
بسم الله الرحمن الرحيم

Neck Trauma

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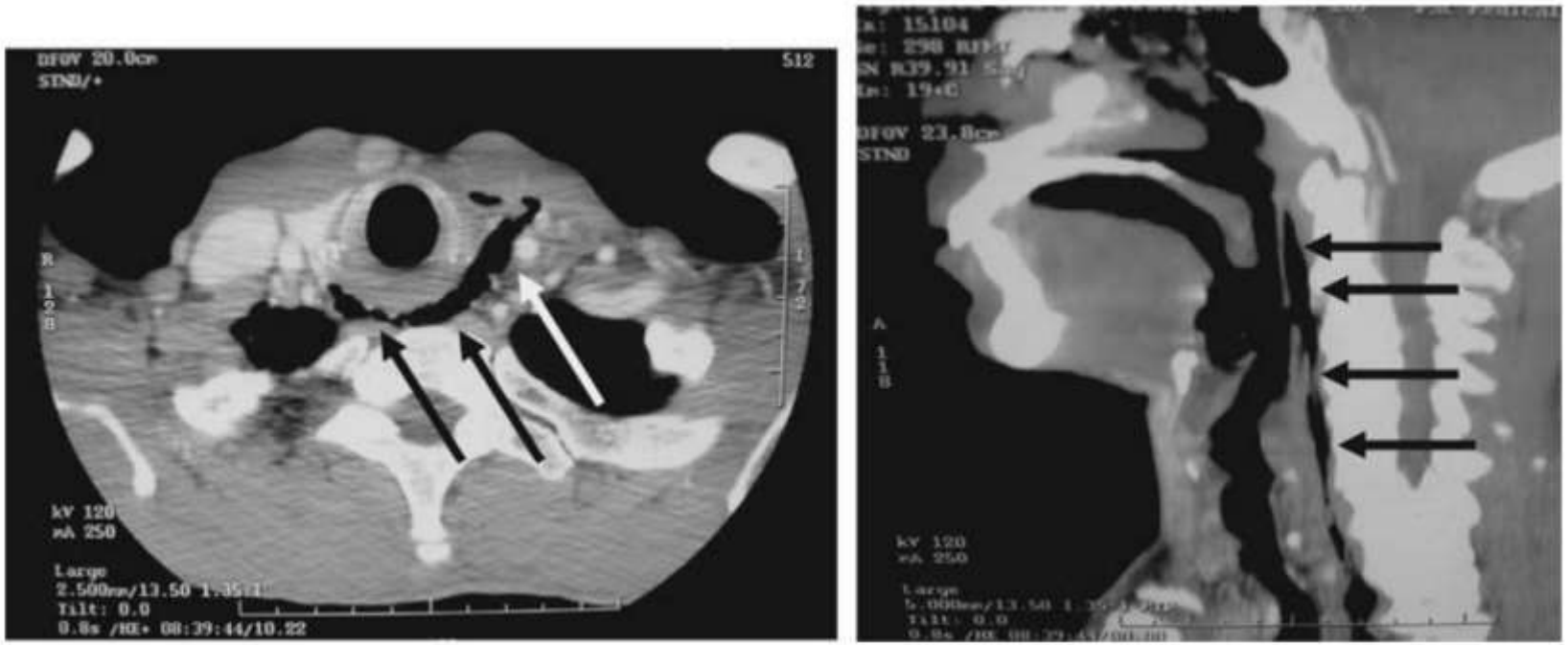
- **All** blunt trauma patients should be assumed to have cervical spine injuries until proven otherwise. During the physical examination, one must maintain cervical spine precautions and in-line stabilization.
- Due to the devastating consequences of quadriplegia, a diligent evaluation for occult cervical spine injuries is mandatory.
- In the awake patient, the presence of posterior midline pain or tenderness should provoke a thorough radiologic evaluation. Additionally, intubated patients, patients with distracting injuries, significant mechanism, or another identified spine fracture should undergo CT imaging.

