Chapter 44 – Laryngeal Trauma

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Trauma to the larynx accounts for less than 1% of all trauma. This is explained in part by the fact that the larynx is relatively protected by the mandible, the sternum, and the flexion mechanism of the neck. An alternative perspective is the percentage of patients with laryngeal injuries who are dead on arrival at the emergency department. Line and associates[1] reported a series of 171 victims of blunt neck trauma (strangulation), of whom 112 persons (65%) did not survive. It has been estimated that the emergency departments of busy trauma centers will treat 1 patient with laryngeal trauma for every 5000 to 30,000 emergency department visits.[2]

A basic knowledge of the laryngeal anatomy and physiology is fundamental to understanding the principles established for the management of laryngeal trauma. The primary functions of the larynx are to serve as the airway and to protect the lower respiratory tract. The production of voice, although extremely important for socioeconomic development, is of secondary importance. Respiratory epithelium that is part of the mucociliary clearing system of the respiratory tract lines most of the larynx. The sensory innervation of the supraglottic larynx is supplied by the paired superior laryngeal nerves, which are also branches of the vagus nerves. The superior laryngeal nerves also innervate the cricothyroid muscle, which tightens the vocal folds and, accordingly, is responsible for pitch. The larynx depends on a complex arrangement of intrinsic muscles innervated by the recurrent laryngeal nerves, which are branches of the right and left vagus nerves. A framework composed of cartilage and ligaments supports the laryngeal soft tissue. The cartilaginous framework of the larynx relies on the blood supply provided by the perichondrium.

The larynx is classically divided into three anatomic areas with different functions and characteristics (Fig. 44-1). Thus, the site of injury influences the management and prognosis of laryngeal trauma. The supraglottis has abundant soft tissue and redundant mucosa and is less dependent on external support than lower areas of the larynx. As long as the sensory innervation is preserved, most of the supraglottis can be lost without major functional deficits. On the other hand, the glottis depends on cartilaginous support, cricoarytenoid joint mobility, and perfect neuromuscular coordination to perform its sphincteric and voice-producing functions. To compound these factors, the adult airway is narrowest at the glottic level; therefore, any decrease in the cross-sectional area of the airway at the level of the vocal cords may compromise the airway significantly (proportional to the square of the radius). The subglottis is supported by the cricoid cartilage, which is the only circular cartilage of the laryngotracheal complex. This is the narrowest point of the neonatal and infant airway.

Trauma to the larynx may manifest in a wide variety of ways, reflecting a multitude of uncontrollable variables. Factors that may significantly affect subsequent patient care include patient age, mechanism of injury, velocity of injury, and cutaneous penetration. Accordingly, evaluation and management of the patient with laryngeal trauma require accurate assessment, a working understanding of the principles of laryngeal reconstruction, and an ability to accommodate unexpected findings at exploration in the operating room.

Children rarely suffer direct trauma to the larynx. This reflects the morphologic differences between children and adults. The larynx, in children, is relatively protected inasmuch as it is high in the neck and generally shielded from direct trauma by the mandible. Additionally, the soft, flexible cartilaginous structures of the pediatric laryngotracheal complex are more tolerant of blunt trauma.

The mechanism of trauma greatly influences the likelihood for associated injury and the need for multidisciplinary collaboration. In general, laryngeal trauma is classified as *blunt* or *penetrating*. The most common mechanism of injury is blunt trauma.[3] With a patient injured in a motor vehicle, a broad general assessment of the patient's overall well-being is clearly mandated. The ABCs (airway, breathing, circulation) of trauma care must be recalled. Even with trauma limited to the head and neck, the integrity of the cardiovascular system, potential for intracranial injury, and status of the cervical spine must always be assessed as an initial step of management.

Blunt trauma to the cervical region may produce serious and life-threatening injury, including total obstruction of the airway and significant life-threatening vascular disruption (Fig. 44-2). Cervical spine injuries occur in a significant percentage of patients and may be unappreciated initially because of the obvious soft tissue damage. Injuries to major structures are more clearly apparent when a sharp instrument or penetrating missile results in soft tissue wounds. Nevertheless, injury may be significant even with minimal signs of external wounds. Any type of blunt trauma may disrupt the laryngeal soft tissue or its cartilaginous framework, producing scarring, loss of support, and subsequent collapse of the airway and stricture. It may also dislocate the cricoarytenoid joint, leading to

fixation of the vocal cord, or disrupt the laryngeal innervation, paralyzing the vocal cords. It is important to realize that significant laryngeal trauma may be possible in the absence of signs of external injury.

A peculiar injury is the one produced by strangulation, which is a broad term that includes hanging, garroting (ligature strangulation), throttling (manual compression), and choke-holds. Strangulation accounts for 10% of the violent deaths in the United States. Victims of strangulation most often die at the site of the incident, accounting for its infrequency as an emergency department visit.[4] Strangulation is characterized by the application of a static force over the laryngeal framework,which may fracture the cartilage and not disrupt the mucosa. This latter fact frequently leads the examiner to the false assumption that the victim has not suffered a significant injury. The classic injury in strangulation victims is a fracture of the superior thyroid cornu, which may be accompanied by cordal hematomas, petechiae of the endolaryngeal mucosa, or arytenoid dislocation. A history of significant bleeding that has spontaneously resolved or a hematoma that developed rapidly suggests a major vascular injury that will require evaluation. The Isadora Duncan syndrome consists of strangulation with carotid contusion, avulsion, or occlusion and laryngeal rupture.[5]

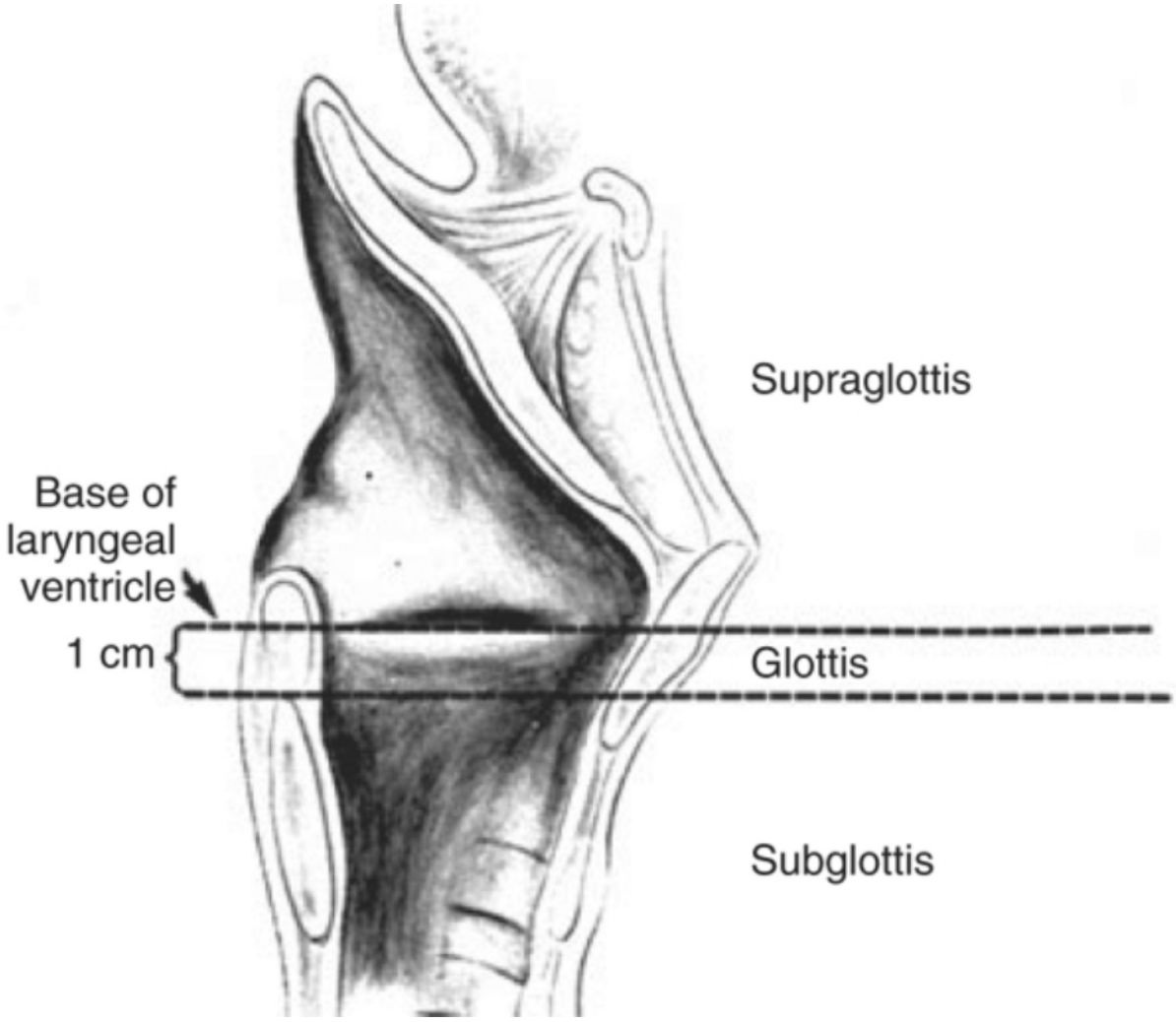

Figure 44-1 Sagittal drawing of the larynx depicting the three anatomic areas. The glottic larynx extends from the free edge of the true vocal cord inferiorly 1 cm. This approximates the histologic observation of stratified squamous epithelium on the glottis changing to respiratory epithelium of the subglottis.

