Blunt Neck Trauma and Laryngotracheal Injury

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Anatomy of the Neck


Contents of the Neck:

- **Musculoskeletal structures**: vertebral bodies; cervical muscles, tendons, and ligaments; clavicles; first and second ribs; and hyoid bone.
- **Neural structures**: spinal cord, cervical roots of phrenic nerve and brachial plexus, recurrent laryngeal nerve, cranial nerves (specifically IX-XII), and stellate ganglion.
- **Vascular structures**: carotids, vertebral arteries, & vertebral vein, brachiocephalic vein, and jugular veins.
- **Visceral structures**: thoracic duct, esophagus and pharynx, and larynx and trachea.
- **Glandular structures**: thyroid, parathyroid, submandibular
- **Fascia**: superficial and deep cervical fascia
Anatomy of the Larynx

Four basic anatomic components of the larynx: a cartilaginous skeleton, intrinsic and extrinsic muscles, and a mucosal lining.

The cartilaginous skeleton, which houses the vocal cords, is comprised of the thyroid, cricoid, and paired arytenoid cartilages. These cartilages are connected to other structures of the head and neck through the extrinsic muscles. The intrinsic muscles of the larynx alter the position, shape and tension of the vocal folds.
Zones of the Neck

This actually applies to penetrating trauma but is useful to review when discussing neck anatomy.

Zone I: thoracic inlet to cricoid cartilage

Zone II: cricoid cartilage to the angle of mandible

Zone III: angle of the mandible to skull base to
Injuries of Blunt Neck Trauma

• Blunt neck trauma (BNT) occurs in 5% of traumas and is more common than penetrating neck injuries (60% of neck injuries)

• Various kinds of BNT correlate with different patterns of injury:
  • Most common form of BNT is motor vehicle collisions. MOA: rapid acceleration or deceleration and a direct blow of the anterior neck on the steering column or dashboard also known as padded dash syndrome. This leads to crushing of the trachea usually at the cricoid ring as well as possible compression of the esophagus against the vertebrae.
Clothesline Injury and BNT

- Form of BNT that occurs typically young in adolescent patients who ride motorcycles, all-terrain vehicles, or snowmobiles when they strike a stationary object such as a wire fence or tree limb. Clothesline injuries can also occur in high contact sports.

- **MOA**: a large amount of energy is transferred to a small neck and this leads to crushed laryngeal cartilage and frequently **cricotracheal separation**. With cricotracheal separation, the injured airway is held together by intervening mucous membranes.
A 43-year-old longshoreman involved in a “clothesline-like” boating accident. (A) Preoperative appearance of the patient on arrival to the emergency room. The patient was intubated in the field because of upper airway obstruction. (B) CT scan of the same patient demonstrates massive subcutaneous emphysema suggestive of upper aerodigestive tract injury. (C) and (D) Montgomery stent and placement. (E) Postoperative appearance of the same patient 1 week after treatment.
Strangulation

- Occurs in 10% of all traumas; victims tend to die at the scene.
- Form of BNT that consists of
  - **homicidal strangulation**: ligature suffocation or manual choking
  - **suicidal strangulation**: aka hanging
  - **postural asphyxiation**: seen in children; occurs when the neck is placed over an object and the body weight produces compression.
- **MOA**: A steady compressive force is applied to the neck.
  - General strangulation can be associated with delayed laryngeal edema.
  - **Homicidal strangulation**: injures via carotid artery occlusion or carotid sinus reflex death; CSRD is a disputed mechanism of death in which manual stimulation of the carotid sinus is believed to cause strong glossopharyngeal nerve impulses leading to terminal cardiac arrest.
  - **Suicidal strangulation**: Injury associated with larynotracheal separation and neurovascular injuries. The mechanism of action for suicidal strangulation is the following: pressure is applied to jugular veins leading to obstruction of venous return from the brain. This results in venous congestion in the brain and loss of consciousness ensues. The patient falls with his or her full weight against the ligature and the trachea is compressed, restricting airflow to the lungs. This results in irreversible asphyxiation or death.
Esophageal Injuries in BNT

- Incidence: It is infrequently associated with BNT and is present 3%-14% of the time with laryngeal fractures.
- MOA: Compression of the cornu of the thyroid cartilage or other parts of the laryngeal cartilage against the cervical spine.
- Sxs: Subcutaneous emphysema, dysphagia, odynophagia, hematemesis, hemoptysis, bloody saliva, tachycardia, fever.
- Evaluation: Gastrografin study recommended as first line, if negative, consider barium swallow (greater sensitivity of about 90%); endoscopy – rigid &/or flexible endoscopy.
  - Weigelt et al reported 100% of esophageal injuries were found with BS and rigid endoscopy.
  - Other studies report 100% of perforations found with a combination of flexible and rigid endoscopy.
- Management: observe - if clinical exam is benign; if surgical - then debridement with two-layered primary closure +/- muscle flap over suture line to prevent TE fistula, intraop drain placement.
Esophageal Injuries in BNT

Multidetector CT of the neck reveals free air adjacent to the esophagus secondary to a traumatic perforation (arrows).