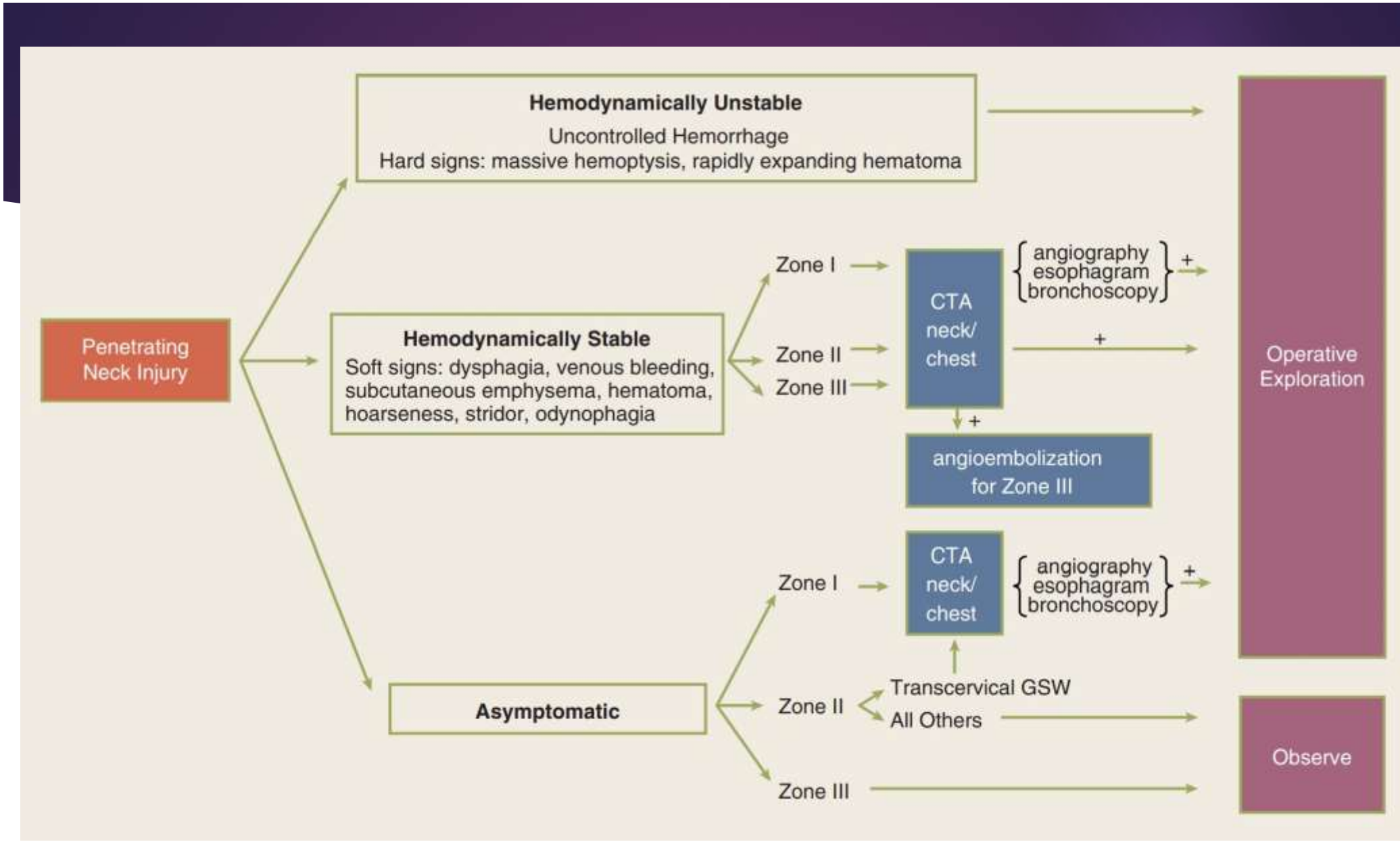
- A ligamentous injury may not be visible with standard imaging techniques. Flexion and extension views or magnetic resonance imaging (MRI) are obtained to further evaluate patients at risk or those with persistent symptoms.
- Spinal cord injuries can vary in severity. Complete injuries cause either quadriplegia or paraplegia, depending on the level of injury. These patients have a complete loss of motor function and sensation two or more levels below the bony injury.
- Patients with high spinal cord disruption are at risk for **shock** due to physiologic disruption of sympathetic fibers. Significant neurologic recovery is rare.

- **Central cord syndrome** typically occurs in older persons who experience hyperextension injuries. Motor function, pain, and temperature sensation are preserved in the lower extremities but diminished in the upper extremities recovery usually occurs, but is often not a return to normal.
- **Anterior cord syndrome** is characterized by diminished motor function, pain, and temperature sensation below the level of the injury, but position sensing, vibratory sensation, and crude touch are maintained. Prognosis for recovery is poor.
- **BrownSéquard syndrome** is usually the result of a penetrating injury in which one-half of the spinal cord is transected. This lesion is characterized by the ipsilateral loss of motor function, proprioception, and vibratory sensation, whereas pain and temperature sensation are lost on the contralateral side.

- During the primary survey, identification of injuries to the neck with exsanguination, expanding hematomas, airway obstruction, or aerodigestive injuries is a priority. A more subtle injury that may not be identified is a fracture of the larynx due to blunt trauma. Signs and symptoms include hoarseness, subcutaneous emphysema, or a palpable fracture.
- Penetrating injuries of the anterior neck that violate the platysma are potentially life-threatening because of the density of critical structures in this region. Although operative exploration is appropriate for overt injuries, selective nonoperative management has been proven safe .



