

## Core Messages

- › The tracheal wall is incised between the second and third tracheal ring. The cricoid should be palpated before tracheal incision to determine the correct level at which to enter the trachea.
- › Opening of the trachea with an inferiorly based flap is recommended.
- › To avoid subcutaneous emphysema, pneumothorax, and infection, a tracheotomy wound is never closed tightly around the tube.
- › Setting of threads is useful for stoma opening and tracheostomy tube introduction in children helpful for the stoma opening and tracheostomy tube reinsertion.
- › Percutaneous dilatation tracheostomy (PCDT), when performed by experienced surgeons is safe and easy to perform with a low complication rate.
- › PCDT is suitable only in adult patients without a midline neck mass and if cricoids cartilage can be palpated above the sternal notch.
- › We strongly recommend this technique with good airway control by anesthetists or intensivists, under direct vision with fiberoptic during the procedure.

## 11.1 Introduction

Tracheostomy is one of the oldest surgical procedures in the history of head and neck surgery. The evolution of tracheotomy stretches back over many centuries. It has been performed for more than 2000 years, but the first successful well documented tracheotomy is attributed to Antonio Musa Brasavolo in 1546. In 1932, Chevalier Jackson [1, 2] standardized the technique and taught the medical community about a well performed tracheotomy and routine surgical care; more specifically, he pointed out the side effects of “the high tracheotomy.” The procedure is described as a potential lifesaving surgery performed sometimes in emergency situations but more often as a planned surgery in the operating room or intensive care unit.

Tracheotomy is a surgical opening into the trachea. It is performed for the purpose of ventilation or/and pulmonary toilet. Today, in the English-language literature the term tracheotomy and tracheostomy are used interchangeably. To clarify, *tracheotomy* is used here for the procedure of opening the trachea and *tracheostomy* as a permanent opening and exteriorizing the trachea to the cervical skin until the opening has become epithelialized. Performed under ideal circumstances (in an operating room, as an elective procedure, on a patient with a slender neck without airway obstruction), tracheotomy is a simple, safe, easy procedure.

Successful management of the airway requires a complete understanding of the structure and function of the upper aerodigestive tract. The goal is to apply the appropriate solution for each specific case to avoid complications and a life-threatening situation.

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This chapter is design to provide information about the following.

- Indications for tracheotomy
- Decision making for open neck tracheotomy versus percutaneous tracheotomy
- Surgical technique
- Management of the tracheostomy

## 11.2 Indications for Tracheotomy

Tracheotomy means “making a stoma into the trachea.” This temporary or permanent opening of the trachea may be necessary when circumstances exist that compromise adequate respiration. There are several situations in which tracheotomy is needed.

- Upper airway obstruction
  - Inflammatory disease
  - Benign laryngeal pathology
  - Malignant laryngeal tumors
  - Benign and malignant tracheal tumors
  - Laryngeal trauma or stenosis
  - Tracheal stenosis
- Need for assisted ventilation over a prolonged period of time
- Deficit of lower airway protection against aspiration of oral or gastric secretions
- Clearance of lower respiratory tract secretions

There is no fixed list of circumstances and morphological or pathological situations for tracheotomy. However, there are a variety of alternatives to tracheotomy.

- Noninvasive positive-pressure ventilation with a face mask or a laryngeal mask
- Endotracheal intubation
- Endoscopic procedure to remove some foreign bodies

An appropriate decision should be made for each patient, taking in account the following facts.

- The laryngeal mask airway is not suitable for all patients, particularly for patients at risk for aspiration, and it requires close intensive care monitoring.
- Endotracheal intubation is not always possible, depending on the patient’s anatomy or pathological

situation. In case of difficult airway management, tracheotomy should be considered according to the “Practice Guidelines for Management of the Difficult Airway” [3].

- Prolonged intubation for more than a week can induce laryngeal and tracheal damage [4].

## 11.3 Decision Making for Open Neck Tracheotomy Versus Percutaneous Tracheotomy

Conventional surgical tracheotomy reported as open neck tracheotomy is a safe, less easy procedure when performed under ideal circumstances. However, many complications following the operation have been reported [5]. Since the report by Ciaglia et al. [6] in 1985 on percutaneous dilatation tracheostomy (PCDT), several studies demonstrated that this technique is safe and easy with a low complication rate; furthermore, it is superior to the conventional surgical tracheostomy as immediate complications as well as complications with the tracheostomy tube in situ are fewer and of less severity [7].

