Caring

Vascular Trauma

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Vascular Trauma - Goals

- Understand mechanisms and patterns of injury
- Diagnosis
  - Physical exam
  - Imaging
- Treatment options
- Specific injuries

Vascular Trauma

- Two main consequences
  - Hemorrhage
  - Ischemia
  - "It either bleeds too much or not enough"
- Unrecognized uncontrolled hemorrhage can lead to death
- Unrecognized untreated ischemia can lead to limb loss, stroke, bowel necrosis and multiple organ failure

Vascular Trauma

- Most commonly by penetrating trauma
  - GSW >> stab wounds
- Blunt trauma

Pathophysiology

- Hemorrhage – prime consequence
- Bleeding may be obvious or concealed
- Concealed bleeding
  - Chest
  - Abdomen
  - Pelvis
  - Buttocks
  - Thighs
  - Swallowed (facial trauma)

Pathophysiology

- Ischemia – acute interruption of blood flow to limb or organ
- Inadequate O2 supply → anaerobic metabolism → lactic acidosis
- Inflammatory pathway activation
- Cell death
  - Skeletal muscle – can recover after 3-6 hr
  - Peripheral nerves are more sensitive to ischemia
- Restoration of arterial supply may result in reperfusion injury

Patterns of Vascular Injury

- Laceration (complete/incomplete transection) – most common
- Bleeding more severe in partially transected vessels
  - Complete transection results in retraction and vasoconstriction

- Blunt trauma injures by crushing, distraction or shearing
- Results in vessel contusion that may extend to some distance

Patterns of Vascular Injury

- Intimal flap may form
  - Thrombosis
  - Dissection
  - Rupture
- Thrombosis may propagate or embolize

Patterns of Vascular Injury

- Bleeding may continue within a contained hematoma (pseudoaneurysm)
  - Pulsatile mass
  - Distal flow is usually preserved
  - Sometimes present late if undiagnosed
  - Risk of rupture

Patterns of Vascular Injury

- Injury to adjacent vein may result in AV fistula
  - Rupture
  - Heart failure
  - Often present late

Diagnosis

- Physical exam – most important
- Absence of hard signs of vascular injury virtually excludes vascular trauma
- Presence of hard signs mandates immediate action

Diagnosis

- Hard signs of vascular injury
  - Pulsatile bleeding
  - Expanding hematoma
  - Absent distal pulses
  - Cold, pale limb
  - Palpable thrill
  - Audible bruit
- Presence of hard signs mandates immediate operative intervention

Diagnosis

- Soft signs of vascular injury
  - Nerve deficit
  - History of bleeding at scene
  - Reduced but palpable pulse
  - Injury in proximity to major artery
- High velocity GSW, multiple fragments or blunt trauma may make diagnosis less obvious, requiring additional studies

Diagnostic Adjuncts

- Pulse Oximetry – lower reading in one limb is suggestive but does not confirm or exclude vascular injury
  - Unhelpful
- Doppler Ultrasound – presence of Doppler signal in a pulseless limb only gives false sense of security
  - Does not imply a less severe or urgent injury
- Duplex Ultrasound – requires experience operator
  - Can detect intimal tears, thrombosis, pseudoaneurysm, AV fistula
  - Can be limited by hardware, dressing, pain

Arterial Pressure Measurements

- Bedside ABI measurement may be useful
- ABI<0.9 suggests major vessel disruption, acute thrombosis or lage intimal flaps
  - requires additional imaging
- Limitations – branch artery disruption (e.g. profunda femoris), small intimal flaps, pseudoaneurysms, AVFs
- Less accurate in proximal injuries
- Does not assess the venous system

