| 8.3.1 Libby | Describe the zones of the neck and zones of the face. How does this impact workup of the patient? |
| 8.3.2 Libby | Give us a grading system of laryngeal fractures. How does the grade affect acute and long term management? What grade injury is represented in the picture? |
| 8.3.3 Libby | Discuss the role of CT scan in decision making for the care of laryngeal trauma. |
| 8.3.4 SW | Discuss the role of stents and keels in operative management of laryngeal fractures. |
| 8.3.5 SW | How do you assess and manage inhalation injury to the larynx? Is there a difference in steam vs. fire inhalations? |
| 8.3.6 SW | An 18-year old female presents to the Trauma Unit after a clothes line injury to the neck (she and her girlfriend were joy riding on a moped at 2AM and ran into a metal chain). She is stable, but appears to be having increasing respiratory distress. What do you look for on physical exam and how will you work this up? Does she need to go to the OR stat? |


| 8.3.7 AL | What is the best way to manage the airway in laryngotracheal trauma? What role does intubation play in that management? |

*Examination and Initial Management*
Examination and initial management of laryngeal trauma should be
part of primary and secondary surveys according to Advanced Trauma Life Support guidelines, to ensure that concomitant injuries are not missed (Table 70-2). The over-riding priority is to establish a safe airway with cervical spine protection, which may, and often does, necessitate performing an emergency tracheotomy with the use of local anesthesia. Endotracheal intubation is not a preferred method of airway control in laryngeal trauma, because it can exacerbate a laryngeal injury and precipitate total airway obstruction. Endotracheal intubation can be particularly difficult to perform in the presence of concomitant maxillofacial injuries in a patient with an immobile neck. If endotracheal intubation has been performed, it is converted at the earliest opportunity to a tracheotomy to prevent long-term laryngeal injury. In selected cases transtracheal jet ventilation or cricothyroidotomy may be a helpful temporizing measure. No manipulation of the neck is permissible until the cervical spine has been “cleared”—that is, until injuries to the cervical spine have been ruled out in a systematic manner.

The neck is inspected for evidence of injury such as skin abrasions, bruising, and entry and exit wounds in penetrating trauma, and is palpated for crepitations, laryngeal tenderness, and any obvious changes in laryngeal anatomy, such as loss of the prominence. Open wounds should not be explored at this stage because instrumentation may restart hemorrhage. Flexible nasoendoscopy is then performed, and the oropharynx and hypopharynx are examined for injuries. The laryngeal mucosa is examined for lacerations and hematomas, and particular care is taken to assess the vibratory edge of the vocal cords and the anterior commissure. Arytenoid adduction is examined during phonation, and abduction is assessed by asking the patient to sniff. Impairment of arytenoid mobility may be secondary to structural damage or due to recurrent laryngeal nerve injury. Note is taken of any exposed or protruded cartilage or submucosal distortion of the framework. A sign of cartilaginous injury is failure of the vocal cords to meet in the same horizontal plane.

Use of Computed Tomography

In our practice, multislice computed tomography (CT) (Fig. 70-4) is performed in all patients presenting with “impending airway obstruction” once their airways have been secured, and in those patients with “stable airway” who are found, on flexible nasoendoscopy to have endolaryngeal abnormalities, because imaging may reveal further injuries not readily identifiable with flexible nasoendoscopy. CT scanning can be deferred only in those patients with a history of relatively minor trauma to the neck, no laryngeal tenderness or surgical emphysema, stable airway, and the finding of minimal laryngeal injuries on flexible laryngoscopy. It is important to appreciate that laryngeal trauma is associated with a cervical spine fracture at a rate approaching 10%. At the same time, injuries that occur close to the cervical spine are known to be more likely to mask a spinal injury than injuries further away. We take the view therefore that all but the most minor of laryngeal injuries constitute a “distracting injury” and mandate cervical spine radiography under National Emergency X-Radiography Utilization Study (NEXUS) criteria (Box 70-1). Our practice of using CT to clear the cervical spine irrespective of plain radiography findings is informed by a growing body of evidence demonstrating a much higher sensitivity for CT over plain radiography in diagnosing spinal injuries. Overall, therefore, detailed radiologic imaging of the larynx is available in the majority of patients with laryngeal trauma both because of primary laryngeal indications and as a by-product of “clearing” of the cervical spine.

Classification

Laryngeal trauma can be classified according the Schaefer-Fuhrman or Lee-Eliashar system. We use the Schaefer-Fuhrman system but also formally and separately document the extent of injuries to the laryngeal mucosa and framework, the vibratory mechanism, and
the laryngotracheal complex (Table 70-4).

Management

Airway Management

The first priority in managing laryngeal trauma is to assess and secure the airway while protecting the cervical spine. We take a stepwise approach to securing the airway based on information available at the different stages of clinical assessment (Fig. 70-5). A stridulous patient with respiratory distress at presentation should immediately undergo tracheotomy with local anesthesia. If the airway is judged to be stable following initial history and examination, the patient undergoes flexible nasoendoscopy. In a small number of cases, unexpected airway-encroaching injuries are identified at this stage and tracheotomies are performed. More subtle endolaryngeal injuries are further assessed with CT, and again, if airway-encroaching injuries are identified, a tracheotomy is performed.