It must be stressed that PCDT is suitable only in adult patients without a midline neck mass and if cricoid cartilage can be palpated above the sternal notch. All patients below the age of 18 years or with a neck deformity or/and unidentifiable anatomy of the neck represent a group for whom PCDT is contraindicated.

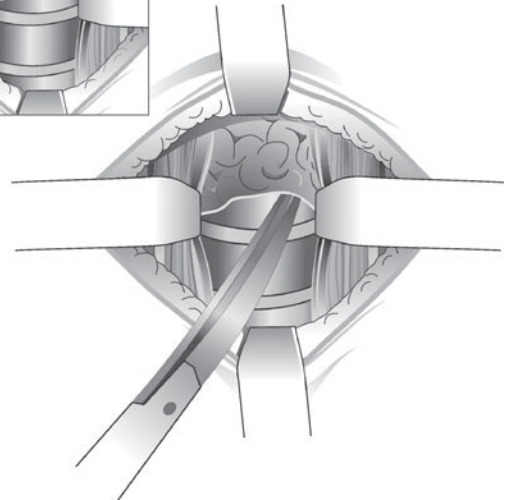
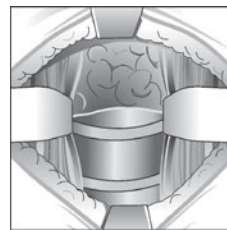
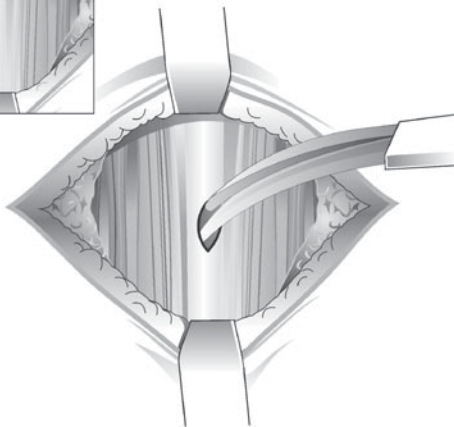
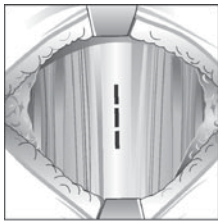
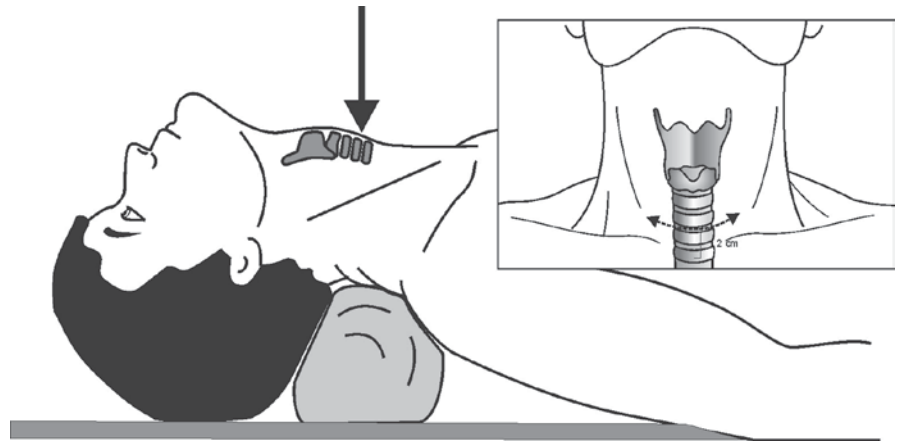
During PCDT the surgeon is sharing the airway with the anesthetist from the start of the procedure. The endotracheal tube is deflated and withdrawn above the vocal cord. In emergency cases or in patients with difficult airway management, this maneuver can result in a nonfunctional airway. In such a situation, conventional tracheostomy is more advisable.

