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CHAPTER 57

Tracheotomy and Intubation

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In this chapter, *tracheotomy* is used to refer to the creation of a surgical opening into the trachea for purposes of ventilation, and *tracheostomy* is used to refer to the opening itself, the stoma. The tube that is placed through the tracheal opening is referred to as a *tracheostomy tube.*

HISTORY OF TRACHEOTOMY

The creation of a surgical opening into the trachea for purposes of ventilation, tracheotomy, is a much older procedure than transoral or transnasal canulation of the trachea with a tube. The practice of tracheal intubation originated in the late nineteenth century, but obscure references to the practice of tracheotomy can be found back into antiquity. The development of tracheotomy has been divided into five periods: the *period of legend* dating from 2000 BC to 1546 AD; the *period of fear* from 1546 to 1833, during which the operation was performed by only a brave few, often at risk of their reputation; the *period of drama* from 1833 to 1932, during which the procedure was performed generally only in emergency situations on acutely asphyxiating patients; the *period of enthusiasm* from 1932 to 1965, during which the adage "if you think of a tracheotomy ... do it" became popular; and the *period of rationalization* from 1965 to the present, during which the relative merits of intubation versus tracheotomy were explored (1). The history of tracheotomy and intubation is outlined in Table 57-1.

INDICATIONS FOR TRACHEOTOMY

The four basic indications for tracheotomy are to bypass upper airway obstruction, to assist respiration over prolonged periods, to assist with the clearance of lower respiratory tract secretions, and to prevent aspiration of oral or gastric secretions. Perhaps more controversial is the comparative indications of tracheotomy versus intubation. Certainly, when there is mechanical or anatomic obstruction to the upper airway as by an obstructing carcinoma, translaryngeal intubation may be impossible or may carry a great risk of causing further immediate deteriorization of the airway. In most cases in which there is no mechanical or anatomic abnormality of the airway and in which the need for respiratory support is thought to be of short duration, translaryngeal intubation is preferable to tracheotomy. In cases of trauma to the larynx, attempted intubation may cause further injury or acute deteriorization of the airway.

In the emergent situation, the skill and knowledge of those in attendance also will play a role in deciding the best way to proceed. For instance, although emergent tracheotomy may be superior to attempted translaryngeal intubation in a patient with laryngeal trauma and a deteriorating airway, it is predicated on the availability of a surgeon who is skillful in emergent tracheotomy in such a setting. Establishment of an airway is the most basic tenet in the support of life; therefore, it is difficult to find fault with its attainment by almost any means. Nonetheless, there are more or less safe and correct ways of obtaining an airway with the least chance of causing further iatrogenic harm to the patient, given an ideal scenario and the availability of knowledgeable and skilled personnel.

TECHNIQUES OF TRACHEOTOMY

Emergent Tracheotomy

Anoxia will result in death in about 4 to 5 minutes. Emergent tracheotomy, therefore, is one that must be performed within 2 or 3 minutes. In general, emergent tracheotomy is a procedure to be avoided. All too often, its necessity is brought about by the ill-advised management of a tenuous but adequate airway. For example, an

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TABLE 57-1. ***History of tracheotomy***

Date	Event
1000–2000 BC	Obscure references to tracheotomy in the Ebers papyrus and Rig Veda
124 BC	Asclepiades credited with performing first tracheotomy
117 AD	Antyllus performed tracheotomy through transverse incision with patient in sitting position
Dark Ages	Few references. Albucasis of Cordova showed that tracheal rings would heal
1546	First well-documented tracheotomy by Antonius Musa Brasavola
1600	Fabricius suggests the use of a cannula
1700s	George Martin suggested the use of an inner cannula on the tracheostomy tube
1833	Trousseau reported >200 cases of tracheotomy for diptheria
1932	Chevalier Jackson standardized the technique of tracheotomy and warned against the "high tracheotomy"

unskilled attempt at translaryngeal intubation in a patient with a bulky glottic cancer in an improper level of anesthesia may precipitate an acute airway emergency that can be handled by few other options. Much better to perform an elective tracheotomy under local anesthesia than to induce such a situation. There are good arguments to prefer this approach in the patient with laryngeal trauma and a deteriorating airway or in the infant or child who cannot be intubated transorally, although as already mentioned, this assumes a degree of sophistication, knowledge, and skill on the part of the surgeon.

Emergent tracheotomy is best carried out through a vertical incision, which begins at the level of the cricoid cartilage and extends inferiorly about 1 to 1 1/2 inches. For the right-handed surgeon, the left hand should be used to palpate and stabilize the larynx and to extend the neck if there are no contraindications, such as possible cervical spine trauma, to this maneuver. A shoulder roll will also be helpful, but it is usually not germane to the situation. The right hand wields the blade and creates a vertical incision through skin, platysma, and subcutaneous tissues. Structures such as the strap muscles and thyroid isthmus are rarely positively identified in such a maneuver. The index finger of the left hand can be used as a dissector to attempt to push the thyroid isthmus inferiorly and to palpate the trachea. It should be possible to avoid incising the cricoid car-