Conventional Angiography and CTA

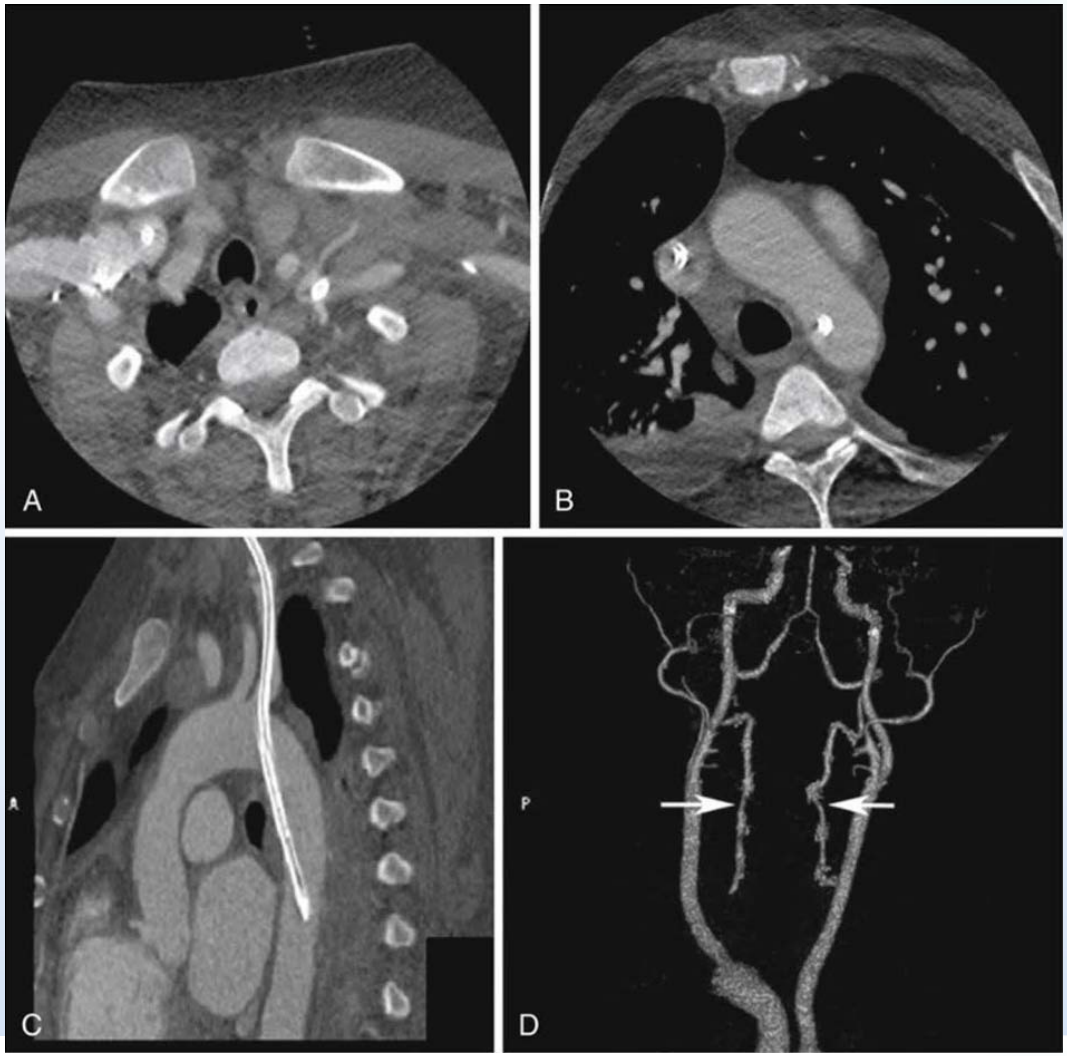
- Conventional angiography was the gold standard
- Very low yield when performed to rule out injury (<5%)
- Quality of CT has improved and supplanted invasive angio
- Exception – patient with planned therapeutic endovascular procedure
  - CTA often used as a guide before angio

Imaging for Neck Injuries

- CTA can be used in place of angio, excluding those who should undergo immediate surgical exploration
- In absence of hard signs physical exam is unreliable for excluding arterial injury
  - Delayed neuro deficits can occur from missed injuries
- Angio – sensitive and specific for vascular injury, but not cost effective
  - 3 million dollar per CNS event prevented

Imaging for Neck Injuries

- CTA – very important in penetrating neck injuries
  - Evaluation of aerodigestive tract
  - 95% sensitivity and specificity for vascular injuries
  - Metal artifacts may limit utility
  - Useful for preoperative planning when patient is stable