A laryngeal fracture results in air tracking around the trachea along the prevertebral space (arrows).


Penetrating Neck Injury
Hemodynamically Unstable
Uncontrolled Hemorrhage
Hard signs: massive hemoptysis, rapidly expanding hematoma
Hemodynamically Stable
Soft signs: dysphagia, venous bleeding, subcutaneous emphysema, hematoma, hoarseness, stridor, odynophagia
Zone I
Zone II
Zone III
CTA neck/ chest
angiography
esophagram
bronchoscopy
+
+
+
angioembolization for Zone III
Asymptomatic
Zone I
Zone II
Zone III
CTA neck/ chest
angiography
esophagram
bronchoscopy
+
Transcervical GSW
All Others
Operative Exploration
Observe

- Indications for immediate operative intervention for penetrating cervical injury include hemodynamic instability, significant external hemorrhage, or evidence of aerodigestive injury. The management algorithm for hemodynamically stable patients is based on the presenting symptoms and anatomic location of injury, with the neck being divided into three distinct zones.
- Zone I is inferior to the clavicles encompassing the thoracic outlet structures, zone II is between the thoracic outlet and the angle of the mandible, and zone III is above the angle of the mandible. Due to technical difficulties of injury exposure and varying operative approaches, a precise preoperative diagnosis is desirable for symptomatic zone I and III injuries.
- Therefore, these patients should ideally undergo diagnostic imaging before operation if they remain hemodynamically stable. Management of patients is further divided into those who are symptomatic and those who are not

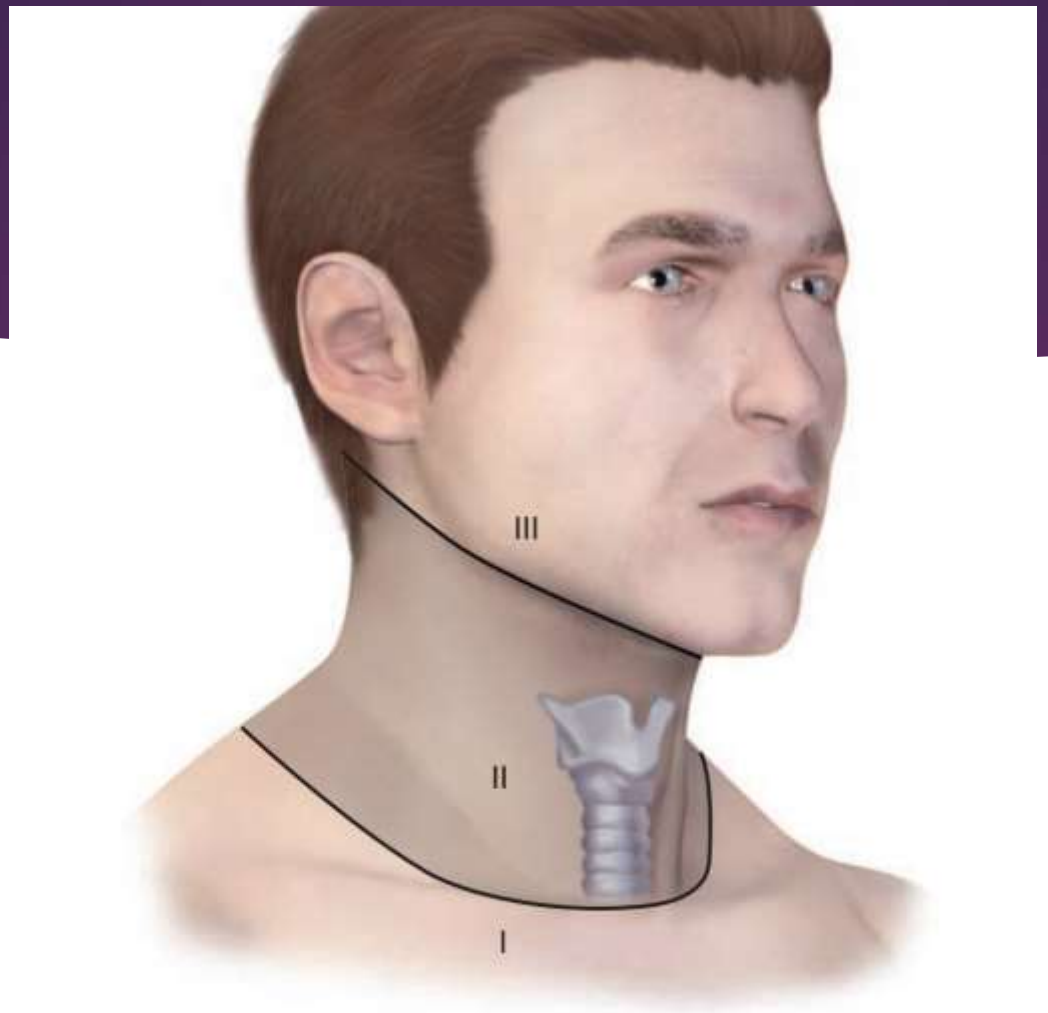


Figure 7-20. For the purpose of evaluating penetrating injuries, the neck is divided into three zones. Zone I is to the level of the clavicular heads and is also known as the *thoracic outlet*. Zone II is located between the clavicles and the angle of the mandible. Zone III is above the angle of the mandible.