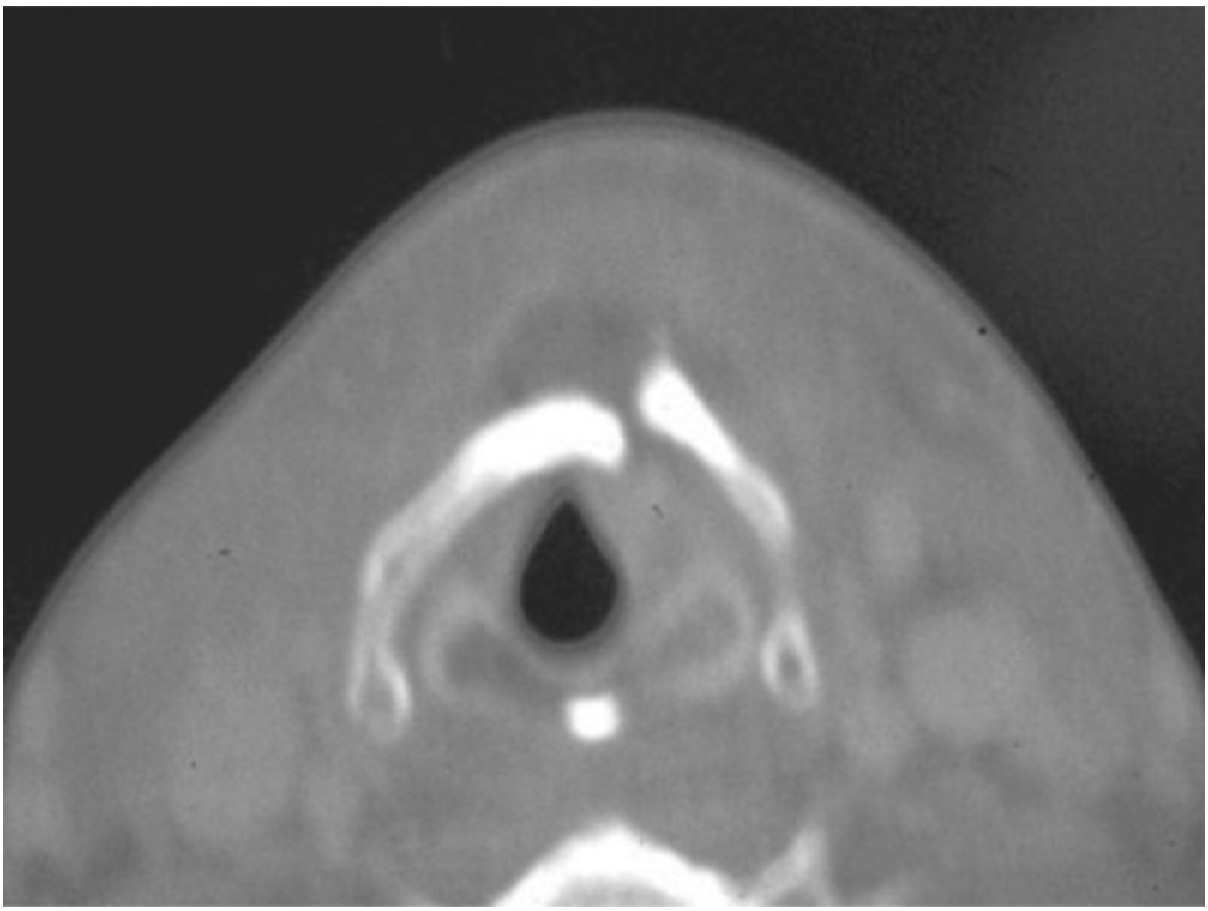

Figure 44-2 Computed tomography demonstrates a displaced cartilage fracture. The integrity of the mucosa should be confirmed endoscopically. The cartilage requires reduction and fixation.

PREOPERATIVE EVALUATION

The larynx may also be involved in penetrating trauma to the neck. It is important to recognize that approximately 60% of the patients with penetrating trauma to the larynx will have other associated injuries, such as neurologic vascular or esophageal injuries.[2] Penetrating trauma includes a wide range of injuries, ranging from stab wounds to gunshot wounds. Although stab wounds usually follow a straight line or predictable path, bullets or other projectiles tend to follow planes of least resistance (e.g., fascial planes), producing less predictable injuries. Bullets cause injury both by direct contact as well as tissue distention caused by the abrupt displacement of the tissues produced by the bullet's shock wave (Fig. 44-3). The trauma caused by this shock wave increases as the square of the velocity, hence high-velocity weapons such as assault rifles cause much greater injury. Therefore, when evaluating patients with penetrating trauma, it is important to know the circumstances of the attack: factors such as angle of penetration, types of bullet and weapon, and distance of attack are all important to estimate the degree of trauma.

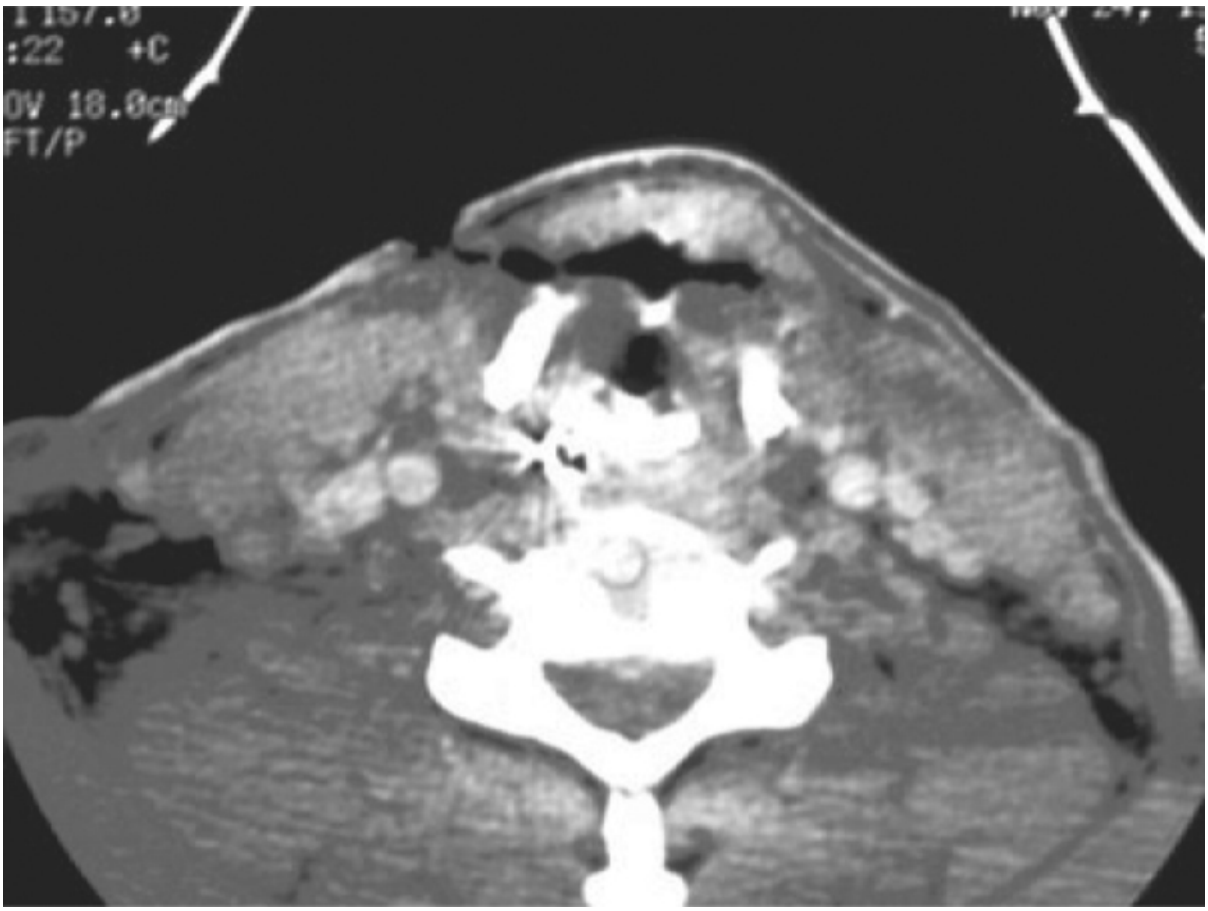

Figure 44-3 This open laryngeal injury (gunshot wound) requires emergent establishment of a tracheotomy and then comprehensive repair of both mucosa and framework trauma.