Cervical Spine Injuries in BNT

- Incidence: reported as highly associated with BNT but no exact statistics
- MOA: Can be caused by severe hyperextension during acceleration/deceleration motor injuries. Significant cervical spine and spinal cord damage can occur in hangings that involve a fall from a distance greater than the body height. Cervical spinal disruption subsequent to strangulation is almost uniformly fatal.
- Sxs: Hemiplegia, quadriplegia, CN deficits, change of sensorium, Horner’s syndrome (disturbance of stellate ganglion), neurogenic shock
- Evaluation: Concern for cervical spine injuries arises based on clinical exam and imaging – AP and lateral cervical radiography plain films and CT scan.
- Management: NSGY should be consulted for any surgical intervention. From the ENT standpoint, cervical stability is important to establish especially in the event of tracheostomy placement or endoscopy. Cervical spine precautions including cervical spine immobilization and supine placement of the patient on a backboard are necessary.
Vascular Injuries in BNT

- Incidence: 1-3% of all BNT, 20-30% mortality
- MOA: Most associated with MVC- rapid deceleration → hyperflexion, hyperextension, and rotation → vascular structures are stretched over the cervical spine → shearing forces create intimal tears in the vessel wall.
- Sxs: “Hard signs” – bruit/thrill, expanding or pulsatile hematoma, pulsatile or severe hemorrhage, pulse deficit. “Soft signs” – hypotension, shock, stable hematoma, CNS/PNS ischemia. Note: often blunt vascular injury in the form of acute ischemic stroke is the initial manifestation of BNT in patients with a delay in presentation of symptoms. Classic presentation: A neurologically intact patient who develops hemiparesis after a high-speed MVC.
- Management: Depending on extent of injury. Surgical repair preferred over ligation; primary repair preferred over grafting. Refer to Denver grading scale.
# Vascular Injuries in BNT

## Table 2
Denver grading scale for blunt carotid artery injury

<table>
<thead>
<tr>
<th>Grade</th>
<th>Angiographic findings</th>
<th>Prognosis</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Vessel wall irregularity or dissection with $&lt;25%$ of luminal diameter</td>
<td>Good, 7% progress</td>
<td>Systemic anticoagulation controversial</td>
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<tr>
<td>II</td>
<td>Raised intimal flap, thrombus, dissection, or hematomas $&gt;25%$ of luminal diameter</td>
<td>Fair with treatment, 70% progress</td>
<td>Systemic anticoagulation</td>
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<tr>
<td>III</td>
<td>Pseudoaneurysm</td>
<td>Require intervention</td>
<td>Surgery or stenting</td>
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<tr>
<td>IV</td>
<td>Total vessel occlusion</td>
<td>Outcome assured at the time of diagnosis</td>
<td>Systemic anticoagulation</td>
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<tr>
<td>V</td>
<td>Transection</td>
<td>Very poor, high mortality</td>
<td>Surgery</td>
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Laryngotracheal Injuries in BNT

- Incidence: 1 out every 5,000-47,000 adults and in 0.05% of trauma admissions in children. The incidence can be as high as 1 in 445 in major urban trauma centers.
  - Jewett et al found an incidence of 1:137,000 in their population-based, time series analysis of LT in 11 states.
- Although not prevalent, it is second to only intracranial injury as the most common cause of death among patients with head and neck trauma and is a clinically important injury.
  - Line et al reported that 112 (65%) of 171 BNT patients with LT injury in their series did not survive.
- 60% of all external laryngotracheal traumas are due to blunt neck trauma.
- The final common pathway of laryngotracheal injury is compressive force on the larynx leads to injury. This is modified by the degree of laryngeal calcification present;
Clinical Presentation of LT injury

- The most common presenting symptom for laryngotracheal trauma is hoarseness.
  - *Juutilainen et al* found that in their review of 33 cases of external laryngeal trauma, hoarseness was the presenting symptom in 85% of cases (28 patients). This finding is consistent with other studies.