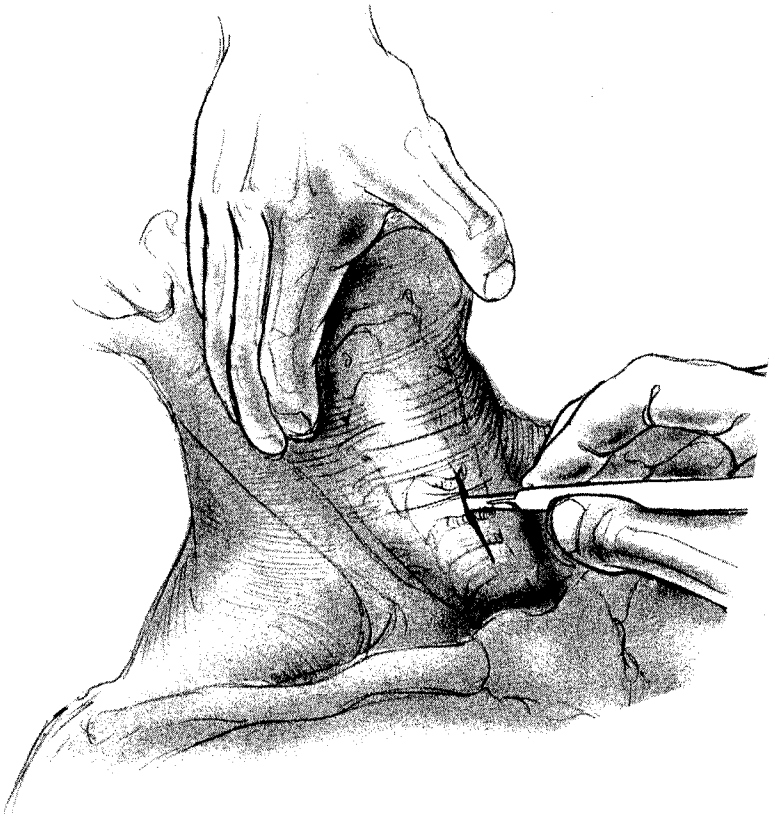

FIG. 57-1. Emergency tracheotomy performed through vertical skin incision.

tilage and to position the actual vertical tracheal incision at about the second or third tracheal ring by palpating the cricoid arch with the index finger of the left hand. The vertical skin incision is crucial to the speed of the procedure and to avoid damage to adjacent neck structures. So long as one stays midline in the anatomically normal neck, little irreversible damage can be done. After the incision in the trachea is made, a tracheal dilator is helpful but not necessary to aid in the introduction of an endotracheal tube, which then is sewn to the adjacent skin. A reinforced endotracheal tube is preferable if available, as it resists kinking. Bleeding in the wound is controlled after the tracheotomy is complete. If the situation allows, the tracheotomy then should be carefully assessed to determine the actual location of the tracheal incision, and appropriate revisions if necessary should be undertaken as soon as the patient's condition allows (Fig. 57-1).

Cricothyrotomy

In most instances, cricothyrotomy is far preferable to emergent tracheotomy. Its major advantage is that the cricothyroid membrane is near the skin surface, and much less dissection is necessary. The procedure is easily standardized and taught to residents and emergency room personnel. Its major drawback is the potential for damage to the

The American Academy of Otolaryngology–Head and Neck Surgery has proposed the following clinical indicators for tracheotomy:

Clinical Indicators for Tracheotomy

Indications (one or more required):

History
- Upper airway obstruction with any of the following:
  - Stridor
  - Air hunger
  - Retractions
  - Obstructive sleep apnea with documented arterial desaturation
  - Bilateral vocal cord paralysis
- Prolonged intubation
- Inability of patient to manage secretions including:
  - Aspiration
  - Excessive bronchopulmonary secretions
- Facilitation of ventilation support
- Inability to intubate
- Adjunct to manage head and neck surgery
- Adjunct to manage major head and neck trauma

Physical examination (one required)
- Respiration—describe
- Voice—describe
- Endotracheal tube—document
- Larynx—describe, if possible
- Neck examination (always required)

Tests (none required)

Postoperative observations

Breathing—satisfactory; both sides of lung ventilating
Bleeding from wound—describe and notify surgeon
Subcutaneous emphysema—notify surgeon
Wound packing and sutures—document removal
Tracheotomy tube—tighten if loose
Chest radiograph—document. Usually ordered after surgery to check for pneumothorax or proper tube placement.

Outcome review

Document complications for departmental review.

Patient information

Although often performed as an emergency in life-threatening situations, tracheostomy may also be required for urgent and elective reasons. A tracheostomy is an opening made in the trachea (windpipe) to allow breathing when the larynx is obstructed or to permit long-term ventilation of the lungs through a tube inserted into the neck opening. The main complication is bleeding and this is often related to the speed required to perform this operation in emergency situations. Other complications include subcutaneous emphysema (escape of air into the tissues of the neck and mediastinum), which is treatable, and postoperative scar formation in the lower neck. Although an endotracheal tube may be used to maintain the airway for several days, there is no alternative to tracheostomy in some cases.

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subglottic larynx, but this is mostly associated with leaving the cricothyrotomy tube in for too long. It is relatively contraindicated in children aged less than 12 years, in cases in which there is infection in the larynx, in cases when it will risk transecting tumor, and in cases of laryngeal trauma.