## 11.4 Tracheotomy Techniques

### 11.4.1 Conventional or Open Neck Tracheotomy

Convention, open neck tracheotomy can be performed in various situations: in an emergency or as an elective

**Fig. 11.1.** The patient is placed on supine position, with the head extended



**Fig. 11.2.** The strap muscles are identified, and then the dissection is changed to the vertical plane

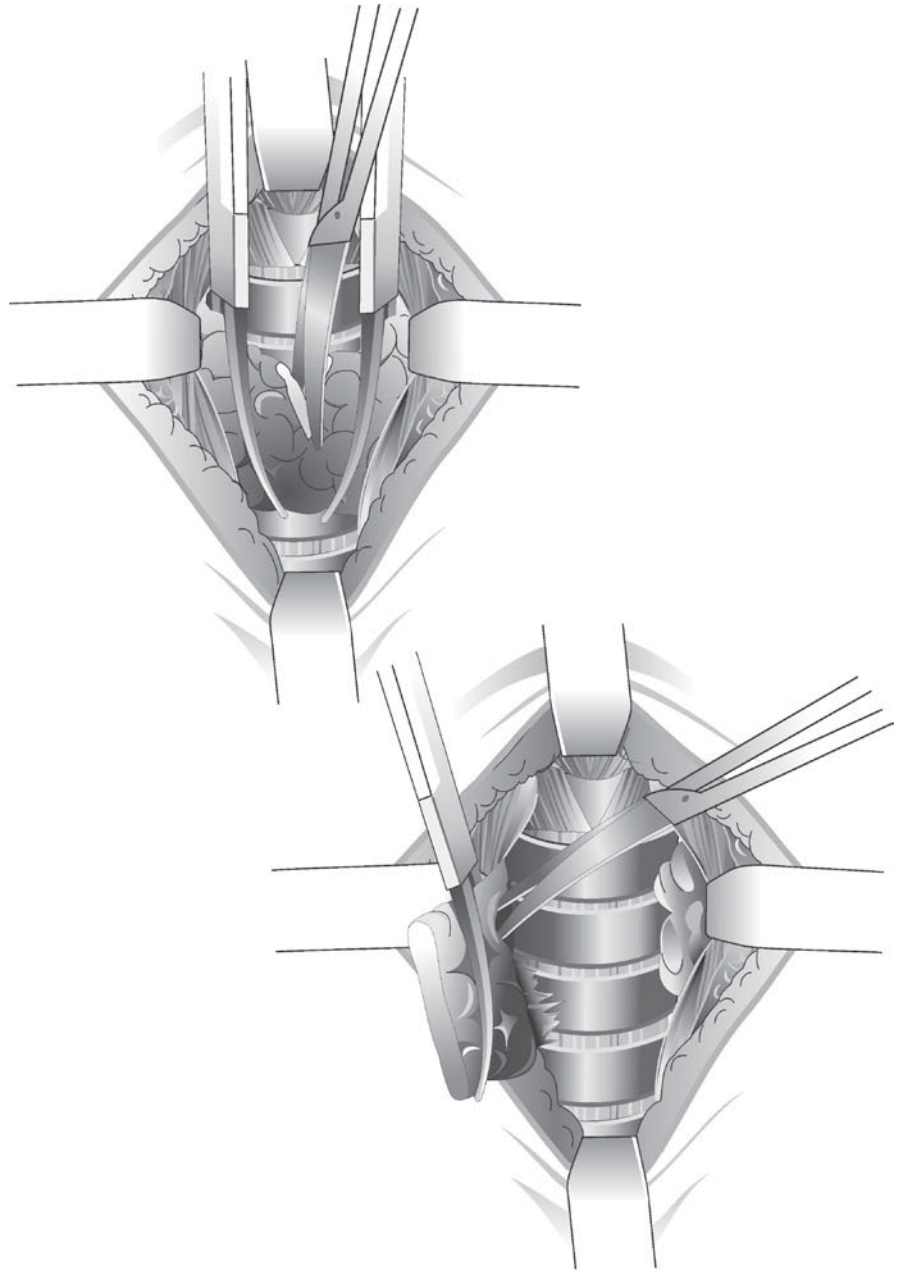
**Fig. 11.3.** Identification of the trachea anterior wall

operation, under general or local anesthesia, in the operating room or by the bedside.