- Other presenting symptoms include, dysphagia (52%), pain (42%), dypsnea (21%), hemoptysis (18%), and symptoms of airway obstruction such as stridor or tachypnea. Other signs include drooling and cervical subcutaneous emphysema or crepitation.
  - *Goudy et al* found that of 236 patients admitted with aerodigestive tract injury or subcutaneous emphysema, only 8% (19 patients) were identified with cervical emphysema/crepitations thought to be caused by aerodigestive injury, thus indicating that this is a low yield sign of laryngotracheal injury.

- In addition to crepitations, physical examination reveals skin abrasions, bruising, laryngeal tenderness, and distortion of the anterior neck anatomy.
A 35 year old male presented with increasing neck swelling on the right side and face region after sustaining BNT to the region. There was history of change in voice and difficulty in swallowing. There was no history of respiratory distress, vomiting, loss of consciousness and disorientation. On examination there was subcutaneous emphysema mainly present on the right side of neck and parotid region. There was blunting of the thyroid prominence and tenderness all along the larynx.
Classification of LT injury

- The mode of injury should be determined – either blunt or penetrating.
  - The site should be identified as supraglottic, glottic, or subglottic.
- The structures injured should be assessed such as hyoid bone, thyroid cartilage, cricoid cartilage, or arytenoids injury.
- Per *Cumming’s Otolaryngology: Head & Neck Surgery*, the systematic approach proposed by the author includes an assessment of the laryngeal framework as stable, unstable, or potentially nonviable and an assessment of the mucosa as intact/minimal injured, injured, or massively injured. The vibratory apparatus is described as intact or injured and the laryngotracheal junction is described as intact or with any degree of separation.
- Schafer-Fuhrman classification of LT trauma
Schafer-Fuhrman

- **Group 1:**
  - Minor endolaryngeal hematomas or lacerations, no detectable fracture
  - Treatment: humidified O2 and observation

- **Group 2:**
  - Edema, hematoma, minor mucosal disruption without exposed cartilage, non-displaced fracture, varying degrees of airway compromise
  - Treatment: tracheostomy to secure the airway along with panendoscopy

- **Group 3:**
  - Massive edema, large mucosal lacerations, exposed cartilage, displaced fracture(s), vocal cord immobility
  - Treatment: tracheostomy along with exploration and repair

- **Group 4:**
  - Same as group 3 but more severe with severe mucosal disruption, disruption of the anterior commissure, and unstable fracture, 2 or more fracture lines
  - Treatment: tracheostomy along with exploration and repair with stent placement

- **Group 5:**
  - Complete laryngotracheal separation
  - Treatment: urgent tracheostomy along with exploration and repair
LT Injury: Securing an Airway

- As these injuries are in the setting of trauma, laryngotracheal injury at times may be addressed during the primary survey of assessing airway, breathing, and circulation.
- It is a priority to establish an airway with cervical spine protection as indicated.
- Tracheostomy is preferred to intubation because intubation can exacerbate laryngeal injury with the feared outcome precipitation of total airway obstruction. Further, it is difficult to perform in the presence of concomitant maxillofacial injuries in patients with immobile necks.
- However, if it is to be performed such as in patients with signs of acute or impending respiratory distress, it is recommended it be done by the most experienced medical professional.
High resolution computed tomography is performed in all patients with laryngotraheal injuries once their airway is secure. Given advances with CT, such as multidetector row CT (MDCT), high resolution can be obtained in shorter scan times.

Slick thickness for imaging in patient with concerns for laryngotraheal trauma should not exceed 1mm in thickness.
MDCT of the Injured Larynx After Trauma, Robinson et al.

- Review 41 scans and characterized findings
- They classified their patients into 8 with Schafer grade 2 classifications, 26 with grade 3 classifications, and 7 with grade 4 classifications
- Thyroid cartilage most fractured:
  - 33 thyroid fractures were found, 23 of which were isolated fractures. 19 cricoid fractures were present and only 1 arytenoid fracture was identified.
- Horizontal fractures often cross the midline and usually occur with supraglottic soft tissue injury
- Isolated fractures of the upper and lower horns of the thyroid are uncommon.
- Visualization of a fracture is easier in ossified cartilages and with displaced fractures.
- Cricoid fractures are typically bilateral and cause airway collapse should the mobile fragment of cricoid retropulse into the airway.
Algorithm for Management of LT injury