- Specific symptoms or signs that should be identified include **dysphagia, hoarseness, hematoma, venous bleeding, minor hemoptysis, and subcutaneous emphysema.** Symptomatic patients, without overt injuries, should undergo CTA with further evaluation or operation based upon the imaging findings.
- Overall, less than 15% of penetrating cervical trauma requires neck exploration. Asymptomatic patients are typically observed for 6 to 12 hours. The one caveat is asymptomatic patients with a transcervical gunshot wound; these patients should undergo CTA to determine the trajectory of the bullet; further studies are performed based on proximity to major structures.
- Such additional imaging includes angiography, soluble contrast esophagram followed by barium esophagram, esophagoscopy, or bronchoscopy. Angiographic diagnosis, particularly of zone III injuries, can then be managed by selective angioembolization.

Chest (Trachea and Esophagus)

- Blunt trauma to the chest may involve the chest wall, thoracic spine, heart, lungs, thoracic aorta and great vessels, and rarely the esophagus.
- Any patient who undergoes an intervention in the ED—endotracheal intubation, central line placement, tube thoracostomy—needs a repeat chest radiograph to document the adequacy of the procedure. This is particularly true in patients undergoing tube thoracostomy for a pneumothorax or hemothorax.
- Patients with persistent pneumothorax, large air leaks after tube thoracostomy, or difficulty ventilating should undergo fiber-optic bronchoscopy to exclude a tracheobronchial injury or presence of a foreign body.

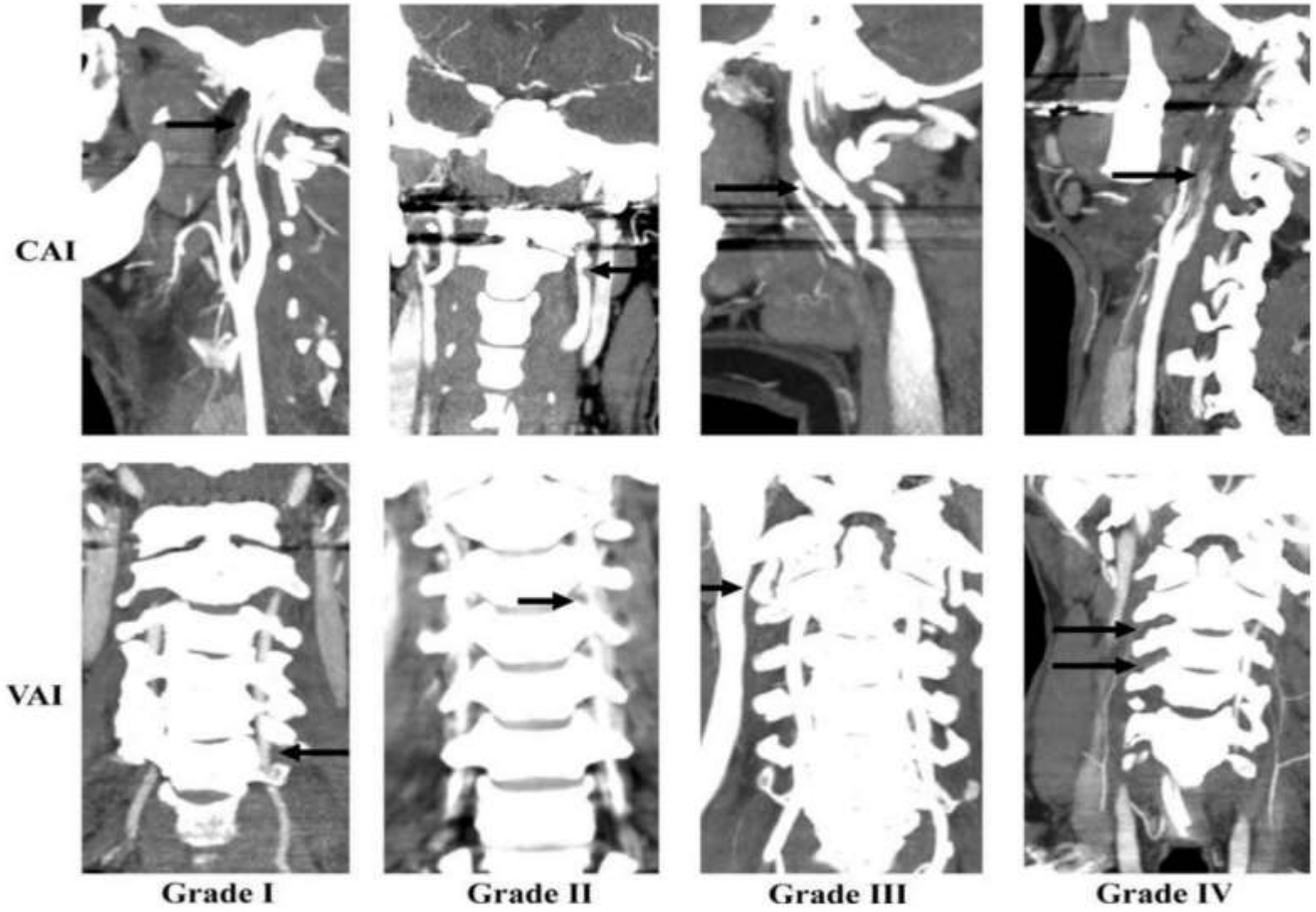
- For penetrating thoracic trauma, physical examination, plain posteroanterior and lateral chest radiographs with metallic markings of wounds, and pericardial ultrasound will identify the majority of injuries.
- Injuries of the esophagus and trachea are the exceptions. **Bronchoscopy** should be performed to evaluate the trachea in patients with a persistent air leak from the chest tube or mediastinal air.
- Patients at risk for an esophageal injury should undergo **bedside esophagoscopy or soluble contrast esophagography followed by barium examination** to look for extravasation of contrast.