Cricothyrotomy can be performed best through a transverse incision directly over the cricothyroid membrane. Again, the right-handed surgeon will do best to stand on the patient's right side, grasping the thyroid cartilage with his or her left hand and palpating the cricothyroid space with the index finger of the left hand. A short stabbing incision is made with the right hand directly through the cricothyroid membrane. Hugging the cricoid cartilage is said to avoid injury to the cricothyroid artery. Once the subglottic space is entered, the handle of the knife is inserted into the wound and twisted vertically, opening the wound. An endotracheal tube is inserted and secured (Fig. 57-2).

Much controversy has surrounded the use of cricothyrotomy as a definitive long-term airway. If respiratory support through a surgical airway will be needed for longer than 3 to 5 days, the cricothyrotomy should be converted to a tracheotomy electively in the operating room to avoid the long-term sequelae of subglottic stenosis, which may result from cricothyrotomy. Esses and Jafek (2) recently succinctly elucidated the various arguments on each side of this controversy.

Maneuvers to Buy Time

Several techniques have been described to ventilate a patient for a short period before more definitive airway management can be undertaken. Transcricothyroid puncture with a 14-gauge catheter has been described. In the adult, there would seem to be little to recommend this over a cricothyrotomy unless the physicians in attendance are untrained in the technique. An adult will not be able to respire through such a catheter, so some method to supply oxygen under pressure, such as via an anesthesia machine or pressurized tank or wall circuit, will be necessary. Some means of intermittently inflating the lungs and controlling peak pressures is also desirable. If the oxygen is delivered under high pressure, some risk of pneumothorax will be attendant. In addition, there must be some route of egress from the lungs for the oxygen. If there is obstruction at the level of the glottis, a second catheter may have to be placed through the cricothyroid membrane to allow a route for oxygen escape; otherwise, overinflation of the lungs with pneumothorax will ensue.

A variety of small "pocket devices" are manufactured for use "at the scene" or on the "roadside"; but this author knows of no controlled study of such devices. Their usefulness in untrained hands remains questionable.

The procedure is perhaps more useful in children in whom cricothyrotomy is best avoided if possible. As already stated, emergency tracheotomy is best avoided as well; in this situation, when transoral intubation is impossible, canulation of the child's cricothyroid membrane with a large-bore catheter might buy enough time to allow a more orderly tracheotomy. The same admonishments apply concerning some site of egress for delivered oxygen.

Timely Tracheotomy

A timely tracheotomy is one that must be performed in 5 to 10 minutes. In such a situation, proper lighting, some assistance, and proper equipment are usually available. Tracheotomy in this situation again is best performed through a vertical incision extending from the cricoid cartilage, about 1 1/2 inches inferiorly, cutting down through the skin, subcutaneous tissue, and platysma muscle as well

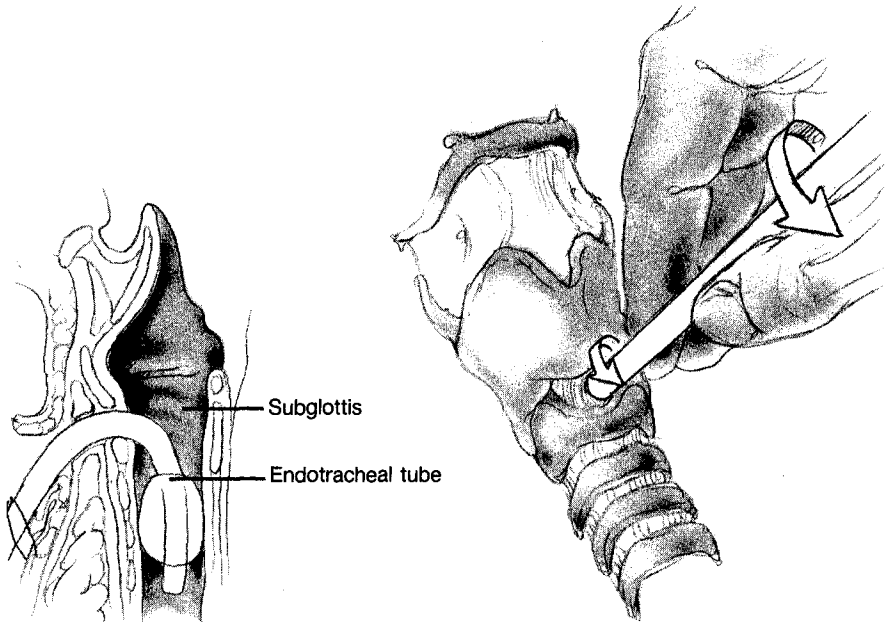

FIG. 57-2. Cricothyrotomy.

as the pretracheal fascia and identifying the strap muscles. The strap muscles are separated in the midline by rapid sharp and blunt dissection, thus exposing the thyroid isthmus. The cricoid cartilage is the central landmark in any tracheotomy. A cricoid hook is inserted into the space between the cricoid cartilage and the first tracheal ring. Traction superiorly on the cricoid pulls the trachea up into the wound. The fascia on the cricoid surface near its inferior edge is sectioned and access is gained to a bloodless plane immediately anterior to the trachea. Hemostats are inserted into this plane, and the thyroid isthmus is clamped and sectioned. Blunt dissection with a sponge exposes the tracheal rings. An inferiorly based U-shaped (Bjork) flap consisting of the second or third tracheal ring is made, and a tracheostomy tube or endotracheal tube is inserted.