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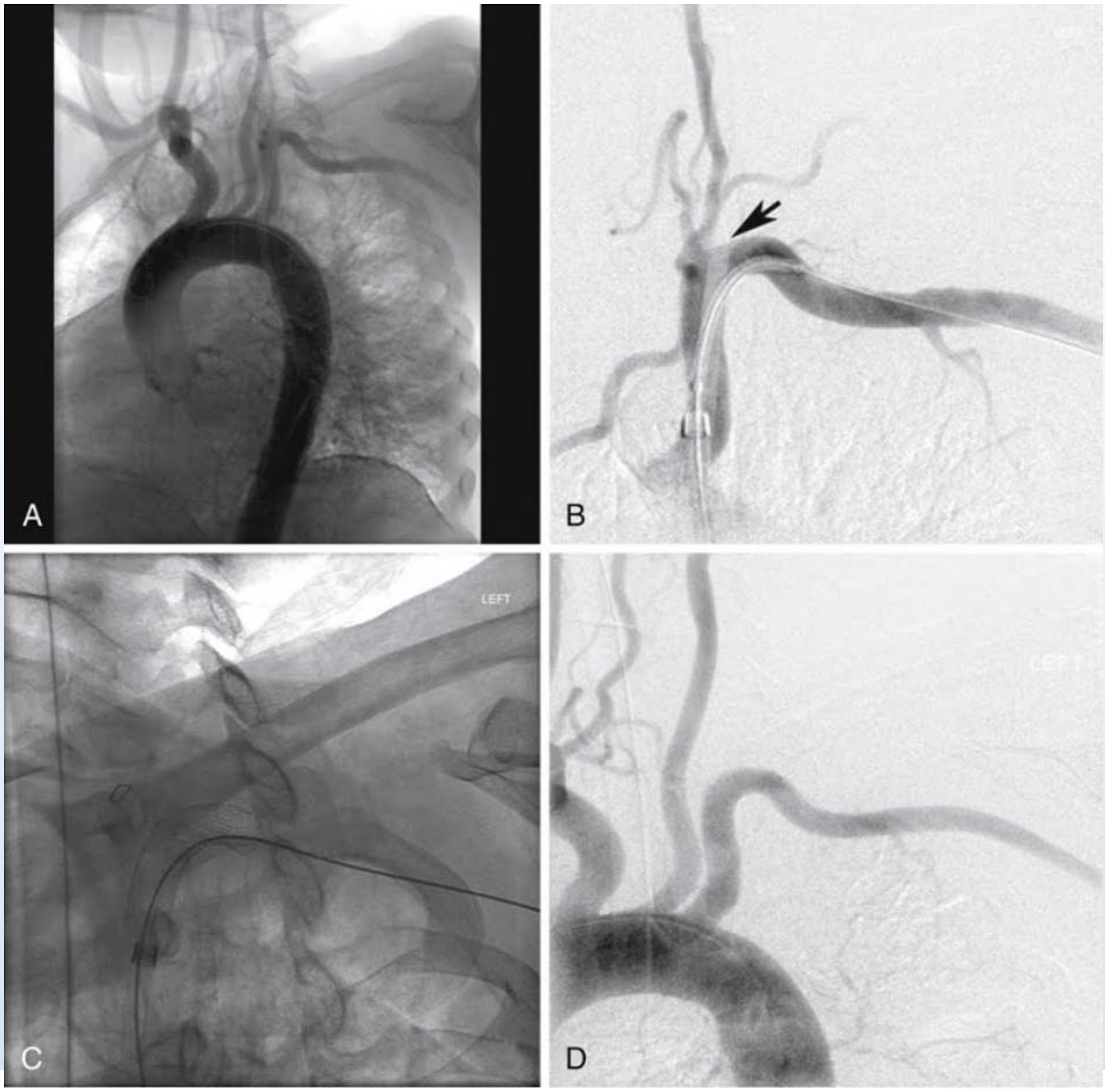

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Imaging for Thoracic Aortic Injuries