Elective tracheotomy is best carried out in the operating room under general anesthesia, where efficient assistance is available with adequate equipment (light, suction, electrocautery, different size and shape tracheostomy tubes). The patient is placed on supine position, with the head extended using a shoulder roll (Fig. 11.1). A horizontal incision is made midway between the sternal notch and the cricoid cartilage. A sharp dissection is carried down through subcutaneous tissue and platysma. The strap muscles are

identified, and then the dissection is changed to the vertical plane (Fig. 11.2). The strap muscles are separated in the midline with a retractor until the thyroid isthmus is encountered and the anterior wall of the trachea is identified (Fig. 11.3). Inferior and median thyroid blood vessels are ligated; the thyroid isthmus is transected, and each side is suture-ligated to prevent bleeding (Fig. 11.4). The anterior wall of the trachea is incised between the second and third tracheal ring. The cricoid should be palpated before tracheal incision to determine the correct level at which to enter the trachea. To secure the opening of the stoma, an

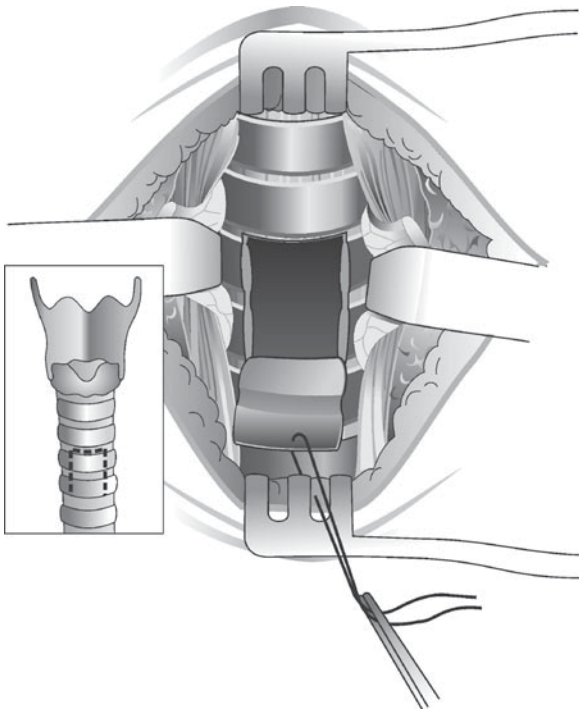
**Fig. 11.4.** Section of the thyroid isthmus



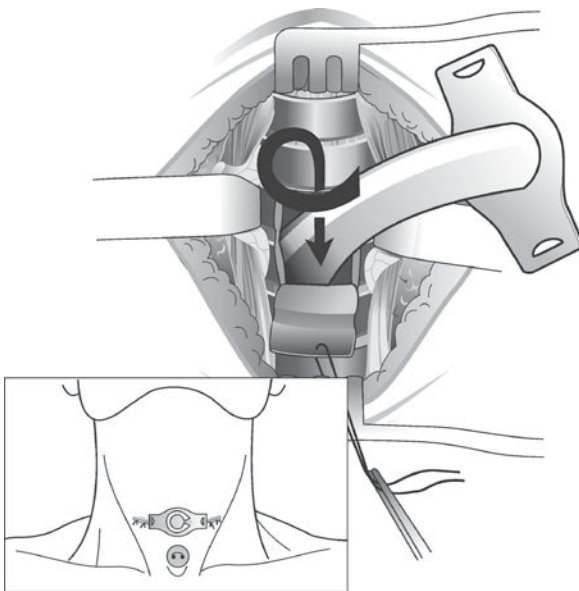
inferiorly based flap consisting of the anterior portion of a single tracheal ring is sutured to the inferior skin margin (Fig. 11.5).

During surgery, a special curved endotracheal tube (Montandon endotracheal tube) is introduced in the stoma and replaced by a tracheostomy tube at the end of the surgery. The placement begins with the tracheostomy

tube at right angles to the trachea (Fig. 11.6); then as the tube is inserted, it is rotated so its axis is parallel to that of the trachea. The tracheostomy tube is sutured to the skin as an added precaution to prevent accidental dislodgement of the tube. To avoid subcutaneous emphysema, pneumothorax, and infection, a tracheostomy wound is never closed tightly around the tube.



**Fig. 11.5.** Opening of the tracheal with an inferiorly based flap



**Fig. 11.6.** Rotation movement for introduction of the tracheotomy tube

### 11.4.2 Percutaneous Dilatation Tracheotomy

Percutaneous dilatation tracheotomy (PDT) is a safe, simple, accepted alternative to conventional tracheotomy. Some studies [8–10] have demonstrated advantages of less cost, infection, bleeding, and operating time for PDT when compared to traditional open neck tracheotomy.

The procedure can be performed under local or general anesthesia. Nevertheless, there is no published proof in the literature to guarantee the safety of the technique in children, emergency situations, and patient with difficult airway management.