Vascular

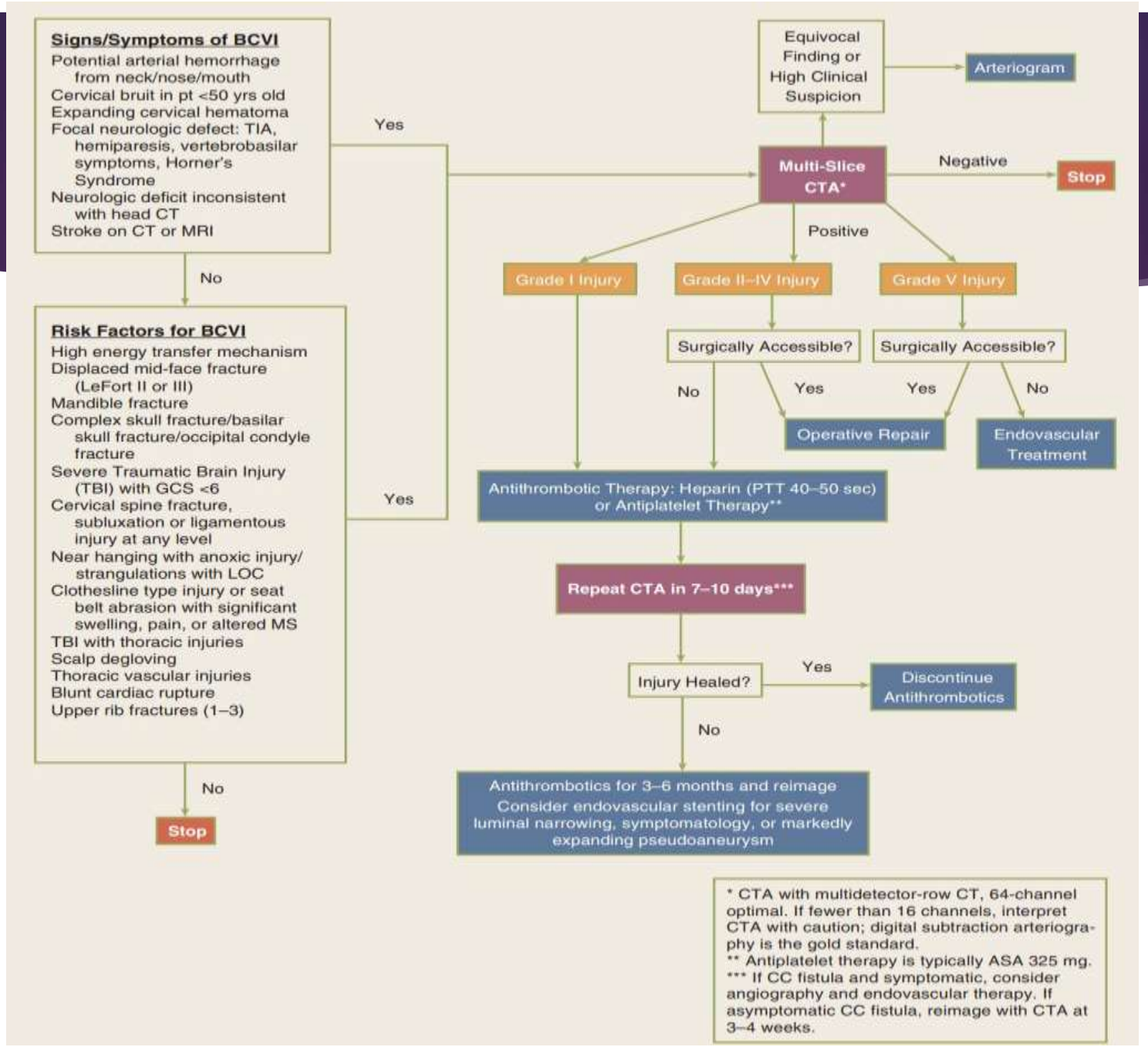
- Cervical vascular injuries due to either blunt or penetrating trauma can result in devastating neurologic sequelae or exsanguination.
- Penetrating injuries to the **carotid artery** and **internal jugular vein** usually are obvious on operative neck exploration.
- The principles of vascular repair techniques (discussed previously) apply to carotid injuries, and options for repair include end-to-end primary repair (often possible with mobilization of the common carotid), graft interposition, and transposition procedures.
- All carotid injuries should be repaired except in patients who present in coma with a delay in transport. Prompt revascularization of the internal carotid artery, using a temporary Pruitt-Inahara shunt, should be considered in patients arriving in profound shock.