The integrity of the airway must be initially assessed. Cyanosis and stridor are indications for immediate intervention. Intubation of the acutely traumatized airway may be dangerous or impossible. Tracheotomy or, under some circumstances, cricothyrotomy should be initiated.[6]

When the status of the cervical spine is either suspect or uncertain, manipulation of the neck and positioning of the patient for tracheotomy may be difficult and imprudent. Under extreme circumstances, insertion of a large-bore needle directly through the cricothyroid membrane or into the trachea with administration of oxygen may be lifesaving and “buy time” for definitive airway intervention. Patients with laryngeal trauma almost invariably have primarily inspiratory obstruction owing to collapsed tissue during inspiration. Accordingly, oxygen delivered directly in the trachea may be expired through the injured larynx in most patients. Concurrent intrathoracic injury, including pneumothorax, fractured ribs with a flail chest, or a pulmonary contusion, may be the cause of respiratory distress and must be considered.

When the airway is compromised but stable, it is possible to carefully observe the airway in the emergency setting while the remainder of the assessment is completed. An innovative way to temporarily manage mild airway compromise is to administer a mixture of helium and oxygen in a ratio of 70:30 via a Venturi system. Helium is less dense than nitrogen and therefore produces less friction and better flow through the airway, decreasing the respiratory workload. A mixture of helium and oxygen may be useful as a temporary measure until surgical airway is established.

Ruling out cervical spine fracture will facilitate patient movement and allow improved positioning of the patient for tracheotomy. At minimum, this requires anteroposterior, odontoid, and cross-table and clinical evaluations. Some spinal cord injuries have no associated fracture; therefore, one may miss some injuries when relying on radiographs alone. Examination for cardiopulmonary, neurologic, orthopedic, abdominal, and other associated injuries allows the resuscitation team to prioritize interventions appropriately. In most facilities, a trauma surgeon coordinates the care of the injured patient.

Dysphonia and hoarseness in the setting of blunt trauma to the neck must be considered evidence of severe laryngeal injury until proven otherwise. These patients should undergo careful clinical and radiographic evaluation before disposition. Similarly, the finding of cervical subcutaneous emphysema warrants a presumptive diagnosis of

a ruptured viscus structure.[7] It is incumbent on the emergency team to identify the injured area and make plans for subsequent management.

The potential for injury to cranial nerves must be considered. Neuropathy in the face of a sharp or penetrating injury is an indication for nerve exploration and neurorrhaphy as needed at the time of surgical exploration. The effectiveness of vagal or recurrent laryngeal nerve repair is controversial. Neurorrhaphy may result in synkinesis, but some authors have reported useful return of motion or at least tone.[8]

The potential for vascular injury must be considered. An expanding hematoma or continuing hemorrhage from an open wound is an indication for immediate operative exploration. If the patient is stable, the area of the carotid sheath may be further evaluated with various vascular imaging techniques. Blunt trauma to the carotid may indicate occlusion or dissection, which may not be initially apparent. The presence of a bruit may be one indication of such an injury. The value of close collaboration with a vascular surgery team is apparent. Lacerations of the cervical esophagus or pharynx may occur, primarily with penetrating injuries, and need to be ruled out. Failure to recognize and treat can lead to serious infectious complications. Depending on the circumstances, evaluation with either contrast radiographic studies or endoscopy is appropriate.

PREOPERATIVE ASSESSMENT

Strict guidelines for preoperative evaluation cannot be employed. Rather, the circumstances surrounding the trauma, including concurrent injuries, the mechanism of injury, and the severity of the injury, must be integrated into the diagnostic plan. Patients with impending airway obstruction must undergo immediate tracheotomy. Similarly, patients with injury to the great vessels may require immediate surgery. Severe or life-threatening injuries to other bodily systems may delay intervention for stable laryngotracheal trauma.

When circumstances permit, a careful physical examination followed by directed imaging studies will facilitate subsequent treatment planning, intervention, and care. In one study of patients with laryngotracheal injury, the most prevalent findings on physical examination were subcutaneous air (53%), hoarseness (47%), neck tenderness (27%), and stridor (20%).[9]

Physical examination should include assessment of the airway and voice. Dysphonia or hoarseness suggests laryngeal injury. The soft tissues of the neck should be carefully observed and palpated. The loss of the prominent contours of the thyroid cartilage and cricoid ring may be significant observations. Soft tissue abrasion and ecchymosis help confirm the severity and direction of injury. The presence of a mass often indicates vascular injury. Soft tissue emphysema suggests perforation of an air-containing viscus.

Examination of the oral cavity and oropharynx should be supplemented by direct visualization of the larynx and hypopharynx. This can be undertaken with either a rigid telescope or flexible fiberoptic endoscopic equipment. The observer should note soft tissue disruption, lacerations, edema, or ecchymosis. Vocal cord function should be ascertained. Shortening of the anteroposterior diameter of the glottis is one indication of thyroid cartilage fracture and subluxation. The arytenoid cartilage may be dislocated. Kennedy and colleagues suggest that strobovideolaryngoscopy may greatly enhance initial evaluation.[10] Traumatic separation of the larynx from the trachea can occur even in blunt injuries and is frequently associated with bilateral vocal cord paralysis. Many patients with the injury do not survive the acute episode, although the author's group has encountered a few such individuals who survive transport to the emergency department. These patients can survive if initial management is direct and skillful.

Findings suggestive of trauma to the laryngotracheal complex should, in almost every circumstance, lead to subsequent imaging. Computed tomography (CT) is useful in assessing the integrity of the laryngeal framework as well as the cervical spine (Fig. 44-4). A CT scan, however, is not necessary in patients presenting with clear indications for surgery, such as active bleeding, hematoma, escape of air through the external wound, hemoptysis, need for emergency cricothyroidotomy, exposed cartilage, or significant lacerations ofthe mucosa. A CT scan is most useful in evaluating questionable findings, clinically mild injuries, and victims of strangulation (Fig. 44-5).