We strongly recommend this technique with good airway control by anesthetists or intensivists, ideally under direct vision with fiberoptic during the procedure. The surgery should be carried out by a skilled surgeon (or under his or her supervision), with the ability to perform a standard tracheotomy.

Anatomical suitability for PDT must be determined preoperatively with the patient's neck extended. A contraindication to the procedure is the inability to palpate the laryngeal landmark. The cricoid cartilage should be felt above the sternal notch. Similarly, the patient with a midline neck mass, a large thyroid gland, should be a candidate for conventional tracheotomy.

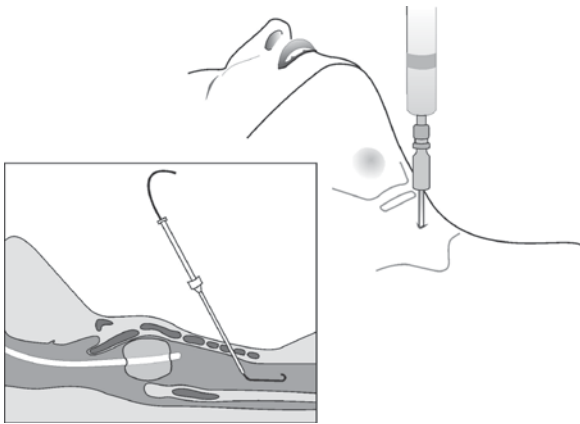
Patient received appropriate sedation, then positioned in supine position with the neck extended by using a shoulder roll. The patient's neck and upper chest are prepped and draped as for open neck tracheotomy.

Fiberoptic tracheobronchoscopy is carried out through the endotracheal tube. If needed, 2 ml of 4% lidocaine is injected into the trachea through the bronchoscope, and pulmonary toilet is performed. The distal extremity of the fiberscope is placed at the tip of the endotracheal tube, and the cuff is deflated.

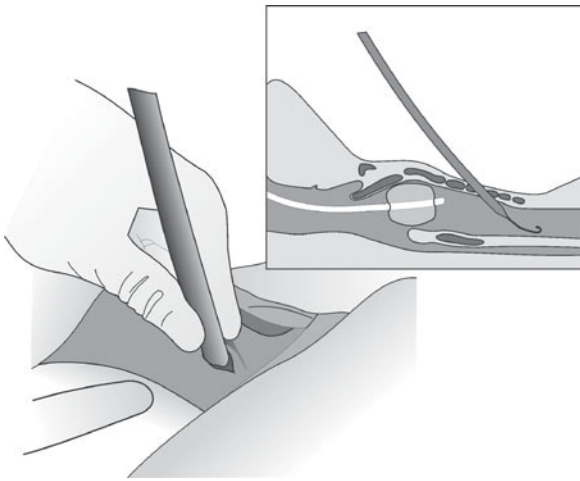
Under fiberoptic vision, the endotracheal tube is slowly withdrawn from the trachea just below the level of the glottic opening and held securely to prevent accidental extubation. Laryngeal and tracheal landmarks are palpated. The light is visualized through the skin, and the tracheal rings are palpated to confirm the proper position of the tip of the tube.

A Teflon catheter introducer needle with a syringe attached is inserted between the first and second





**Fig. 11.7.** Insertion of the needle



**Fig. 11.8.** Introduction of the Ciaglia dilators

tracheal rings. Aspiration of air bubbles confirms entry into the trachea, and the location of the needle is verified endoscopically until a midline position is achieved inside of the trachea without puncturing the posterior tracheal wall (Fig. 11.7). The needle is removed and a J-tipped guidewire is threaded through the catheter into the trachea. The catheter is removed and replaced by the introducer dilator. A horizontal skin incision of 1.0–1.5 cm is then performed at the level of the puncture; a guiding catheter is placed over the guidewire after removal of the introducer dilator.

A hydrophilically coated Ciaglia Blue Rhino dilator is now introduced over the guiding catheter into the trachea until the 38F marking is identified endoscopically (Fig. 11.8). A tracheostomy tube with the

inner cannula replaced by a corresponding loading dilator from the Ciaglia' set is introduced over the guiding catheter into the trachea. The correct intratracheal position of the tracheostomy tube is confirmed endoscopically; the guidewire and guiding catheter are removed; and the inner cannula is put back. The respirator is disconnected from the endotracheal tube and is connected to the tracheostomy tube. The latter is fixed and adjusted, and the cuff is inflated. Final endoscopic control is performed through the tracheostomy tube; and if needed, excess secretions and/or blood are aspirated to prevent airway obstruction.