Elective Tracheotomy

Elective tracheotomy is best carried out in the operating room with adequate equipment and assistance. The patient is positioned supine with a roll between the shoulder blades to hyperextend the neck and bring the trachea up out of the chest. A horizontal incision is made midway between the sternal notch and the cricoid cartilage. The incision is carried down through skin, subcutaneous tissue, and platysma to reveal the strap muscles. At the level of the strap muscles, the dissection is changed to the vertical plane. The pair of sternohyoid and sternothyroid muscles are separated from each other in the midline by incising the fascia vertically, which connects the muscles on the two sides. Retractors then pull the strap muscles to each side, revealing the thyroid isthmus. At this point, the cricoid cartilage is identified by palpation through the wound, and the overlying fascia is sectioned near its inferior border. At this level, a bloodless plane just anterior to the trachea is identified, and the thyroid isthmus is transected and each side suture ligated. A cricoid hook is used to pull the trachea superiorly by placing it between the cricoid cartilage and the first tracheal ring. A Kittner sponge dissector then is used to push the fine fascia away from the anterior tracheal wall.

Some controversy has surrounded the best incision to use in the trachea. The safest incision to make in the trachea is an inferiorly based (Bjork) flap consisting of the second or third tracheal ring anteriorly. This tracheal flap is sewn to the inferior skin margin and greatly reduces the risk of accidental postoperative extubation and makes reintubation much safer should this occur. Because of the risk of tracheocutaneous fistula with the Bjork flap, if the tracheostomy is to be in place for only a short time, a horizontal H incision based on the second or third tracheal ring is preferred. Alternatively, the anterior section of a

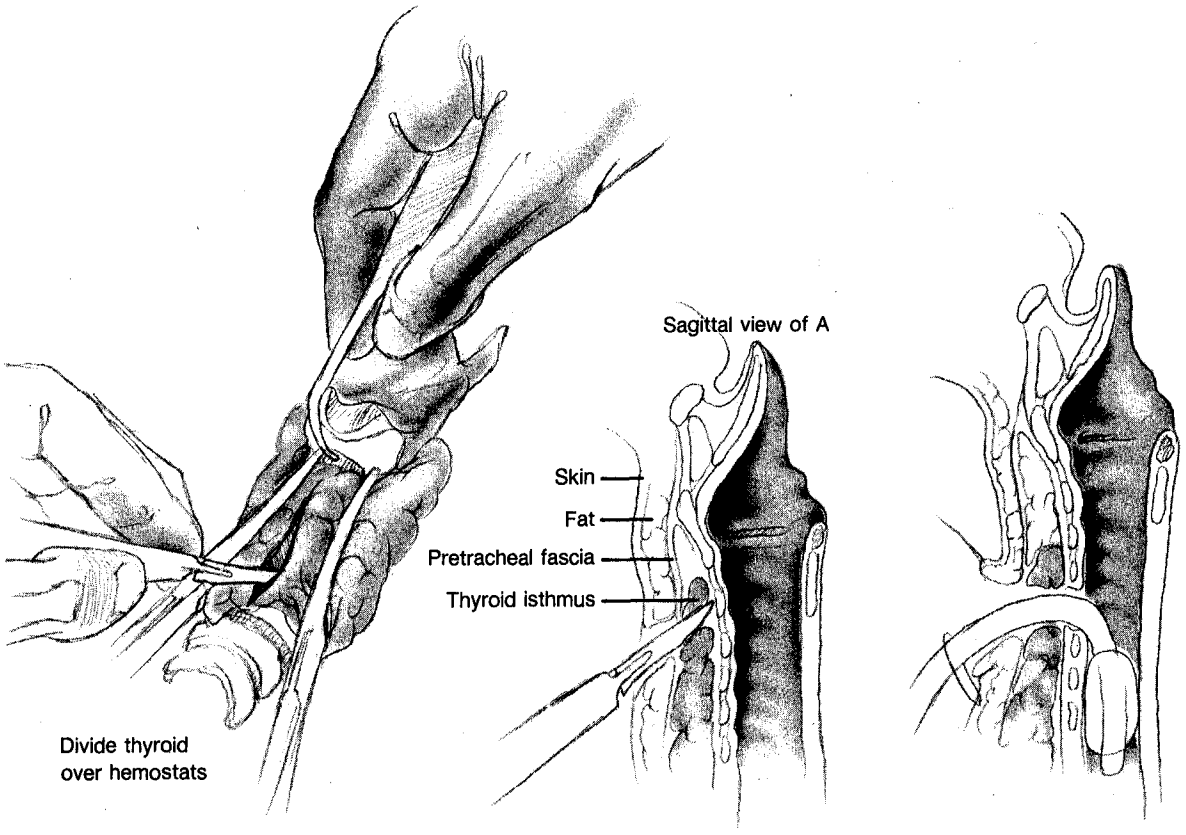

FIG. 57-3. Elective tracheotomy; note the horizontal skin incision, cricoid hook, and division of thyroid isthmus.

single tracheal ring can be resected, with little risk of tracheal stenosis in an adult (Fig. 57-3).