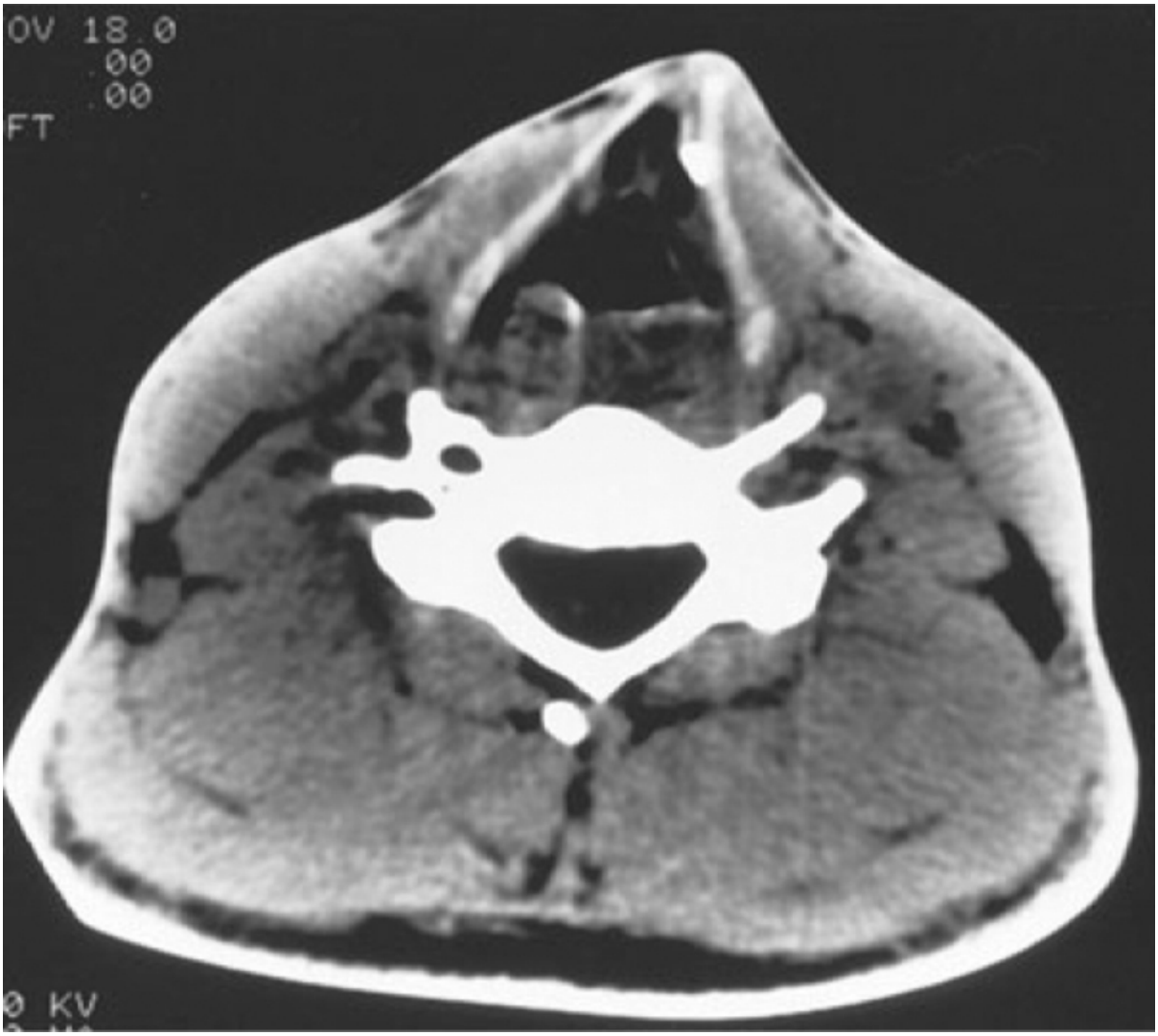

Figure 44-4 Computed tomography (CT) scan shows diffuse subcutaneous emphysema. Asymmetry of the laryngeal framework suggests laryngeal fracture.

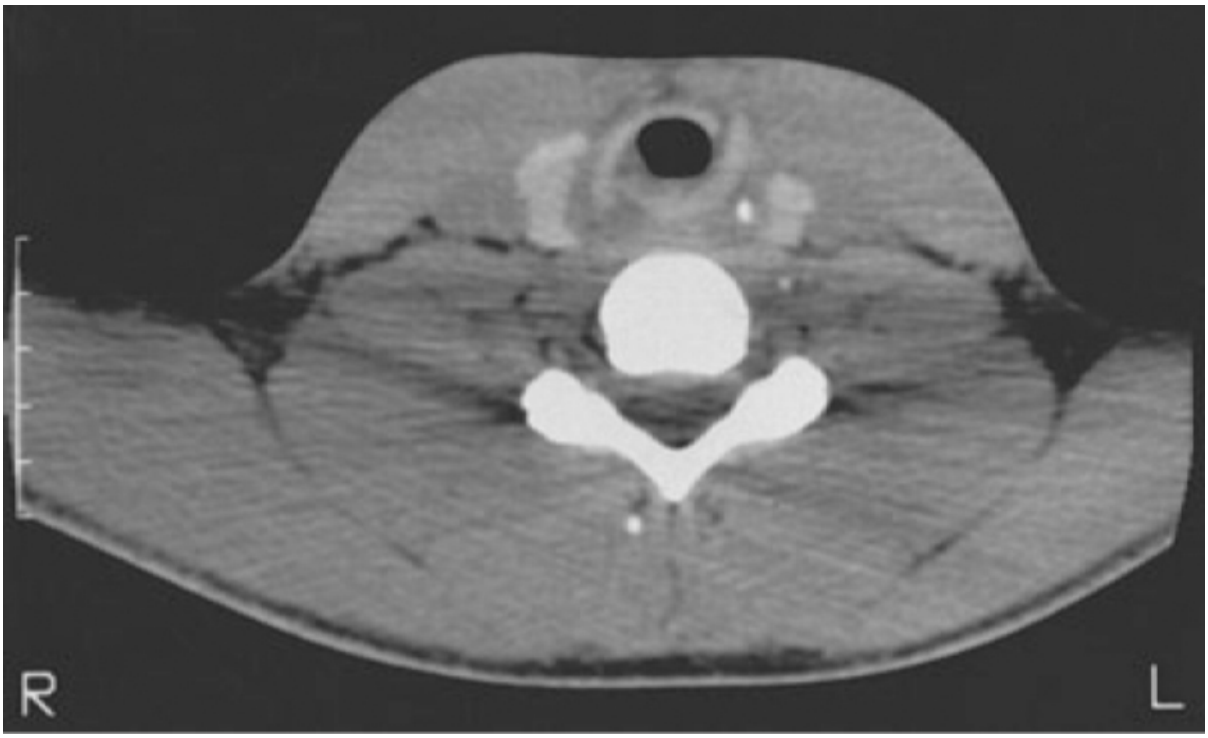

Figure 44-5 This telescoping fracture of the cricoid cartilage was the result of strangulation.

It is of utmost importance to secure the airway and to perform a flexible laryngoscopy before transferring the patient to the CT scanner. We prefer the use of high-resolution CT with contrast. Undisplaced fractures of the thyroid or cricoid cartilage in the face of normal physical examination may require no further intervention (Fig. 44-6). Displaced fractures or soft tissue disruption almost always requires surgical exploration and repair. With soft tissue disruption, interval tracheotomy is usually required. Early exploration invariably results in easier reduction of cartilaginous injury and more accurate soft tissue repair.[8] Delay in the performance of the procedure leads to scarring, edema, local infection, and distortion of tissues that may lead to a poor outcome. We favor exploration within 24 to 48 hours if the patient's general condition permits. Perioperative antibiotics are warranted and should be initiated be-fore surgery and discontinued within 24 hours postoperatively.

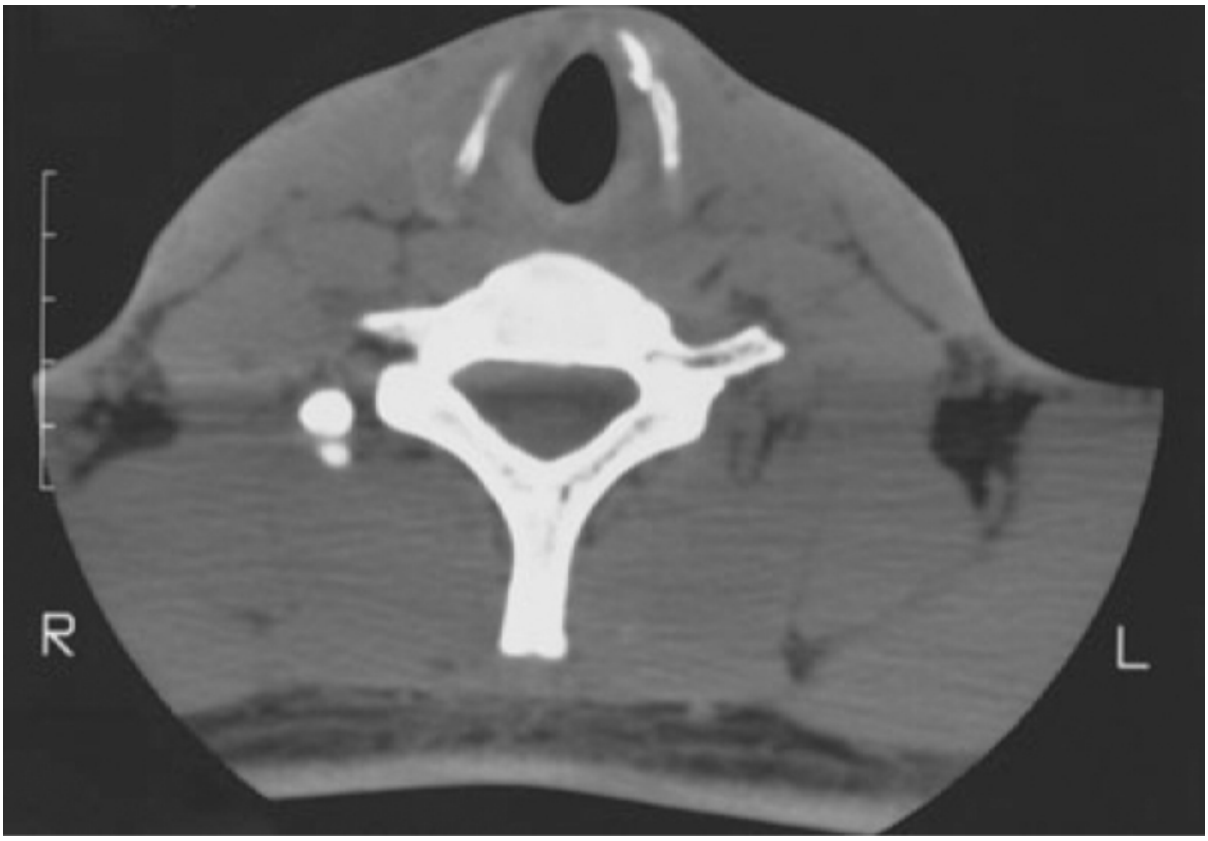

Figure 44-6 Minimal displacement of the thyroid cartilage demonstrated on computed tomography scan may not require open reduction, but the mucosa must be carefully evaluated before nonoperative intervention can be deemed satisfactory.

