannula is ensured with end-tidal CO_2.