Bjork Flap

In 1960 Bjork introduced the concept of suturing an inferiorly based flap consisting of the anterior portion of a single tracheal ring to the inferior skin margin, which greatly reduced the incidence of accidental decanulation and the ease with which the tracheostomy tube could be reinserted should accidental decanulation occur. The technique is contraindicated in children in whom it will lead to an unacceptable rate of tracheal stenosis and persistent tracheocutaneous fistulae. It also may be less desirable in a temporary tracheostomy, which is planned to be maintained for only several days, such as after maxillofacial trauma or extensive surgery on the oral cavity. In these cases, use of the Bjork flap may predispose to a tracheocutaneous fistula. This risk can be largely ameliorated by being sure to cut the suture securing the trachea to the skin surface at the time of the first tracheostomy tube change. During the surgical procedure, a reinforced tube is left in the tracheostomy, which aids in ease of positioning the patient and keeps the bulky tracheostomy tube out of the surgeon's way. Accidental intraoperative decanulation is prevented (Fig. 57-4).

When the tracheostomy is to be permanent or of long duration, the Bjork procedure can be modified by defatting the surrounding skin and suturing the tracheastoma to the skin circumferentially. This procedure is especially useful in obese patients who are undergoing tracheotomy because of intractable obstructive sleep apnea. In this way, a semipermanent tracheastoma can be fashioned, which will be less susceptible to maceration because it is immediately matured by apposing skin to respiratory mucosa. It also allows the tracheostomy tube to sit better and makes removal and reinsertion easier by decreasing the length of the tract (3).

A tracheotomy wound should never be closed tightly around the tube, and in general no suturing should be done. Suturing the wound can lead to subcutaneous emphysema, pneumomediastinum, pneumothorax, and infection.

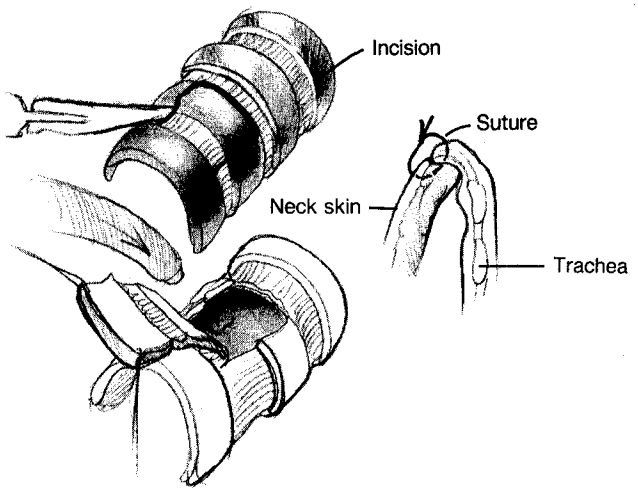

FIG. 57-4. Bjork flap.

Tracheotomy in the Pediatric Patient

Vertical Incision

Tracheotomy in the child is carried out similarly to the procedure in an adult; however, in the child, a simple vertical incision in the trachea was shown in an animal model to be best (4). This incision should be made in the second and third tracheal rings. Excision of any anterior tracheal wall or the use of a Bjork flap should be avoided in the child. Additionally, if at all possible, tracheotomy in children should be performed only with a secured airway either from intubation with an endotracheal tube or over a ventilating bronchoscope. As in the adult, but even to a greater extent, emergency tracheotomy should be avoided if possible. The smaller diameter, shorter length, and reduced stability of the infantile trachea, along with the greater mobility of the soft tissues of the neck and greater deformability of the tracheal cartilage in the child, call for some special techniques.

Guide Sutures

At the time of tracheotomy in the child, it is wise to place two sutures, one on either side of the vertical incision in the trachea, to serve as guides should the tracheostomy tube accidentally come out of the trachea. If such a technique is used, it is essential that the personnel actually taking care of the child in the hospital be trained in the proper use of these guide sutures. In a panic, it is easy to pull the sutures right out. By gently pulling the sutures, the trachea can be elevated into the wound and the incision in the trachea slightly opened to assist reinsertion of the tube. A small 4 or 5-O nonabsorbable monofilament suture is usually used and is removed at the time of the first tracheostomy tube change at 3 or 4 days (Fig. 57-5).

Pediatric Tracheostomy Tubes

Hollinger modified the metal Jackson tracheostomy tube in the early 1960s to approximate better the infant anatomy. Aberdeen described a pediatric polyvinylchloride tracheostomy tube in 1965, which was the forerunner of most modern pediatric tracheostomy tubes. Polyvinylchloride or Silastic tubes tend to collect fewer secretions; however, they have no inner cannula and are prone to accidental decannulation by virtue of their intrinsic malleability, which allows the tip sometimes to come out of the tra-