OPERATIVE TECHNIQUE

The first initiative in the management of patients who have trauma to the laryngotracheal complex is to establish a secure and safe airway. Under many circumstances, this is the most challenging and dangerous aspect of the entire procedure. The most experienced members of both the surgical and the anesthetic teams must be present at this juncture. Delegation of this aspect of the case to the junior members of the team is a serious error in judgment. When preoperative assessment has indicated significant disruption of laryngotracheal anatomy, an airway must be secured with tracheotomy. When time permits, we prefer tracheotomy between the second and third or third and fourth tracheal cartilage rather than cricothyrotomy. If cricothyrotomy is performed, it should be revised to a tracheotomy if it will be needed for more than 7 days. The presence of cervical spine fracture must be ruled out before any airway or endoscopic procedure in which the head is moved. If it cannot be ruled out, the safest route is tracheotomy without neck extension.

Following establishment of a secure airway, diagnostic endoscopy is almost always indicated. Once again, the cervical spine must be “cleared” before endoscopic manipulation. The cervical esophagus as well as the larynx should be examined. Cartilage displacement without significant mucosal disruption may be successfully managed without formally entering the airway. Conversely, significant injury to the laryngeal skeleton with soft tissue disruption requires a direct approach that allows soft tissue repair and reduction of the laryngeal fracture.

The choice of incision must consider the need for exploration and repair of concurrent injuries as well as the position of coexistent lacerations. When a procedure is to be limited to the laryngotracheal complex, a transverse incision may be sufficient. Under many circumstances, a superiorly based apron flap is appropriate. The inferior aspect of the apron will be the site of the tracheotomy. The strap muscles are separated, allowing direct observation of the site of injury. Fractures may be reduced by employing small elevators and hooks, taking care to avoid further damage to the cartilaginous structures and underlying mucosa.

When exploration of the mucosal surfaces is required, efforts should be made to place the cartilage incision directly through the midline at the level of the glottis. This is facilitated by horizontally incising the mucosa at the cricothyroid membrane, then cutting superiorly under direct visualization. Entering the anterior commissure from either side is a serious technical error that will adversely affect the outcome of the repair. Mucosal repair then is undertaken using fine absorbable sutures. Attachment of the true vocal cord to the anterior commissure must be ensured (Fig. 44-7). When in doubt, we employ a fine nonabsorbable suture to fix the anterior-most portion of the vocal cord to the anterior commissure. Soft tissue avulsion injuries are unusual, so that repair is similar to assembling a puzzle. Lacerations and flaps can be repaired and anatomyrestored. Rarely, denuding injuries are close to one another, especially with penetrating injuries; these may result in scar contracture and subsequent stenosis, so replacement of lost mucosa with mucosal grafts or flaps and stenting may be required.

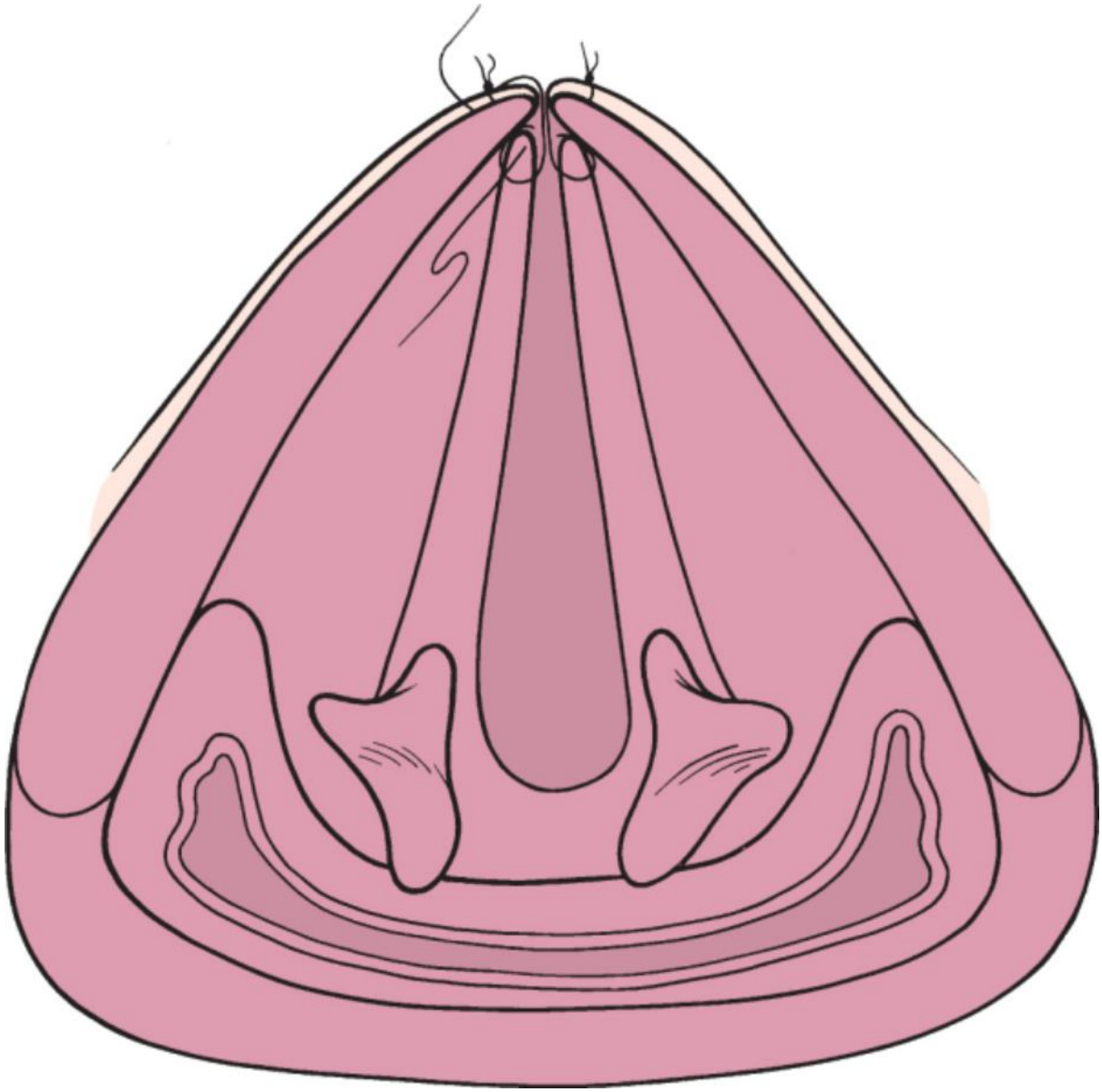

Figure 44-7 When laryngofissure is used to expose the larynx, the surgeon must ensure that the anterior commissure is fixed at the completion of the case. This is best done by employing fine nonresorbable suture.

Stents may be either hard or soft and require stabilization with nonresorbable sutures passed through buttons. Wire tends to break and should be avoided. The use of stents in the lumen is controversial. Clearly, the presence of a foreign body carries with it the potential for further trauma to the mucosal surfaces of the laryngotracheal

complex. This potential disadvantage must be weighed against the need to support cartilaginous and soft tissue repairs. It is important to clearly distinguish the functional difference between a stent and a keel. A stent is designed to support 360 degrees of the airway, thereby providing support to the cartilaginous framework and mucosa. Theoretically, epithelial migration can progress, circumferentially if needed, and contracture or adhesion may be prevented. Unfortunately, experience has taught that scar contracture may progress after stent removal, and soft tissue injury induced by stent motion or a poorly fitting stent may contribute to subsequent stenosis.