- CTA – screening modality of choice for blunt aortic trauma
- Less useful in penetrating injuries to chest
- Penetrating wounds **traversing** the mediastinum are often lethal (heart / great vessel injury)
- Penetrating wounds **outside** mediastinum typically do not result in vascular injury
- CTA – useful if missile trajectory crosses midline and can involve mediastinum
  - Aid in determining need for surgery, aerodigestive tract evaluation or angiography

Imaging for Penetrating Abdominal Vascular Injuries

- Penetrating vascular injuries rarely occur in isolation, usually accompanied with solid or hollow viscus injuries
- Patients with significant tenderness or hemodynamic instability require emergent laparotomy
- In stable patients with unreliable exam imaging should be considered to determine peritoneal violation
- CT is the imaging modality of choice
- Triple contrast CT (IV, PO, rectal) approaches 100% sensitivity, and negative predictive value

Conventional Angiography in Abdominal Trauma

- Reserved for patients treated non operatively
- Extravasation from kidney or liver injury – angio with embolization has good results in bleeding control
- Diagnostic angio – not as good as CT
  - Risk of missing bowel injury

Minimal Arterial Injury

- Small pseudoaneurysms, AVFs, intimal flaps
- Historically – concern for delayed bleeding, embolization or acute occlusion
- Seen frequently with endovascular intervention
- Most are benign and less than 5% require later operative intervention
- In penetrating trauma, minimal arterial injuries seem to be of minimal clinical significance

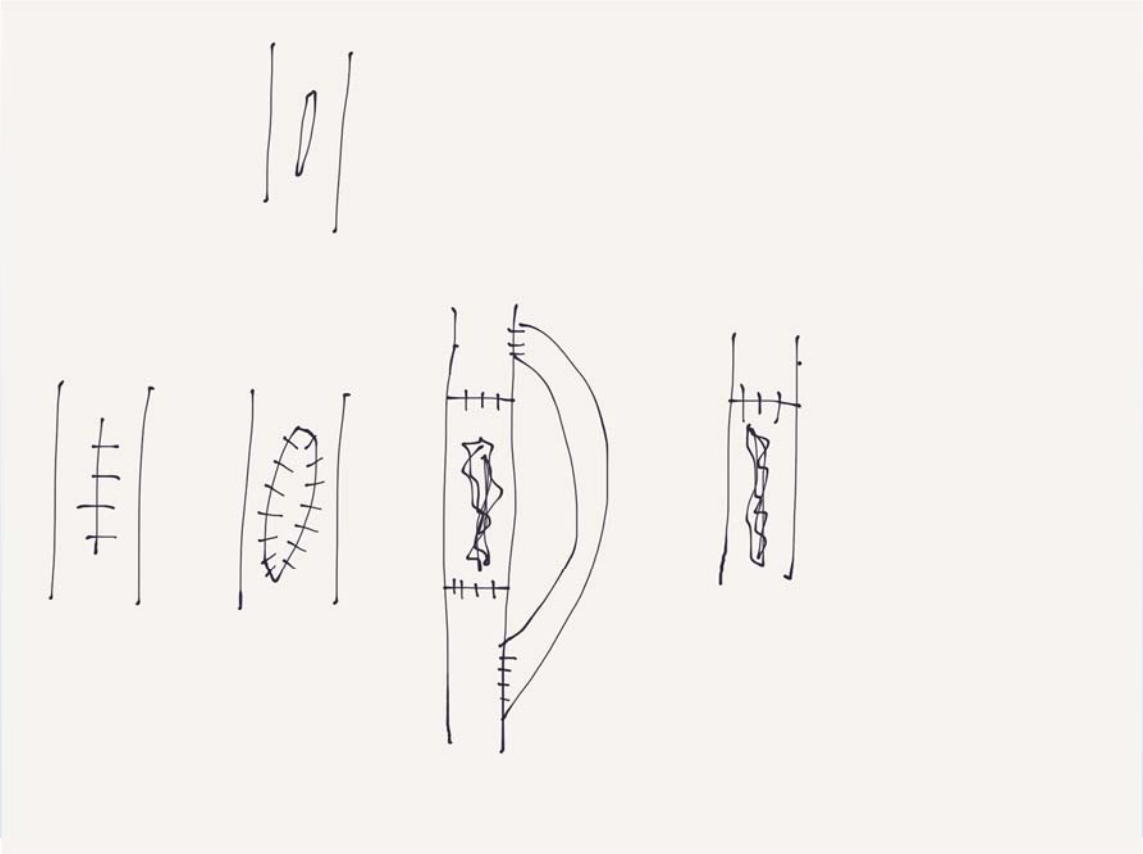
Imaging for Penetrating Extremity Injuries