Postoperative chest radiography should be performed to ensure the absence of pneumothorax and pneumomediastinum.

The tracheostomy tube is first changed 7 days postoperatively.

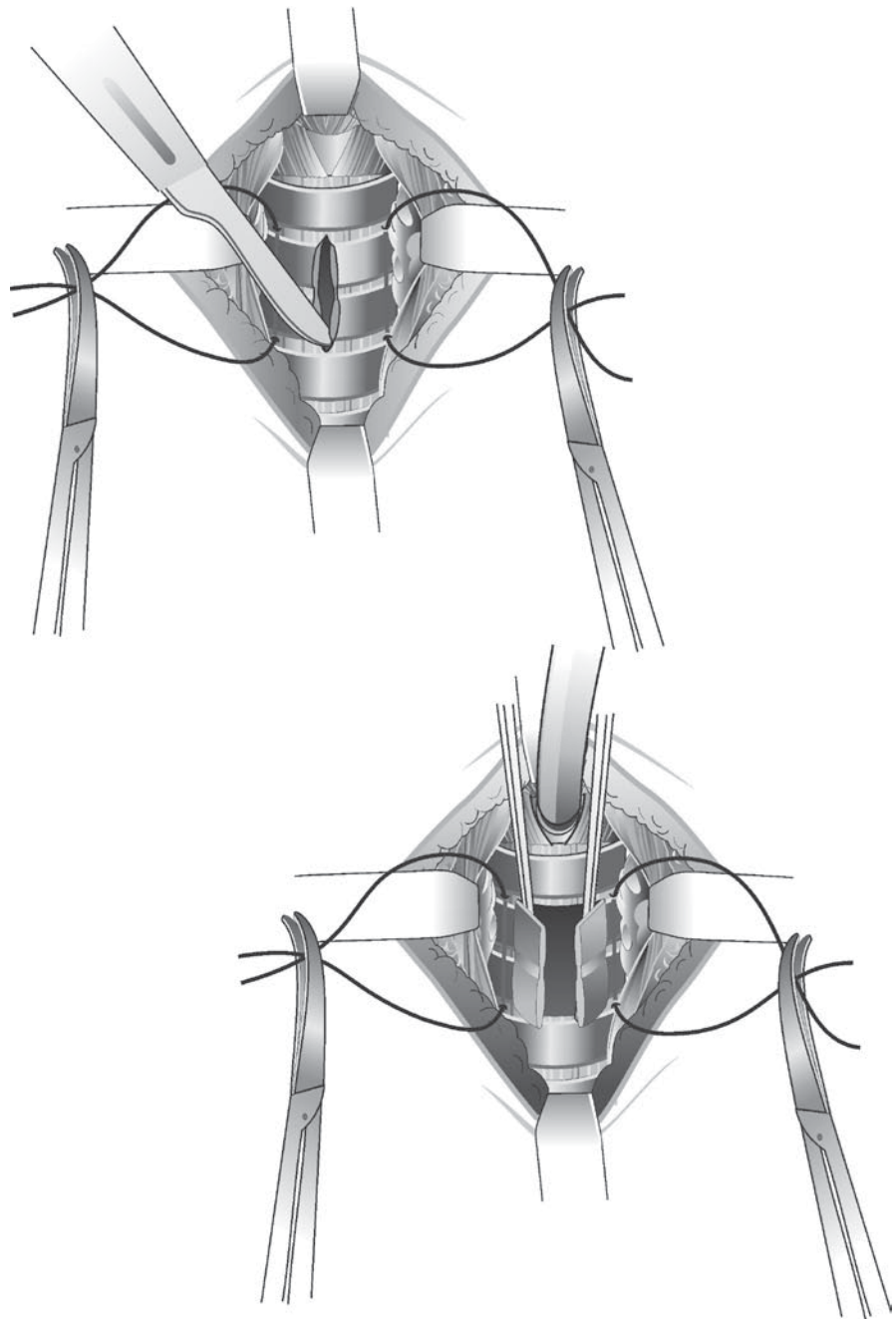
### 11.4.3 Tracheotomy in the Pediatric Age Group

To prevent complications, preoperative planning is the first step to successful tracheotomy in a child. All patients should be examined and the airway secured before surgery. The surgical procedure is carried out in a manner similar to that in adults—in the operating room when possible.