- Otherwise, carotid shunting should be done selectively as in elective carotid endarterectomy, but the patient should be systemically anticoagulated.
- Currently, we administer heparin with an ACT target of 250 sec. Tangential wounds of the internal jugular vein should be repaired by lateral venorrhaphy, but extensive wounds are efficiently addressed by ligation. However, it is not advisable to ligate both jugular veins due to potential intracranial hypertension.
- Vertebral artery injuries due to penetrating trauma are difficult to control operatively because of the artery's protected location within the foramen transversarium. Although exposure from an anterior approach can be accomplished by removing the anterior elements of the bony canal and the tough fascia covering the artery between the elements, typically the most efficacious control of such injuries is angioembolization
- Fogarty catheter balloon occlusion, however, is useful for controlling acute bleeding if encountered during neck exploration.

- Blunt injury to the carotid or vertebral arteries may cause dissection, thrombosis, or pseudoaneurysm, typically in the surgically inaccessible distal internal carotid.
- Early recognition and management of these injuries is paramount because patients treated with antithrombotics have a stroke rate of <1% compared with stroke rates of 20% in untreated patients.
- Because treatment must be instituted during the latent period between injury and onset of neurologic sequelae, diagnostic imaging is performed based on identified risk factors



The Denver grading scale for blunt cerebrovascular injuries. Grade I: irregularity of the vessel wall, dissection/intramural hematoma with <25 % luminal stenosis. Grade II: visualized intraluminal thrombus o raised intimal flap, or dissection/intramural hematoma with 25% or more luminal narrowing. Grade III: pseudoaneurysm. Grade IV: vessel occlusion. CAI = carotid artery injury; VAI = vertebral artery injury