A keel, in contrast, is designed to keep the opposing surfaces of the two vocal cords from contracting, thereby allowing the surface to fully mucosalize to prevent web formation (Fig. 44-8). The presence of the keel inserted through a laryngofissure may lengthen the anteroposterior dimension of the larynx. The need for a keel to prevent webbing at the anterior commissure in patients with significant injury to the true vocal cord is far less controversial. Insertion of a keel allows migration of mucosa anteriorly and prevents adhesions and synechiae.

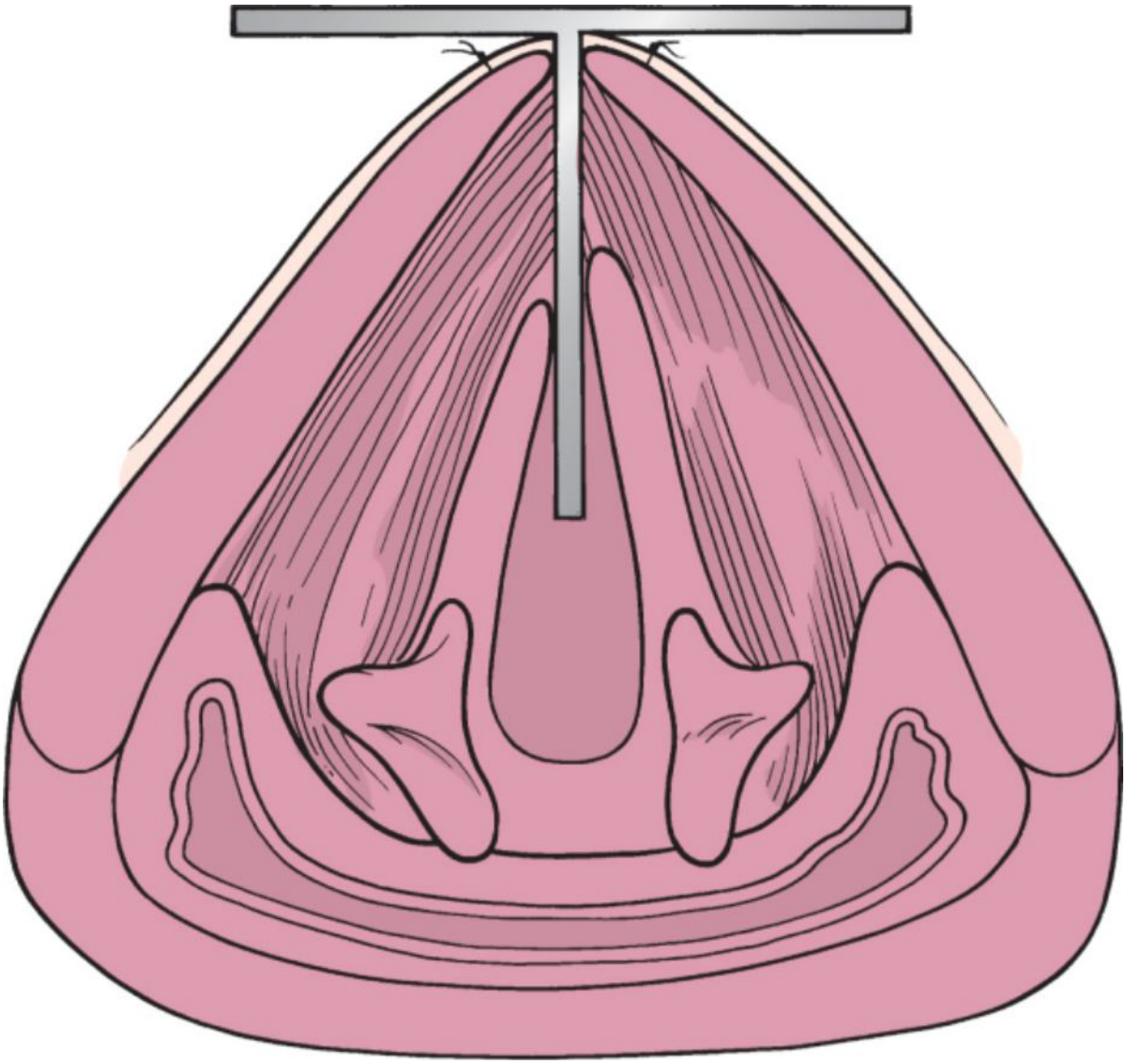

Figure 44-8 The use of a keel is intended to allow the injured surface of the vocal cord to reepithelialize to the anterior limit of the keel, thereby avoiding development of a side-to-side web.

Cartilage repair must be meticulous and may be undertaken with nonresorbable suture, wire, or miniplating systems (Figs. 44-9 through 44-12). We and others[11,12] have successfully employed small plates to repair injuries to the thyroid and cricoid cartilages. Resorbable miniplates are now available.[13] The surgeon must be certain that the screws are properly sized such that they do not penetrate the mucosal surfaces. Supporting the framework in an anatomic position often requires overcorrection of the thyroid cartilage, because the natural vector of force tends to spread the alae, thereby shortening the anteroposterior dimension of the larynx.

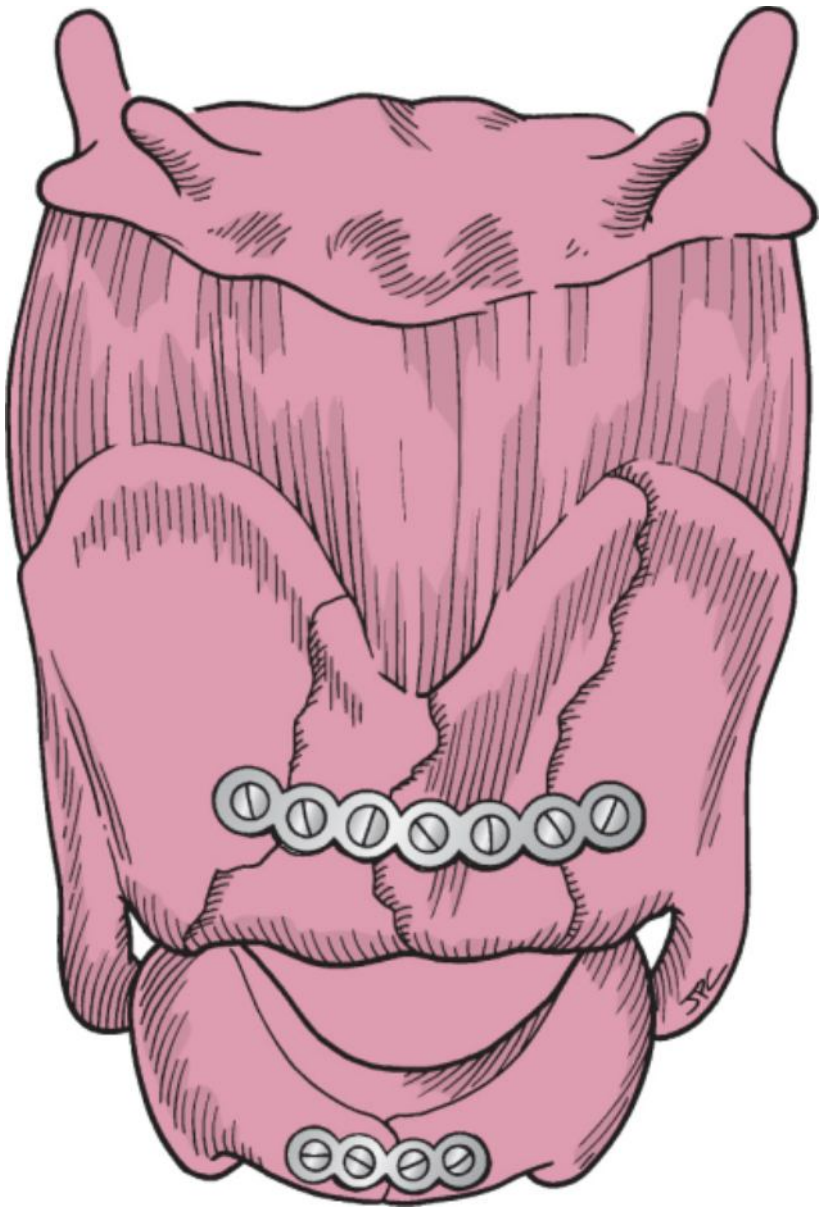

Figure 44-9 This schematic demonstrates how miniplates can be employed to repair thyroid or cricoid cartilage injuries.