More than in adults, care must be taken to avoid excessive dissection lateral to the trachea to prevent the possibility of recurrent nerve injury and dissection of air into the tissues. The thyroid isthmus is divided only if it cannot be retracted superiorly. The tracheal opening is a simple vertical incision made in the second and third tracheal rings. Nylon traction sutures are placed on either side of the incision line before the incision is performed and then after a second pair of traction sutures is placed along the cut edge of the trachea (Fig. 11.9). Those sutures will be helpful for the stoma opening and tracheostomy tube reinsertion. Excision of any anterior trachea wall during tracheotomy should be avoided in this age group.

Pediatric tracheostomy tubes generally have no cuff. The size of the tracheostomy tube is determined according to the age of the child with respect to the carina.

**Fig. 11.9.** Threads for traction are put in place for an easy opening



#### **11.4.4 Bedside Open Tracheotomy**

Intensive care unit patients are at higher risk for complications than other groups of patients because they frequently have multisystem diseases. When tracheotomy is required for these patients, they are taken to the operating room for conventional tracheotomy. Operating room time is expensive, in high demand,

and often in short supply. On the other hand, moving critically ill patients is associated with a number of risks (e.g., accidental extubation, changes in the vital signs).

Open tracheotomy can also be performed at the bedside in the intensive care unit setting [11]. In such a situation, surgeons must ensure that proper lighting, some assistance, and proper equipment are

available. Patients with unfavorable anatomy (morbid obesity, short and fat neck, cervical mass lesions, enlarged thyroid gland) should proceed to the operating room for a standard tracheotomy under ideal circumstances.

The surgical technique is the same as describe above for conventional open neck tracheotomy. The advantages of performing a tracheotomy at the bedside is that operating room coast are defrayed, the procedure is generally less expensive than a PDT, and the procedure can be performed as soon as the surgeons are available. As for main disadvantages, the procedure is more longer compare to PDT, it require transporting electrocautery, instrument trays and extra lighting from operating room to intensive care unit. Often there are no available trained operating room nurses and assistants.

### 11.4.5 Emergency Tracheotomy

#### 11.4.5.1 Open Tracheotomy

It is widely accepted by head and neck surgeons that emergent tracheotomy is a procedure to be avoided. Nevertheless, in an acute airway emergency that cannot be handled by other option, tracheotomy should be considered.

Patients are positioned in supine position with the neck extended using a shoulder roll. The patient's neck and upper chest are prepared and draped as for open neck tracheotomy. A median vertical incision of 3–4 cm is performed starting at the level of the cricoid and extended to the sternal notch. The incision is continued through the skin, platysma, and subcutaneous tissues. The strap muscles are divided with retractors, and the thyroid isthmus is pushed inferiorly (or superiorly) with the index finger. The trachea is palpated and incised at about the second or third tracheal ring. The endotracheal tube or tracheostomy tube is introduced inside the trachea; sometimes a tracheal dilator is helpful during the introduction and so must be prepared as a part of the equipment for emergent tracheotomy.

The tracheostomy is securely fixed. As soon as the patient's situation allows, the tracheotomy is carefully assessed to control hemostasis, determine the exact

location of the tracheal incision, and if needed perform appropriate revisions.

#### 11.4.5.2 Cricothyroidotomy

Cricothyroidotomy is a rapid technique to create an opening in the cricothyroid membrane followed by placement of a stenting tube. The procedure is a good alternative to emergent tracheotomy. Its main advantage is that the cricothyroid membrane is near the skin surface and much less dissection is necessary. The major disadvantage is possible damage to the subglottis area, often because the cricothyrotomy tube is too large and/or is left in place for a long time.

The surgical technique is simple: The cricothyroid space is palpated, and a short, transverse incision is performed directly over the cricothyroid membrane. The knife is inserted into the cricothyroid membrane and twisted vertically to open it (Fig. 11.10). An endotracheal tube is inserted and secured.

When the patient's condition has stabilized, if respiratory support through the surgical airway is needed for more than 2–4 days the cricothyroidotomy should be converted to a conventional tracheotomy.

## 11.5 Complications of Tracheotomy

As for any surgical procedure, complications of tracheotomy may occur even with the use of optimal surgical techniques. Those complications can be generally divided into two categories: early and late.