Suspicion of Laryngeal Trauma

- History of Neck Trauma, Examine for Physical Signs of Injury
  
  Impending Airway Obstruction
  
  Tracheotomy
  
  Direct Laryngoscopy and Esophagoscopy

  - Hematoma, Small Laceration, but Endolarynx Intact
    
    Observation
  
  - Isolated Fracture, Displaced or Angulated Thyroid Cartilage but Endolarynx Intact
    
    Open Exploration of Neck with Open Reduction and Internal Fixation of Fracture without Thyrotomy

  - ORIF Fractures, Repair Mucosal Lacerations + Endolaryngeal Stent

  - Mucosa and Cartilage Disrupted
    
    Observation
    
    Laryngeal Thyrotomy
  

Airway Stable

Flexible Fiberoptic Laryngoscopy

- Nondisplaced, Nonangulated Thyroid Cartilage Fracture
  
  Observation

- Mucosa and Cartilage Disrupted
  
  CT Scan

  - Mucosa and Cartilage Disrupted
    
    Observation
    
    Laryngeal Thyrotomy and Esophagoscopy

  - Mild Abnormality Endolarynx
    
    Tracheotomy or Intubation
    
    Direct Laryngoscopy and Esophagoscopy

  - Normal Endolarynx
    
    Observation

- Normal
  
  Abnormal
  
  Observation

ORIF Fractures, Repair Mucosal Lacerations
Flexible fiberoptic nasolaryngoscopy

- For a preliminary assessment of the extent of trauma and vocal cord mobility in stable patients preoperatively; no symptom or combination thereof correlates with severity of injury.
- Care should be taken during this exam so as not to exacerbate compromise to the airway.
- Clinical findings seen on endoscopy include deformities of the larynx, swelling, lacerations, exposed cartilage, complete or partial vocal cord fixation indicative of RLN injury or dislocation of the cricoarytenoid joint, and hematoma.
- Of note, prior to any manipulation of the neck for positioning, the examiner should be aware of c-spine injury and this should be ruled out.
Conservative Management

- Indicated in patients that fall under group 1 and some in group 2 of Schafer’s classification.
- Specifically, observable conditions include: edema, small hematomas with intact mucosal coverage, small glottic or supraglottic lacerations without exposed cartilage, and single non-displaced thyroid cartilage fractures in a stable larynx.

The following should be implemented:

- Admission to the ICU for strict monitoring
- Serial flexible nasolaryngoscopy examinations.
- Humidified oxygen should be at the bedside and serves to help prevent crust formation in the presence of mucosal damage and transient ciliary paralysis.
- HOB elevated – reduces swelling.
- Anti-reflux precautions are always recommended as they serve to prevent scar formation in the setting of mucosal injury.
- Prophylactic broad spectrum antibiotics should be given if laryngeal mucosa injury as occurred.
Surgical Repair of LT injury

- **Indications:**
  - lacerations involving the free margin of the vocal fold
  - large mucosal lacerations
  - exposed cartilage
  - multiple and displaced, or unstable, or comminuted cartilage fractures
  - avulsed or dislocated arytenoids cartilages
  - vocal fold immobility or detachment of the anterior commissure
  - cricotracheal separation,
  - fractures of the median or paramedian parts of the thyroid alae
  - cricoid fracture
  - airway compromise

- **Goal:**
  - restore laryngeal function including phonation, protection from aspiration, ventilation, and deglutition to as near baseline as possible.

*It is recommended that all surgical patients receive panendoscopy intraoperatively for a detailed examination of the injury before surgical repair.*
Endolaryngeal Approach for LT injury: Anterior Laryngofissure/Thyrotoomy

Thyroid and cricoid cartilage identified by careful dissection and retraction of the straps and the extent of injury is determined.

Midline thyrotomy is performed with an oscillating saw and carried to the anterior commissure, which is divided with a number 12 scalpel or scissors.

View of the endolarynx demonstrates mucosal lacerations that are closed with 3-0 or 4-0 chromic sutures.
Endolaryngeal Approach for LT injury: Anterior Laryngofissure/Thyrotomy

Anterior attachment of the vocal cords to the thyroid cartilage. Broyle’s ligament is resuspended to the external perichondrium with 4-0 PDS suture.

Laryngeal stent is secured in place with two sutures placed through the skin, thyroid lamina, and subglottic space and out through the opposite thyroid lamina and skin. The sutures are tied loosely over silicone buttons.
Plating Laryngeal Fractures

- **Approach:** After splitting the strap muscles and exposing the thyroid cartilage and the cricoid, the perichondrium is incised at the midline and perichondrial flaps are raised on both sides of the fracture.