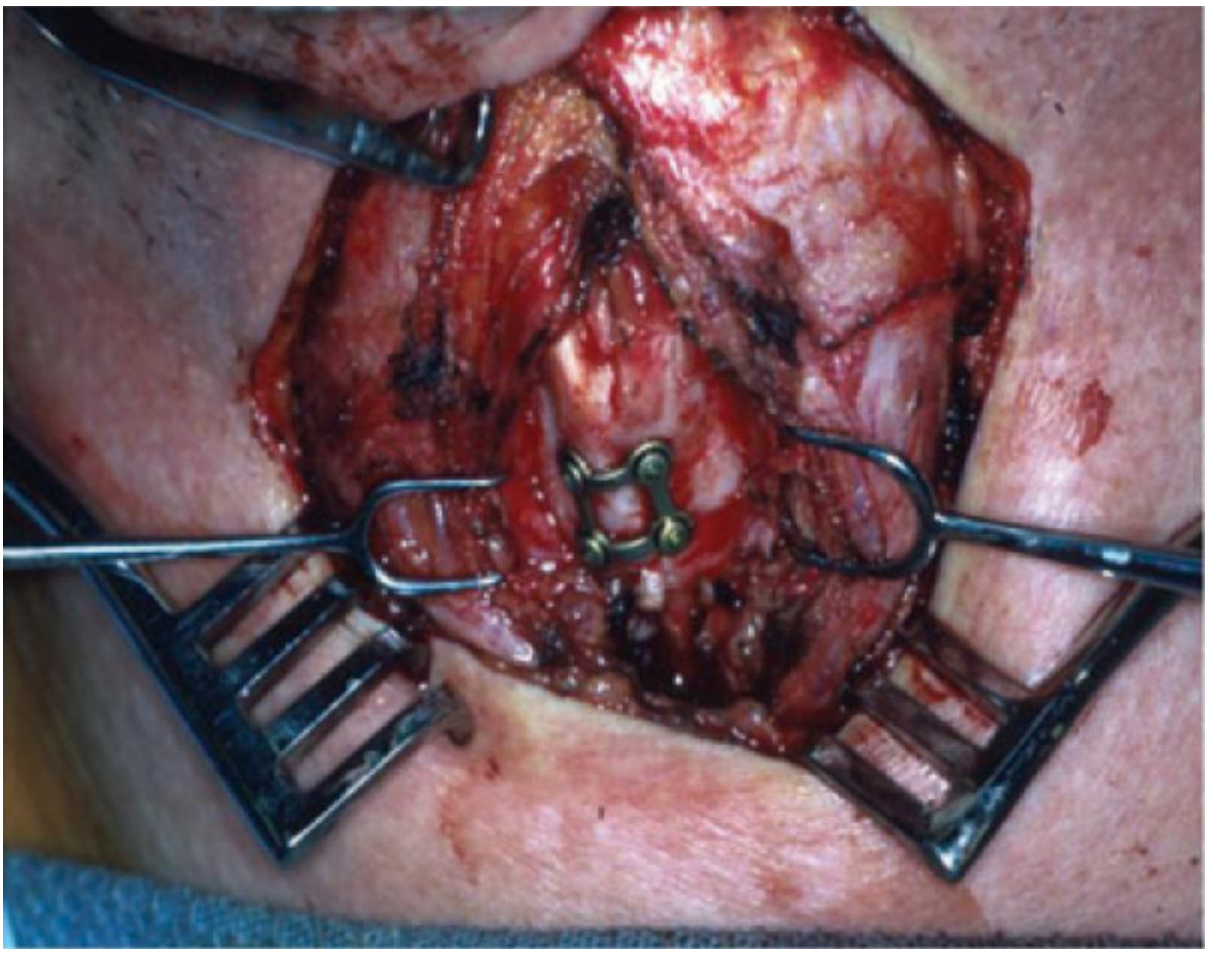

Figure 44-10 Miniplates, with appropriate length screws, are ideally suited to repair and stabilize cartilage fractures.

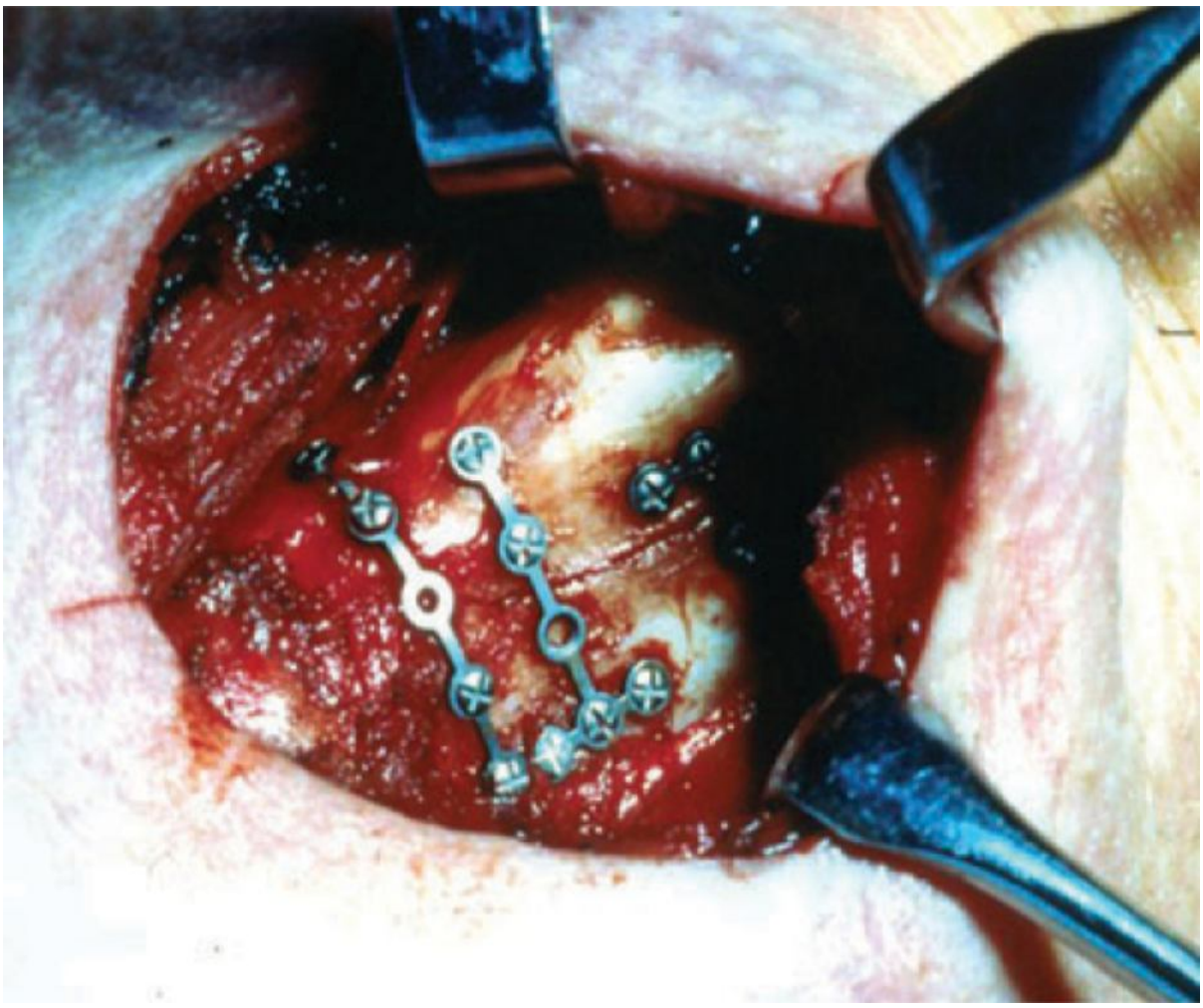

Figure 44-11 Complex fractures may require more than one plate for fixation.