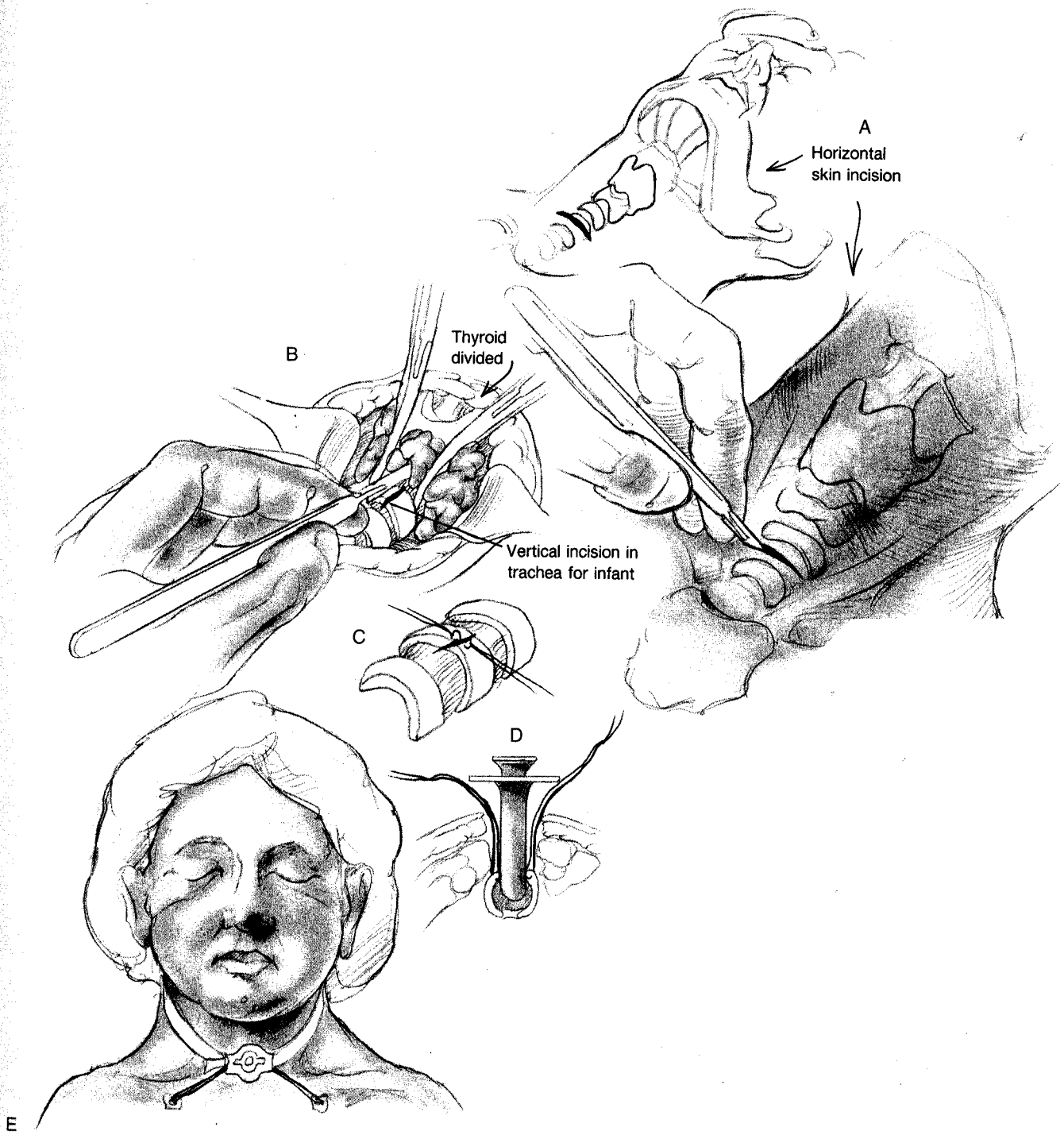

FIG. 57-5. Pediatric tracheotomy. Note the vertical incision in the trachea and guide sutures for ease of reintubation in the event of accidental decannulation.

chea while the body of the tube remains in the neck wound. Pediatric tracheostomy tubes generally have no cuff.

Percutaneous Dilational Tracheotomy

Recently, interest in percutaneous tracheotomy has increased. This procedure began as "minitracheotomy," which was a percutaneously performed cricothyrotomy done for evacuation of bronchial secretions in critically ill postoperative patients who otherwise might simply have remained intubated for an extended period. Most of these initial reports were by critical-care specialists and general surgeons rather than by otolaryngologists or head and neck surgeons, for whom perioperative standard tra-

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Clinical Indicators for Tracheotomy

Strategy

Indicators (one of the following):
- Upper airway obstruction
- Inability of patient to handle own secretions
- Facilitation with intubation
- Difficulties with intubation
- Prolonged intubation
- Adjunct to head and neck surgery with possible compromise of the airway
- Adjunct to management of severe facial fractures

Lab tests (as indicated)
Other tests (as indicated)
Type of anesthesia (as indicated)
Location of service (as indicated)

Process

Criteria for discharge
Recovery from anesthesia
Absence of subcutaneous or mediastinal emphysema
Absence of bleeding
Absence of pneumothorax
Tracheostomy decannulated or ability for home care

Outcome

Results
- Control of airway

Follow-up
- Wound healing of tracheostoma
- Adequacy of airway, immediate and delayed stenosis
- Adequacy of vocal function

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cheotmy has long been an accepted method of short-term airway control. More recently, percutaneous tracheotomy through the first or second tracheal rings has developed into a more standard technique, especially for bedside tracheotomy in critically ill patients in the intensive care unit requiring long-term ventilation. It is now most appropriately called *percutaneous dilational tracheotomy.* Unfortunately, the controversy surrounding the short- and long-term efficacy of this technique has been clouded by something of a "turf battle" over who will perform these tracheotomies. Percutaneous tracheotomy has never been safer or more effective than standard elective tracheotomy; so the proponents of this technique have pointed to shorter operative time, ease of performance, ability to perform the technique at the bedside, the ease with which the technique can be taught, the lower expense, and the lack of need to transport the patient to the operating room with the attendant dangers associated with the transport itself, such as dislodgement of lines.