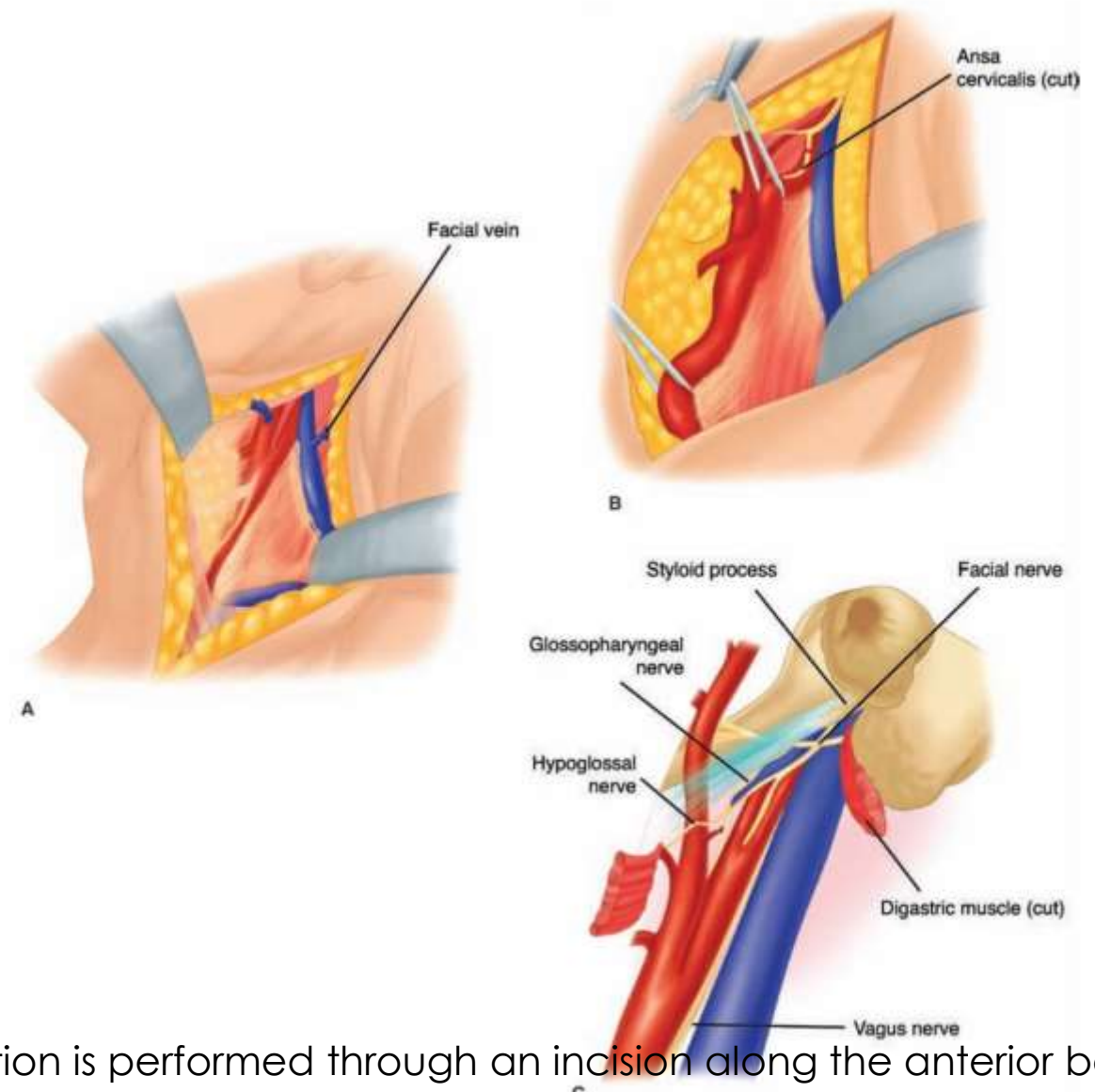

Signs/Symptoms of BCVI
Potential arterial hemorrhage from neck/nose/mouth
Cervical bruit in pt <50 yrs old
Expanding cervical hematoma
Focal neurologic defect: TIA, hemiparesis, vertebrobasilar symptoms, Horner's Syndrome
Neurologic deficit inconsistent with head CT
Stroke on CT or MRI
Yes
No
Risk Factors for BCVI
High energy transfer mechanism
Displaced mid-face fracture (LeFort II or III)
Mandible fracture
Complex skull fracture/basilar skull fracture/occipital condyle fracture
Severe Traumatic Brain Injury (TBI) with GCS <6
Cervical spine fracture, subluxation or ligamentous injury at any level
Near hanging with anoxic injury/ strangulations with LOC
Clothesline type injury or seat belt abrasion with significant swelling, pain, or altered MS
TBI with thoracic injuries
Scalp degloving
Thoracic vascular injuries
Blunt cardiac rupture
Upper rib fractures (1–3)
Yes
No
Stop
Equivocal Finding or High Clinical Suspicion
Arteriogram
Multi-Slice CTA*
Negative
Stop
Positive
Grade I Injury
Grade II–IV Injury
Grade V Injury
Surgically Accessible?
Surgically Accessible?
No
Yes
Yes
No
Operative Repair
Endovascular Treatment
Antithrombotic Therapy: Heparin (PTT 40–50 sec) or Antiplatelet Therapy**
Repeat CTA in 7–10 days***
Injury Healed?
Yes
Discontinue Antithrombotics
No
Antithrombotics for 3–6 months and reimage
Consider endovascular stenting for severe luminal narrowing, symptomatology, or markedly expanding pseudoaneurysm
* CTA with multidetector-row CT, 64-channel optimal. If fewer than 16 channels, interpret CTA with caution; digital subtraction arteriography is the gold standard.
** Antiplatelet therapy is typically ASA 325 mg.
*** If CC fistula and symptomatic, consider angiography and endovascular therapy. If asymptomatic CC fistula, reimage with CTA at 3–4 weeks.