- Plating helps to not only approximate but helps with stabilization/fixation. This is beneficial as it is known that motion of fracture fragments increases bleeding, hematoma formation, inflammation, and, thus, the likelihood or infection or scar.

- **Ballenger’s Otolaryngology: Head and Neck** recommends:
  - Paramedian fractures be plated using a four hole “box-type” plate around the fracture aka four point fixation.
  - With midline fractures make considerations for the curvature of the thyroid cartilage anteriorly. Four point fixation is still recommended.
  - Cricoid fractures: height will not allow for four point fixation but single horizontal plate is adequate to re-establish the integrity of the cricoid.
Fig. 13 A 42-year-old male assault victim with severe multisystem trauma, including panfacial fractures and highly disrupted fractures of the thyroid and cricoid cartilage. (A) Clinical appearance after initial stabilization that included emergent tracheostomy and nasal packing for severe epistaxis. (B) Clinical appearance 1 week before definitive management of his laryngeal injuries and facial injuries. (C) CT scan of the same patient demonstrates fractures involving the thyroid cartilage. (D) Intraoperative exposure for repair of laryngeal injuries. (E) ORIF of thyroid cartilage and cricoid ring. There was no significant endolaryngeal injury. (F) Postoperative appearance of patient 6 months after injury.
Success of Plating

- Sasaki et al evaluated the efficacy of both MacroPore (MedTronic) and Leibinger (Stryker) resorbable reconstruction plates in 3 adult male patients and found both plates to be equally easy to use. In addition, adequate skeletal stabilization was achieved, which allowed for early phonation and respiratory function without long-term stenting.

- In Brazil, de Mello-Filho et al performed a retrospective study on the efficacy of adaptation plate fixation (APF) to repair the larynx. This group had no complications with the use of APF, and 19 out of 20 patients recovered their voices.
The Management of Laryngeal Fractures Using Internal Fixation, de Mello-Filho et al

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<th>Fracture</th>
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<th>Intraluminal Stent</th>
<th>Airway</th>
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DOC = death of other cause (not related to surgery or airway); AD = airway distress; H = hoarseness; P = pain; D = dysphagia; O = odynophagia; A = aphonia; T&C = thyroid and cricoid; NT = no tracheotomy.
Cricotracheal Separation

- Separation of the airway most often occurs between the cricoid and the trachea and at times between the upper trachea.
- This condition is highly associated with clothesline injuries.
- Cricotracheal separation is usually associated with cricoid fractures and avulsion of the mucosa from the anterior surface of the posterior cricoid plate.
- Concerns: Precarious situation associated with a high chance of asphyxiation and mortality.
- **EMERGENT TRACHEOSTOMY** must be secured.
  - Mobilize substernal trachea for tracheostomy.
  - A small ET tube is placed through the tracheostomy for ventilation during surgery.
Surgical Repair of Cricotracheal Separation

- Primary re-anastomosis from posterior to anterior with a combination of 3-0 absorbable and non-absorbable suture.

  - If the cricoid is intact:
    - only the mucous membrane needs to be repaired primarily with absorbable suture.
    - Tension should be distributed away from the anastomosis by placing non-absorbable sutures from the superior cricoid to the inferior portion of the first or second tracheal ring.

  - If the cricoid is fractured:
    - internal fixation of the cricoid cartilage should occur first as the strength of the repair is limited by stability of the cricoid cartilage.
    - Stenting may be considered given the extent of injury.
Cricotracheal Separation: RLN injury

- Cricotracheal separation is highly associated with recurrent laryngeal nerve injury.
- *Couraud et al* reviewed 19 laryngotracheal disruption patients and found that 14 of the patients have bilateral RLN injury and 4 had unilateral RLN injury. Mucosa was retracted in all patients to expose cricoid cartilage.
Exposed Cartilage

- Must be covered. If not, it is responsible for granulation tissue and scar formation.
- Possible grafts: mucous membrane, dermis, STSG.
- Unfortunately, this graft wound heals by secondary intent and the risk of scar formation is greater than primary closure of innate lacerated mucosa over the exposed area.
- Mucous membranes closely resemble the normal endolaryngeal epithelium but use of the graft is associated with high donor site morbidity and the need to enter the mouth to harvest graft.
Endolaryngeal Stenting

- **Indications:**
  - With extensive lacerations involving the anterior commissure.
    - used to prevent webbing of the anterior commissure in cases of bilateral vocal cord epithelial loss.
  - With multiple cartilaginous fractures that cannot be stabilized adequately with open reduction.