Two commercially available percutaneous tracheotomy kits are now available. One uses a "tracheotome," which looks something like a nasal speculum for dilating the tracheostomy tract; the other uses serial dilators. The single nonrandomized comparison of these two systems in the literature found the serial dilator method to be preferable (5) (Fig. 57-6).

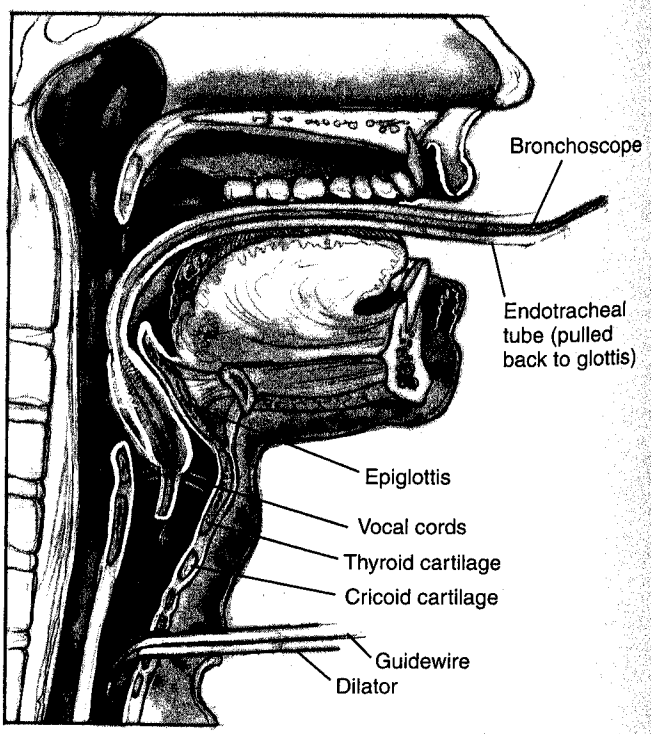

FIG. 57-6. Percutaneous dilational tracheotomy with bronchoscopic monitoring. The endotracheal tube is pulled back into the glottis so that the puncture site can be seen with the bronchoscope.

The two procedures that most need to be compared are bedside standard tracheotomy and bedside bronchoscopically monitored percutaneous dilational tracheotomy. No such comparison has yet been made. Both require sedation, special equipment, and assistance.

COMPLICATIONS OF TRACHEOTOMY

In the most general sense, complications can be divided into those occurring intraoperatively, during the early postoperative period, and during the late postoperative period. During the operation, damage can be done to the great vessels or the wall between the trachea and esophagus. The cupula of the lung enters the low neck and can be damaged, resulting in pneumothorax or pneumomediastinum; for this reason, postoperative orders after any tracheotomy should include a chest radiograph.

Early postoperative complications include tube obstruction, usually from mucous plugging; tube displacement, which is seen more frequently in children because of the more pliable neck tissue and the soft malleable tubes commonly used; postobstructive pulmonary edema seen commonly in those who have labored for some time with a partially obstructed airway; and infection. Obstruction from dried mucous can be largely prevented by meticulous tracheostomy care. A humidifier should be used postoperatively, and the tube should be suctioned frequently after the instillation of 1 to 2 mL of sterile saline. Guide sutures can assist with reinsertion of a displaced tracheostomy tube in a child. Postobstructive pulmonary edema should be treated with mechanical ventilation with positive end expiratory pressure (PEEP) and possibly diuretics.

Late complications include tracheal stenosis, which can occur at the level of the tracheastoma, at the level of the tracheostomy tube cuff, and at the level of the tube tip (Fig. 57-7). These complications have become much less common since the introduction of large-volume, low-pressure cuffs. Cuffs should be inflated only to the minimally occlusive volume. Cuff pressure should be checked regularly and kept below 25 Cm H_2O, the pressure at which submucosal capillaries are occluded. In children, in whom cuffed tubes generally are not used, a slight air leak around the tube is desirable. A properly sized and fitted tracheostomy tube can decrease the incidence of damage from the tube tip. Some patients with severely distorted neck anatomy may require the use of special tracheostomy tubes, such as the Rusch tube, which is essentially a soft endotracheal tube that can be variably advanced through the neck plate to accommodate a variety of anatomic situations. Stenosis at the level of the tracheastoma usually occurs at the upper anterior border, where the anterior tracheal wall becomes softened and displaced into the tracheal lumen. Granulation tissue forms commonly at the level of the tracheastoma and can occur more distally from too vigorous tracheal suctioning.

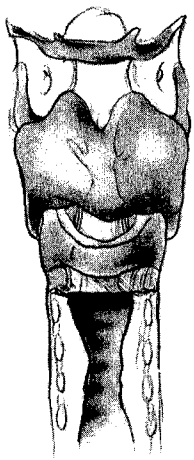

FIG. 57-7. Tracheal stenosis.