- After identification of an injury, **antithrombotics** are administered if the patient does not have contraindications (intracranial hemorrhage, falling hemoglobin level with solid organ injury or complex pelvic fractures). Heparin, started without a loading dose at 15 units/kg per hour, is titrated to achieve a PTT between 40 and 50 seconds or antiplatelet agents are initiated (aspirin 325 mg/d or clopidogrel 75 mg/d).
- The types of antithrombotic treatment appear equivalent in published studies to date, and the duration of treatment is empirically recommended to be 6 months.
- The role of carotid stenting for grade II or III internal carotid artery injuries remain controversial; current literature suggests stenting be reserved for symptomatic patients or markedly enlarging pseudoaneurysms.
- Thrombosis of the internal jugular veins caused by blunt trauma can occur unilaterally or bilaterally and is often discovered incidentally because most patients are asymptomatic. Bilateral thrombosis can aggravate cerebral edema in patients with serious head injuries; stent placement should be considered in such patients if ICP remains elevated

Operative Approaches and Exposure
Cervical Exposure

- Operative exposure for midline structures of the neck (e.g., trachea, thyroid, bilateral carotid sheaths) is obtained through a collar incision; this is typically performed two finger breadths above the sternal notch, but can be varied based on the level of anticipated injury.
- After subplatysmal flap elevation, the strap muscles are divided in the midline to gain access to the central neck compartment. More superior and lateral structures are accessed by extending the collar incision upward along the sternocleidomastoid muscle; this may be done bilaterally if necessary. For unilateral injuries, neck exploration is done through an incision extending from the mastoid down to the clavicle, along the anterior border of the sternocleidomastoid muscle.

- The carotid sheath, containing the carotid artery, jugular vein, and vagus nerve, is opened widely to examine these structures. The facial vein, which marks the carotid bifurcation, is usually ligated for exposure of the internal carotid artery a
- Exposure of the distal carotid artery in zone III is difficult. The first step is division of the ansa cervicalis to facilitate mobilization of the hypoglossal nerve. Next, the posterior portion of the digastric muscle, which overlies the internal carotid, is transected. The glossopharyngeal and vagus nerves are also mobilized and retracted as necessary.
- If accessible, the styloid process and attached muscles are removed. In desperate situations, anterior displacement of the mandible (subluxation) may be helpful or the vertical ramus of the mandible may be divided. However, the latter maneuver often entails resection of the parotid gland, and the facial nerve is at risk of injury. and the hypoglossal nerve is the next structure encountered.



A. Unilateral neck exploration is performed through an incision along the anterior border of the sternocleidomastoid muscle; exposure of the carotid artery requires early division of the facial vein. B. The distal internal carotid artery is expose by dividing the ansa cervicalis, which permits mobilization of the hypoglossal nerve. C. Further exposure is facilitated by resection of the posterior belly of the digastric muscle

Trachea, Bronchi

- Less than 1% of all injured patients sustain intrathoracic tracheobronchial injuries, and only a small number require operative intervention.
- Although penetrating injuries may occur throughout the tracheobronchial system, blunt injuries most commonly occur within 2.5 cm of the carina.
- For patients with a massive air leak requiring emergent exploration, initial control of the injury to provide effective ventilation is obtained by passing an endotracheal tube either beyond the injury or into the contralateral mainstem bronchus.
- Principles of repair are similar to those for repair of cervical tracheal injuries. Devitalized tissue is debrided, and primary end-to-end anastomosis with 3-0 PDS suture is performed.

- Dissection should be limited to the area of injury to prevent disruption of surrounding bronchial vasculature and ensuing ischemia and stricture. Suture lines should be encircled with vascularized tissue, either pericardium, intercostal muscle, or pleura.
- Expectant management is employed for bronchial injuries that are less than one-third the circumference of the airway and have no evidence of a persistent major air leak.
- In patients with peripheral bronchial injuries, indicated by persistent air leaks from the chest tube and documented by endoscopy, bronchoscopically directed fibrin glue sealing may be useful.

Esophagus

- Due to the proximity of the structures, esophageal injuries often occur with tracheobronchial injuries, particularly in cases of penetrating trauma.
- Operative options are based on the extent and location of esophageal injury. With sufficient mobilization, a primary single-layer end-to-end anastomosis may be performed after appropriate debridement.
- As with cervical repairs, if there are two suture lines in close approximation (trachea or bronchi and esophagus) interposition of a vascularized pedicle is warranted to prevent fistula formation.
- Perforations at the gastroesophageal junction may be treated with repair and Nissan fundoplication or, for destructive injuries, segmental resection and gastric pull-up.
- Small esophageal injuries can be managed with stenting. With large destructive injuries or delayed presentation of injuries, esophageal exclusion with wide drainage, diverting loop esophagostomy, and placement of a gastrostomy tube should be considered.


THANKS FOR YOUR ATTENTION