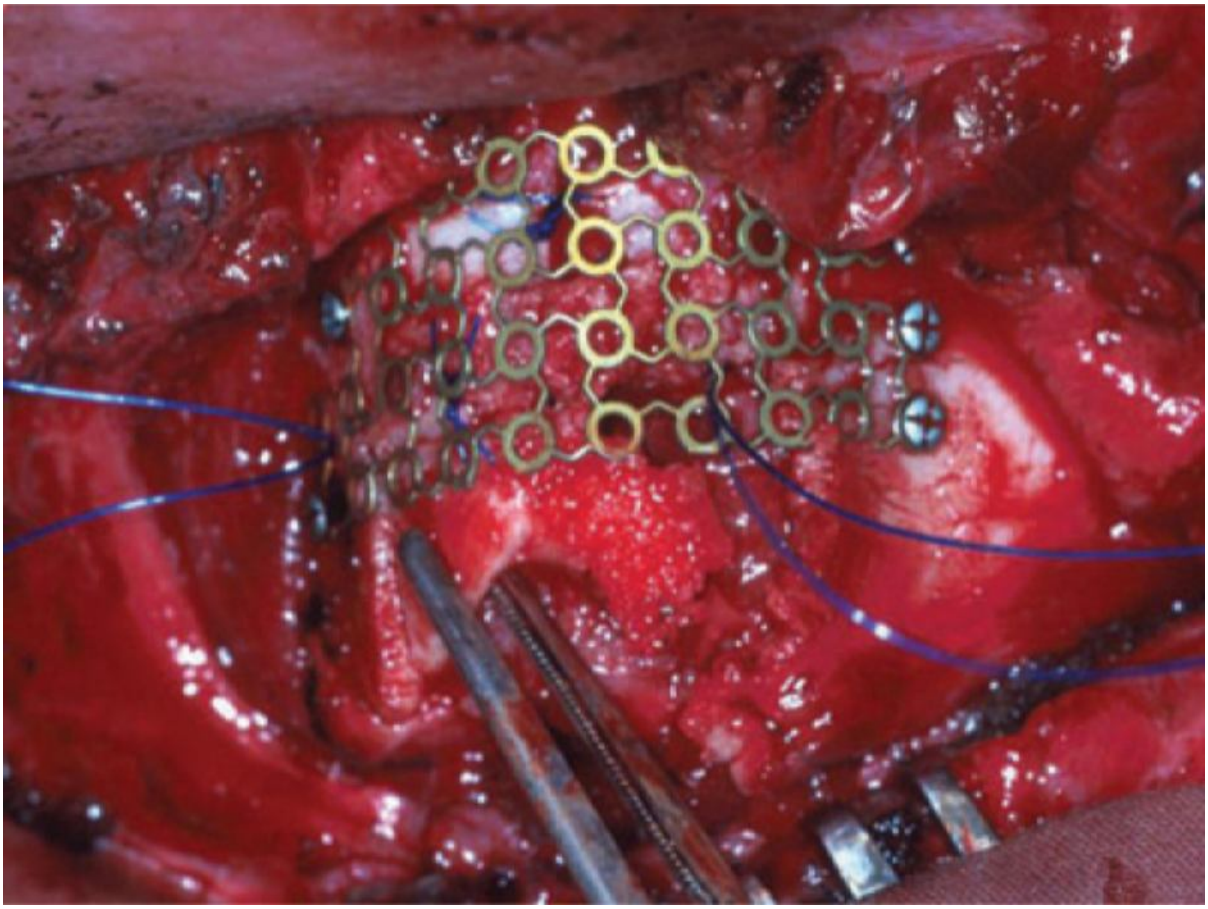

Figure 44-12 Shattered laryngeal cartilage is supported by mesh framework. A Montgomery stent is fixed with translaryngeal-transcutaneous sutures.

Cricoid fractures can be elevated and wired to either a microplate or an arch bar. Soft tissues are returned to the anatomic position, and the wound is closed in layers. A passive drain (e.g., Penrose) should be employed because a watertight mucosal closure is rarely possible. Accordingly, use of a suction drain is imprudent in that it will aspirate mucus into the wound. If the skin incision incorporates the tracheotomy, efforts must be made to seal the tracheotomy wound from the rest of the wound by approximating the subcutaneous tissues of the flap to the strap muscles. Use of a compressive dressing may be ill-advised, especially in the face of cartilage injury. The administration of perioperative prophylactic antibiotics that are effective against oral flora is indicated.

POSTOPERATIVE MANAGEMENT

Patients undergoing surgery for laryngeal trauma should be observed postoperatively in an acute care setting. Routine use of oximetry is advisable. Nothing isgiven by mouth in the acute period. In the face of injury to the hypopharynx or esophagus, the patient may be fed through a nasogastric tube until edema and pain have resolved enough to permit oral feeding. Patients with injuries limited to the laryngotracheal complex can frequently be fed by the third or fourth postoperative day.

Routine tracheotomy care includes the use of humidified air delivered to the tracheotomy with a tracheotomy mask. A T tube connector should be avoided because it may torque the tracheotomy, producing unnecessary damage. The nursing service should begin regular tracheotomy care with suctioning and cleansing of the inner cannula.

The tracheotomy tube can be removed when the airway is stable and the glottis is competent to prevent aspiration. We test for glottic competency by deflating the tracheotomy tube cuff. Aspiration is an indication that the glottis is incompetent, and continued use of a cuffed tracheotomy tube is necessary. Continued cough may be a more subtle indication of aspiration.

The adequacy of the airway can be ascertained through direct visualization with fiberoptic equipment. The airway can be functionally assessed for integrity by changing the tracheotomy to a smaller uncuffed tracheotomy tube. The tube is then plugged and the patient observed for respiratory distress. Patients who tolerate the use of a plugged tracheotomy tube during a 24-hour day may be safely decannulated. The tracheotomy site is allowed to heal by secondary intention.

It may be advisable to prepare patients with significant laryngotracheal trauma for home tracheotomy care and to discharge them for subsequent follow-up and decannulation as an outpatient. Minimal follow-up of severe laryngotracheal injury in which stenosis may result from scar contracture must be measured in months.

Accidental decannulation may be life-threatening in the case of acute repair of a laryngotracheal injury. This is especially true in patients in whom a stent has been inserted. Prevention is the first principle in the management of this complication. The tracheotomy tube should be sutured to the cervical skin. Ties around the neck are used as reinforcement. Recovery room and intensive care personnel must be advised of the nature of the injury. If intubation is not possible, these personnel, especially, must be briefed on the management of accidental tube displacement. Tube reinsertion can be facilitated by replacement of traction sutures through the tracheal ring above and below the tracheotomy site. These sutures are taped to the skin during the postoperative period. Replacement of a fresh tracheotomy tube is facilitated if the patient can be placed in a head-extended position. Direct visualization of the tracheotomy site facilitates proper placement of the tube. Blind insertion of the tube into the tracheotomy site may lead to placement in the peritracheal soft tissue anterior to the trachea, with subsequent efforts at ventilation associated with a high resistance and the development of subcutaneous air or pneumothorax. This disastrous circumstance can be prevented only by placing the tube in the tracheal lumen. Immediate access to prop-er lighting, retraction instruments, and small-caliber replacement tubes may facilitate management under emergent situations.

Mucus or saliva coming from the drain is an indication of wound dehiscence and a fistula. The drain should be maintained until soft tissues have had an opportunity to seal. This usually takes 7 to 10 days, following which the drain can be advanced and the fistula tract will close. Antibiotics may be administered to prevent the development of systemic sepsis. Premature removal of the drain may result in a subcutaneous collection with subsequent elevation of the cervical skin flap. Collections require opening of the wound and reinsertion of a drain.

The most significant long-term complication of laryngotracheal repair is stenosis. All healing tissue goes through a period of wound contracture. Circular wounds are the most likely to lead to stenosis. The medical literature is replete with a menu of secondary reconstructive techniques (see Chapter 45). Prevention of stenosis through gentle handling of tissue, accurate reapproximation of injured tissue, and judicious use of stents, keels, and other lumen-keepers seems to be the most reliable tactic.

Long-term stenting may succeed in maintaining a lumen, but it will not prevent stenosis due to scar contracture. Eventual open exploration with adequate grafting may be necessary to create a permanent lumen.

PEARLS

- Penetrating laryngeal trauma requires endoscopic evaluation and repair of disrupted epithelium and cartilage.
- Voice change following blunt cervical trauma mandates evaluation of laryngeal anatomy.
- All patients with significant laryngeal trauma should be considered at risk for cervical spine injury.
- Penetrating airway trauma may be associated with significant neurovascular injury.
- Tracheotomy (or cricothyrotomy) may be required when laryngeal trauma results in stridor or cyanosis.
- Displaced thyroid and cricoid cartilage fractures require early reduction to improve long-term results.
- Keels and stents may facilitate epithelial regrowth and prevent scarring following major disruption.
- Tracheotomy tubes must be secured in the presence of severe laryngeal trauma.

PITFALLS

- Failure to reduce a significant laryngeal fracture may result in permanent dysphonia.
- Failure to establish normal contour of the thyroid cartilage will result in poor voice and often requires rigid fixation.
- Failure to observe and document post-traumatic injuries may lead to patient dissatisfaction.
- Poorly secured tracheotomy tubes may lead to airway obstruction.
- Laryngeal stents and keels may obstruct if poorly secured.