One of the most feared complications of tracheotomy is trachea-innominate artery fistula, which commonly occurs at the level of the tip of the tracheostomy tube and has been ascribed to a too low tracheotomy (below the level of the third tracheal ring), erosion from a high pressure cuff, tube torsion and movement from a ventilator, and local infection. Sixty percent occur within 2 weeks of the tracheotomy, and the complication carries a 73% mortality rate. It may be heralded by some minor sentinel bleeding. It is best treated by initially attempting to control the hemorrhage by overinflating the tracheostomy tube cuff or inserting an endotracheal tube below the level of the bleeding while attempting to compress the innominate artery anteriorly against the sternum with a finger inserted through the tracheotomy wound anterior to the trachea. Definitive treatment involves dividing and suture ligating the two ends of the innominate artery (6) (Fig. 57-8).

The incidence of complications in pediatric tracheotomy is generally considered higher than that in adults. Gianoli et al. (3) reported a 3.3% incidence of intraoperative complications, a 13.3% incidence of early postoperative complications, and a 38.3% incidence of late complications in children aged less than 1 year. Tube obstruction was the most common early postoperative complication, and granulation tissue was the most common late complication (7). The mortality rate for the procedure itself was 1.6%, but the overall mortality in the group of patients was 42%, reflecting the degree of underlying illness. Duration of tracheostomy was the most important factor influencing the rate of late complications. Higher complication rates were seen in preterm infants as opposed to full-term infants, and infants undergoing tracheotomy for upper airway obstruction suffered more complications than those undergoing tracheotomy for ventilator dependency. This

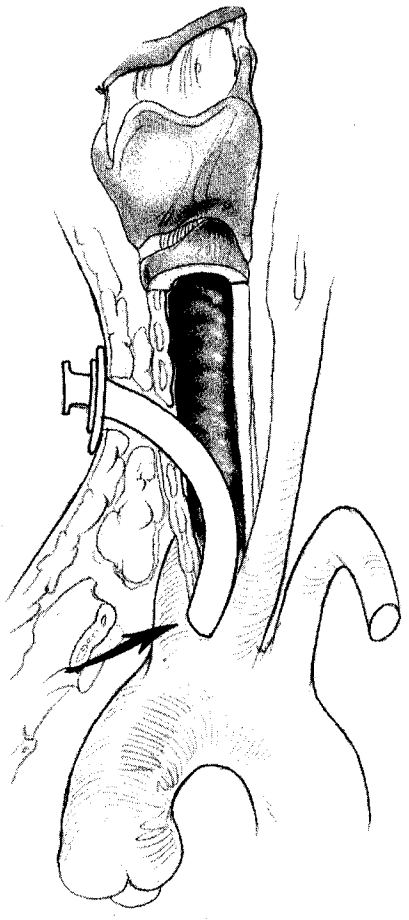

FIG. 57-8. Low tracheotomy resulting in trachea-innominate artery fistula.

correlation, however, seemed to be explained by the longer survival of patients undergoing tracheotomy for upper airway obstruction than those undergoing the procedure for ventilator dependency with the subsequently greater period over which complications had a chance to develop (6) (Table 57-2).

Complications of Percutaneous Dilational Tracheotomy

Many studies have documented the relative safety of this technique in well-trained hands (8–14). Several authors (15,16) also noted an increased complication rate. The main reported immediate complications include misplacement of the dilator tracheotomy tube in a paratracheal position within the soft tissues of the neck or laryngeal structures, hemorrhage, subcutaneous emphysema, damage to the posterior tracheal wall, and death. Long-term complications parallel those of standard tracheotomy, although some authors have been concerned about the possibility of a higher incidence of long-term tracheal stenosis with this technique. Although theoretically the dilation process causes a symmetric dilatation of a hole in the anterior tracheal wall,

TABLE 57-2. *Complications Tracheotomy*

Intraoperative
Damage to great vessels
Damage to tracheo-esophageal common wall
Pneumothorax
Pneumomediastinum
Early postoperative
Tracheostomy tube obstruction
Tracheostomy tube displacement
Pulmonary edema
Infection
Late
Tracheal stenosis
Granulation tissue
Trachea-innominate artery fistula

more likely there is tearing of tracheal cartilage and soft tissue and displacement of the wall of the trachea directly above the tracheostomy into the tracheal lumen. Several articles imply that bronchoscopic monitoring of the technique can add significantly to its safety and decrease the incidence of complications (17–19). The lack of the Bjork flap increases the possibility of tacheostomy tube dislodgement and makes it less likely that once the tube is displaced it can be replaced easily. When performing percutaneous dilational tracheotomy in the intubated patient, the endotracheal tube must be withdrawn to near the level of the vocal cords to afford space for the needle and dilators. During this procedure, it is possible for the endotracheal tube to become displaced, and unless personnel skilled at reintubation are

TABLE 57-3. *History of intubation*

Date	Event
1000 AD	First account of orotracheal intubation written by Avicenna using gold and silver cannulas
1788	Charles Kite reported the use of a curved metal cannula to resuscitate a drowning victim
1878	William Macewen described orotracheal intubation for the administration of anesthesia, utilizing brass tube
1889	A rubber tube was devised by Annandale
1917	Rubber tube became the standard used by Magill
1928	Guedel and Waters added a rubber cuff to Magill's endotracheal tube
1964	First polyvinylchloride tube with an integral inflatable polyvinylchloride cuff was marketed
1970	High-volume, low-pressure cuffs introduced