Surgical versus Nonsurgical Therapy.

The decision as to the most appropriate therapy for laryngeal trauma rests on assessing the stability of, and the extent of injury to, the laryngeal framework, the extent of mucosal injuries, the presence of injury to the vibratory apparatus, and the integrity of the laryngotracheal junction. Jewett and colleagues showed that 37% of patients with laryngeal trauma could be managed with no airway intervention and that a further one sixth of patients required only a tracheotomy.

Conservative Management

Patients in whom nasoendoscopy has found the endolarynx normal, as well as patients with minimal endolaryngeal abnormalities and a stable laryngeal framework whose airway patency has been confirmed by CT, can be conservatively managed (see Fig. 70-5). Conservative management consists of a minimum of a 24-hour admission to a high dependency unit, with regular observations, serial flexible nasoendoscopy examinations, and use of humidified oxygen. A mixture of oxygen and helium should be on standby in case respiratory embarrassment develops. The patient’s head is elevated to reduce further edema, and corticosteroids are administered if presenting within 24 hours of injury. All patients are prescribed a proton pump inhibitor and, if the laryngeal mucosa has been breached, are also given prophylactic broad-spectrum antibiotics.

Surgical Management

Patients with more significant injuries require surgical intervention. The optimal timing of repair is a subject of debate, and in patients with polytrauma, laryngeal surgery may have to be coordinated with other procedures. We aim to repair all laryngeal injuries within 12 hours of presentation and are reluctant to accept delays beyond 24 hours. Delays in treatment can lead to granulation and scar tissue formation, which can progress to laryngeal stenosis (Fig. 70-6), a difficult surgical problem to correct.

Diagnostic or Therapeutic Endoscopy.

All patients who are not managed conservatively should undergo microlaryngoscopy and tracheoscopy, direct pharyngoscopy, and direct esophagoscopy. In a proportion of patients definitive, endolaryngeal treatment can be undertaken endoscopically. Hematomas can be drained, mucosal and selected vocal cord lacerations can be repaired, and dislocated cricoarytenoid joints can be reduced. If there have been extensive injuries to opposing laryngeal mucosal surfaces, stents can also be deployed endoscopically to prevent adhesions.

Open Laryngeal Repair.

The main indications for open repair are unstable or comminuted laryngeal fractures, cricotracheal separation, detachment of the anterior commissure, and extensive mucosal disruption. For open exploration, a transverse neck incision is placed over the cricoid, and subplatysmal flaps are elevated. Strap muscles are separated in the midline and retracted. In some patients with unstable laryngeal fractures but with minimal or endoscopically treatable endolaryngeal injuries, a thyrotomy can be avoided. Repair of the
anterior commissure or significant endolaryngeal injuries is achieved through an anterior vertical laryngofissure. However, a paramedian fracture close to the midline may also be used. Hematomas are evacuated and mucosa tears repaired with 5-0 or 6-0 absorbable sutures. Mucosal loss can often be reconstructed with local mucosal flaps, and, in particular, posterior commissure injuries can and should be reconstructed with piriform fossa or supraglottic mucosa to prevent laryngeal stenosis. The anterior margins of the vocal folds are attached to the anterior limit of the thyroid cartilage or its outer perichondrium with a slow-absorbing monofilament suture. It is very important to reestablish the appropriate height of the vocal folds to optimize voice outcomes. Thyroid cartilage fractures are repaired with the use of permanent or resorbable miniplates. Even in the older patient, the cricoid arch is not fully calcified and can be repaired with suture material alone (Fig. 70-7).

**ENDOLARYNGEAL STENTING.** The indications for stenting are controversial because the need for endolaryngeal support must be weighed against the potential for further mucosal injury. Our primary indication for stenting is significant framework comminution. Stents can also be used to prevent anterior commissure webbing in cases of bilateral vocal fold epithelial loss. We prefer to use soft polymeric silicone (Silastic) stents for this purpose (Figs. 70-7B and 70-8) in order to minimize further mucosal injury and foreign-body reaction associated with the use of stents fashioned from endotracheal tubes. Endolaryngeal stents are commercially available but can also be fashioned from the vertical limb of a Montgomery T-tube that is oversewn at the top. The stent is held in place with a 2-0 polypropylene (Prolene) suture passed through the anterior stent and laryngeal ventricles and knotted over the larynx after closure of the laryngofissure. The stent is removed endoscopically 10 to 14 days later. The securing suture can be cut flush with the endoluminal airway or removed via a small neck incision.