- **Function:**
  - To prevent webbing
  - Stabilize the internal configuration of the larynx.

- **Controversy:** Stenting can be a source of mucosal injury and its placement is associated with an increased risk of infection and granulation tissue formation.

- **Placement:**
  - It should be fixed in a fashion that it moves with the larynx during swallowing and can be accessed endoscopically; pass a suture through the stent and larynx at level of laryngeal ventricle and at cricothyroid membrane and tie it over buttons over the skin. The stent is usually left in place for 10-14 days and removed early to avoid granulation tissue formation.
Endolaryngeal Stenting

Weisberger and Huebsch Laryngeal Stent, 1982
Under endoscopic guidance, three percutaneous sutures were passed into the tracheal lumen. One suture was used as a guide to transorally place the stent in its desired location while the other two sutures were used to secure the stent in place. **Note: patients cannot phonate with this.**

Eliachar and Nguyen subsequently reported the use of a laryngotracheal stent placed under rigid bronchoscopic guidance that allowed for continued phonation. The presence of a domed one-way valve that rises above the level of the vocal cords in the **Eliachar stent** permits air to escape from the lungs but blocks passage of materials beyond the glottis. Another difference is a posterior skirt-like projection that extends inferiorly to support the posterior tracheal wall down to the level of the upper convex surface of the tracheostomy tube.
Post operative care

- Same as guidelines for conservative management.
- Regular endoscopic exams should be performed to assess recovery.
- Of note, in patients with cricotracheal separation, neck flexion for 7 days is recommended to prevent traction on the anastamosis.
Complications

- Granulation tissue formation is the most common complication.
  - **Prevention:**
    - Meticulous primary closure and covering exposed cartilage coverage
    - Limiting stent use to Group 4 and 5 injuries and removing them in a timely manner.

- Laryngeal and tracheal stenosis:
  - Related to granulation tissue formation and treated with surgical repair or dilatation.
  - Extensive stenosis: may require an endolaryngeal approach with excision of stenosis and grafting over area +/- stenting.
  - Subglottic stenosis: Difficult to treat

- Thin anterior glottic webs: may be lysed with a laser or cold knife and a keel placed to prevent recurrence.

- Posterior glottic webs or interarytenoid scarring may be excised along with an arytenoidectomy and grafted or covered with mucosal advancements.
Complications

- Subglottic stenosis is difficult to treat.
  - Dilation
  - Laser excision
  - Cricoid split
  - Resection of stenosis and end-to-end anastamosis. Stenosis length < 4cm

- Persistently immobile vocal fold:
  - recurrent laryngeal nerve injury
  - cricoarytenoid joint fixation
  - Assess with endoscopy – rigid (check arytenoid mobility) or flexible endoscopy.
  - If the arytenoid is fixed unilaterally with an adequate voice and airway, no treatment is needed.
  - Bilateral arytenoid fixation or recurrent laryngeal paralysis with a compromised airway can be treated with arytenoidectomy and vocal fold lateralization, but this results in a weak voice.
Longterm Outcome

- F/U regularly for at least 1 year to evaluate for combination of laryngeal stenosis, dysphonia, aspiration, both structural and neurovascular injuries, and monitoring for recovery of VC paralysis.
- Procedures to correct VC paralysis can only be done after 9-12 mos of observation for full recovery.
- The Management of Laryngeal Fractures Using Internal Fixation, de Mello-Filho et al
Special Considerations: Pediatric LT Injury.

- BNT is not common in children; however, LT injury is most commonly related to in BNT in children.
- Bicycle accidents and falls are common causes in younger children
- Anatomy difference:
  - The larynx is situated higher in neck and protected by mandible
    - Lies at C3 level in the neonate and descends during first 3 years of life to its adult position at C6.
  - Less laryngeal fractures because of elasticity of cartilages
  - Submucosal tissues are loosely attached to the underlying perichondrium, increasing the likelihood of soft tissue damage like edema or hematoma and subsequent airway obstruction
  - Cricothyroid membrane narrower less likely to have laryngotracheal separation
Special Considerations: Pediatric LT Injury....Con’t

- **Airway:**
  - *Controversial.* Rapid sequence intubation vs trach placement. It is usually not possible to perform an awake tracheostomy; it is recommended to manage with intubation followed by prompt tracheostomy.

- **High association of LT injury in pediatric patients with cervical spine injury.**
  - Some sources say as high as 50% of children with LT trauma were found to have cervical fractures.
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