1. Early complications (those occurring intraoperatively and early in the postoperative period)
  - (a) Hemorrhage
  - (b) Tracheoesophageal perforation
  - (c) Recurrent nerve injury
  - (d) Cricoid cartilage injury
  - (e) Tracheostomy tube obstruction
  - (f) Tracheostomy tube dislodgement
  - (g) Pneumothorax
  - (h) Pneumomediastinum
  - (i) Subcutaneous emphysema
  - (j) Wound infection



2. Late complications (those occurring in the late post-operative period)
  - (a) Infection
  - (b) Hemorrhage
  - (c) Granuloma
  - (d) Aspiration
  - (e) Laryngotracheal stenosis
  - (f) Subglottic stenosis
  - (g) Tracheoesophageal fistula
  - (h) Tracheomalacia

The best way to prevent complications during tracheotomy and in tracheotomized patients is a good knowledge of the following.

- Potential complications of tracheotomy
- Variety of strategies available for airway management
- Various surgical techniques for tracheotomy and their application
- Proper cannula selection based on the patient's anatomy and pathology
- Appropriate postoperative care for each specific situation

As soon as the complication is recognized, it must be managed efficiently to achieve the expected positive outcome.

## 11.6 Pearls and Tips

### 11.6.1 Pearls

- Tracheotomy stands out as one of the most helpful therapies in the management of compromised airway. In decision making for tracheotomy, appropriate solutions must be taken for each specific case, in order to avoid complications and life-threatening situations.
- The key features in preventing complications are good knowledge of:
  - The potential complications of tracheotomy.
  - The variety of strategies available for airway management.
  - The different surgical techniques for tracheotomy and their applications.

- The proper cannula selection according to the patient's anatomy and pathology.
- Appropriated routine and specific postoperative care.



**Fig. 11.10.** Cricothyroidotomy

### 11.6.2 Practical Tips

- *Conventional or open neck tracheotomy*
  - Secure the airway first before performing the surgical procedure.
  - Be sure that efficient assistance and adequate equipment are available.
  - Dissecting in the midline to prevent
    - Bleeding from jugular vein, carotid artery, thyroid isthmus, or aberrant innominate arteries.
    - Injury to recurrent laryngeal nerves.
    - Pneumothorax or pneumomediastinum.
  - Secure the opening of the stoma, by suturing the anterior portion of a single tracheal ring to the inferior skin margin, and insert the tracheotomy tube into the trachea under direct vision to prevent false passage between the trachea and the sternum.
  - Prevent tracheotomy tube displacement by
    - Appropriate selection of the tube according to patient's anatomy.
    - Sewing the tracheotomy tube to the peristomal skin.
    - Setting the low-pressure cuff pressure under 25 mmHg.
- *Percutaneous dilatation tracheotomy (PDT)*
  - The principle contraindication to the PDT procedure is the inability to palpate the laryngeal landmarks.
  - Flexible bronchoscopy for endoscopic guidance is mandatory to
    - Visualize the trachea.
    - Confirm the proper position of the tip of the endotracheal tube.
    - Transilluminate for palpation of anatomic landmarks and visualize needle placement through the anterior tracheal wall.
    - Confirm the safe tracheal dilation and the proper tube placement.
  - Have a standard tracheotomy tray available.
  - Tracheotomy tube should be securely fixed to avoid accidental decannulation.
  - Never perform unnecessary change of the tracheotomy tube during the first post operative 3 days. If the tube replacement is inevitable, be prepared with:
    - Endotracheal tube ready for patient re-intubation if need.
    - A good preoxygenation of the patient.
    - Tracheotomy dilatation forceps.
    - Fiberscope ready for tracheal assessment.
  - When long-term tracheotomy is planned, it is preferable to perform conventional tracheotomy.
- *Emergency tracheotomy*
  - Depending on the severity and primary cause of the airway impairment.
  - Other airway management options should be considered.
  - All information related to the patient must be shared with the operating team and anaesthesiologist prior to the procedure.
  - Avoid
    - Percutaneous dilatation tracheotomy.
    - A high tracheotomy through or near the cricoid cartilage.
  - Cricothyroidotomy should be converted to conventional tracheotomy.
- *Tracheotomy in pediatric age group*
  - The tracheal opening must be a simple vertical incision.
  - Placed nylon traction sutures on either side of the incision line before tracheal opening.
  - Avoid any anterior trachea wall excision.
  - Tracheostomy tube size is determined according to the child's age.

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