- In presence of hard signs of vascular injury –imaging not indicated
  - Possible exception – hybrid trauma room (angio can be done without delay)
- With soft signs – additional imaging
  - Incidence of major vascular injury is low
- Angio – very sensitive , allows intervention
  - Has risks
- In a prospective study, CTA for patients with penetrating extremity trauma and soft signs had 100% sensitivity and specificity for detecting clinically significant arterial injuries

Imaging for Penetrating Extremity Injuries

- CTA can be safely used as initial diagnostic study in patients with penetrating extremity trauma with soft signs
- Limitations of CTA
  - Scatter from metallic artifact
  - Resolution detail at tibial or pedal level

Surgical Repair Options



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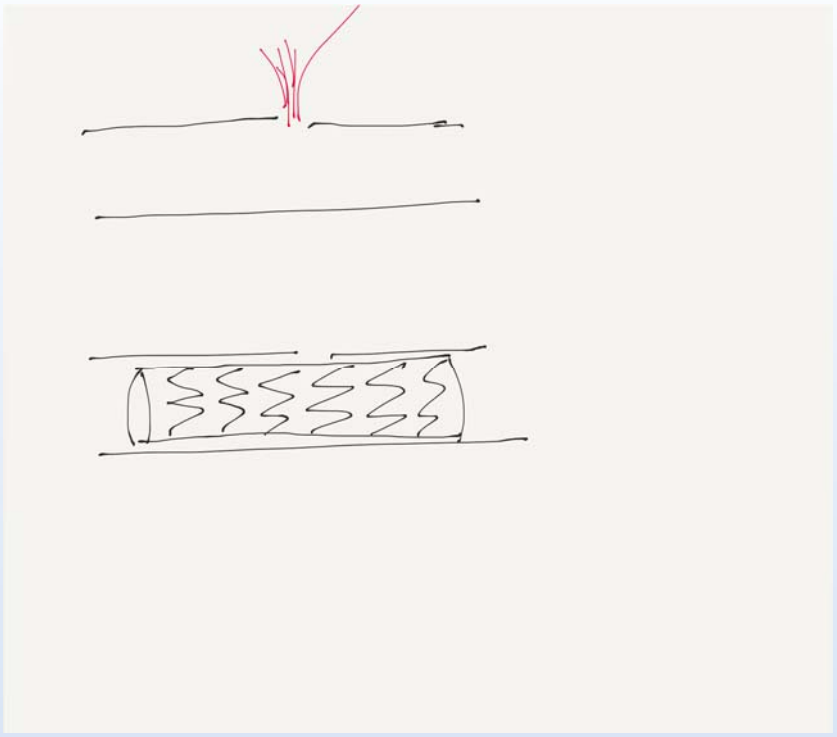
Endovascular Options – Covered Stent