**TREATMENT OF VOCAL CORD IMMOBILITY.** Vocal cord mobility can usually be determined during preoperative flexible laryngoscopy. Cricoarytenoid joint mobility can be assessed preoperatively, but definitive assessment of joint mobility requires microlaryngoscopy and instrumentation. Vocal cord immobility due to cricoarytenoid joint dislocation can often be managed with endoscopic manipulation and reduction. Recurrent laryngeal nerves can be severed in penetrating trauma or during cricotracheal separation, or crushed during laryngeal trauma. Only if a complete palsy is confirmed should exploration of the affected nerve be considered. Anatomically intact nerves should be allowed to regenerate. When possible, severed nerves should be repaired in a tension-free manner. If such repair is not possible, a cable graft using the greater auricular or sural nerve should be considered. The other option is to consider ansa cervicalis–recurrent laryngeal nerve repair. Nerve repairs do not restore the intricate motor function of the larynx but may provide sufficient muscle tone to improve vocalization.

**MANAGEMENT OF CRICOTRACHEAL SEPARATION.** After surgical exposure in a patient with cricotracheal separation, a tracheotomy is fashioned or moved to a healthy part of the lower trachea prior to reanastomosis. A small reinforced endotracheal tube is placed through the tracheotomy for ventilation during surgery and is replaced with a small tracheotomy tube at the end of the procedure. The surgeon begins the repair with the posterior anastomosis, using a combination of 3-0 absorbable and nonabsorbable sutures, and works toward the anterior trachea (see Fig. 70-7C). All knots are extraluminal, and the sutures are run through the submucosal plane. Avascular and damaged tissue is resected. If there is an associated crush injury to the trachea, a temporary soft polymeric silicone stent may have to be placed in the lumen prior to anastomosis.

**PARTIAL OR TOTAL LARYNGECTOMY.** In cases of massive laryngeal
injury with significant tissue loss (Fig. 70-9), partial or total laryngectomy may be indicated, although this situation is rare in civilian practice.

**Table 70-3**

<table>
<thead>
<tr>
<th>Schaefer-Fuhrman Classification of Laryngeal Trauma</th>
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<td><strong>Group 1</strong></td>
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<td><strong>Group 5</strong></td>
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8.3.8 CB What is the role of steroids in acute management of laryngeal fractures?

8.3.9 CB Tell us about penetrating injuries to the larynx and esophagus. Does stab penetrations differ from gunshot injuries in regards to the nature of the injury? How?

8.3.10 AL Do pediatric patients differ from adults in the incidence and extent of laryngeal trauma? Why? How is the management of pediatric laryngeal trauma similar and different from adults?


Acute laryngeal trauma in the pediatric patient.
Merritt RM, Bent JP, Porubsky ES.

**Pediatric laryngeal trauma: a case series at a tertiary children's hospital.**
Shires CB, Preston T, Thompson J.

**Source**
Department of Otolaryngology, University of Tennessee Health Science Center, Memphis, TN 38163, USA.
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**Abstract**
**BACKGROUND:** Pediatric blunt or sharp laryngotracheal injuries are infrequent because of the softer cartilages and the protection of the prominent mandible. These injuries usually occur secondary to striking furniture or via the "clothesline" injury.

**METHODS:** We present five cases of pediatric laryngotracheal injury (thyroid cartilage, true vocal cords, cricoid cartilage, cricotracheal junction, and posterior tracheal wall).

**RESULTS:** We examined the need for intubation, need for tracheostomy, length of intubation, length of hospital stay, interval until direct laryngoscopy, use of steroids, post-injury swallowing, and post-injury phonation.

**DISCUSSION:** Three of the five patients were intubated either prior to arrival or upon arrival to the emergency department. Two of the patients underwent direct laryngoscopy on the day of arrival. Three patients received steroids. CT (computed tomography) was not helpful in diagnosis or decision regarding treatment. The patients with thyroid cartilage fracture, cricoid cartilage fracture, cricotracheal separation, and posterior tracheal wall tear required open repair. The tracheal wall injury, cricoid fracture, and cricotracheal separation were repaired with sutures and the thyroid cartilage fracture with a plate and screws. One tracheal stent was placed. Two open repairs were performed within 24h of injury. The patient with posterior tracheal wall injury experienced persistent dysphagia and dysphonia, which may have been secondary to intraoperative dissection.

**CONCLUSION:** Dyspnea was not necessarily indicative of the severity of injury in our patients. CT added little information about the integrity of the larynx not already known by physical examination. Open repair was usually indicated for the blunt neck injuries in our series. Oral intubation proved less difficult than tracheostomy in our patient with cricoid cartilage fracture.

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**8.3.11 TT**
An adult male presents to the Trauma Unit with a knife lodged in zone II of neck. Discuss selective vs. mandatory exploration.

**8.3.12 CB**
Would you use plates to fixate a laryngeal fracture?

de Mello-Filho FV, Carrau RL. The management of laryngeal fractures using internal fixation. Laryngoscope. 2000 Dec;110(12):2143-6. PMID:11129037

<table>
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<tr>
<th>8.3.13 TT</th>
<th>What is the proper work-up of a patient with a GSW to the neck?</th>
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<td>van As AB, van Deurzen DF, Verleisdonk EJ. Gunshots to the neck: selective angiography as part of conservative management. Injury. 2002 Jun;33(5):453-6. PMID:12095728</td>
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| 8.3.14 TT | A trauma patient experiences a 1 cm tear of the hypopharynx? Would you manage this differently than a similar tear in the lower cervical esophagus? |