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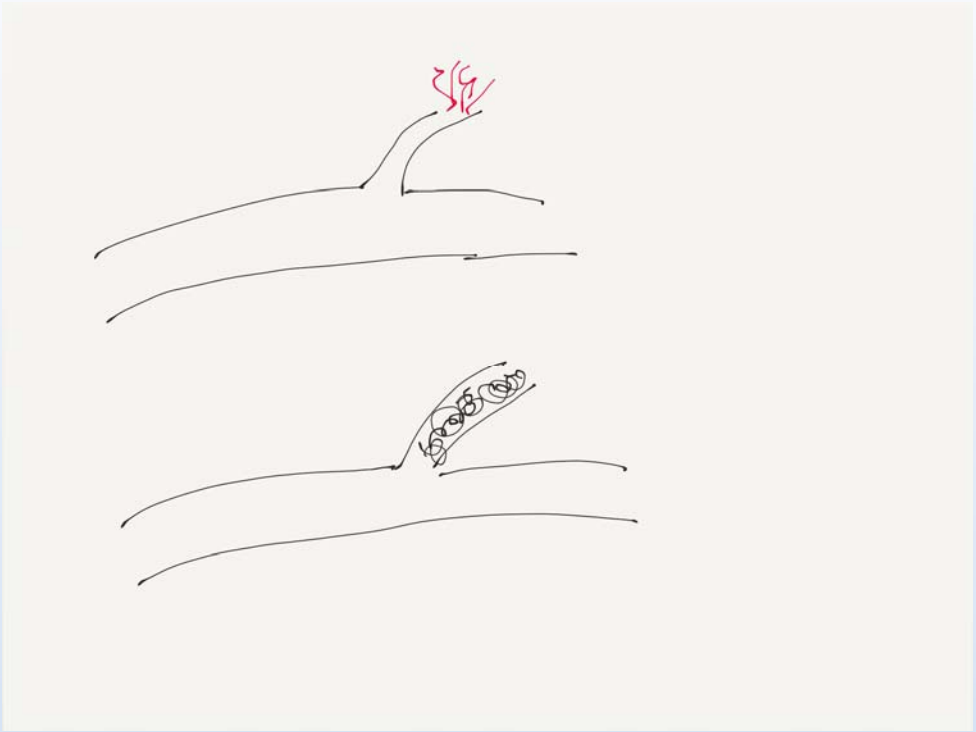
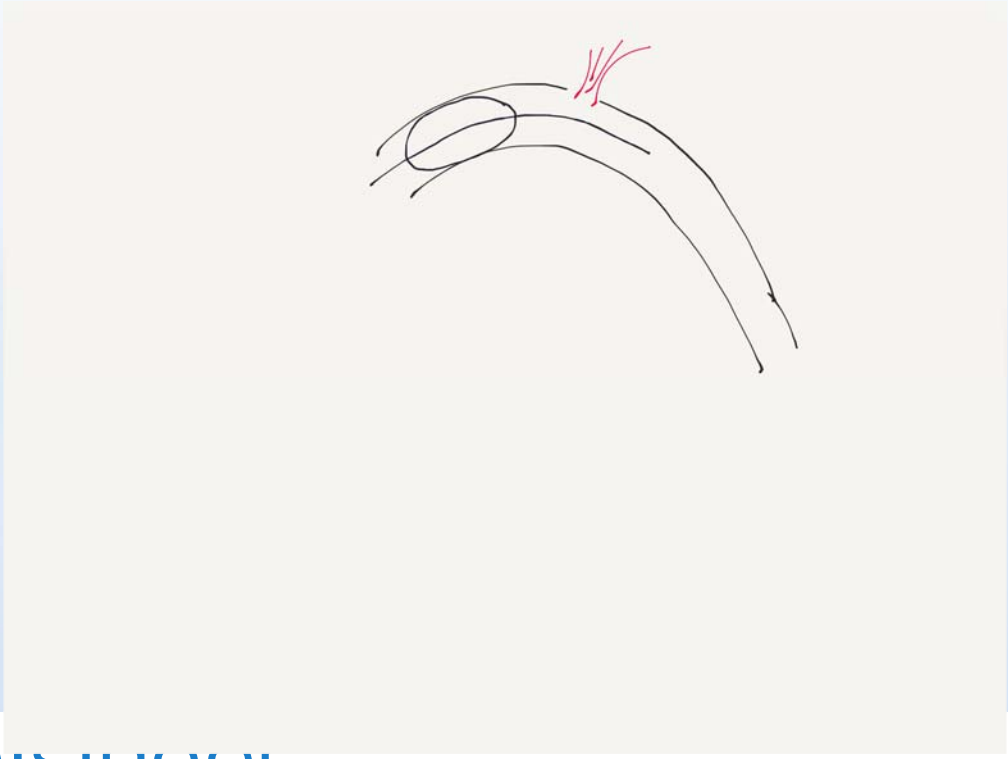
Endovascular Options - Embolization



Endovascular Options – Proximal Control



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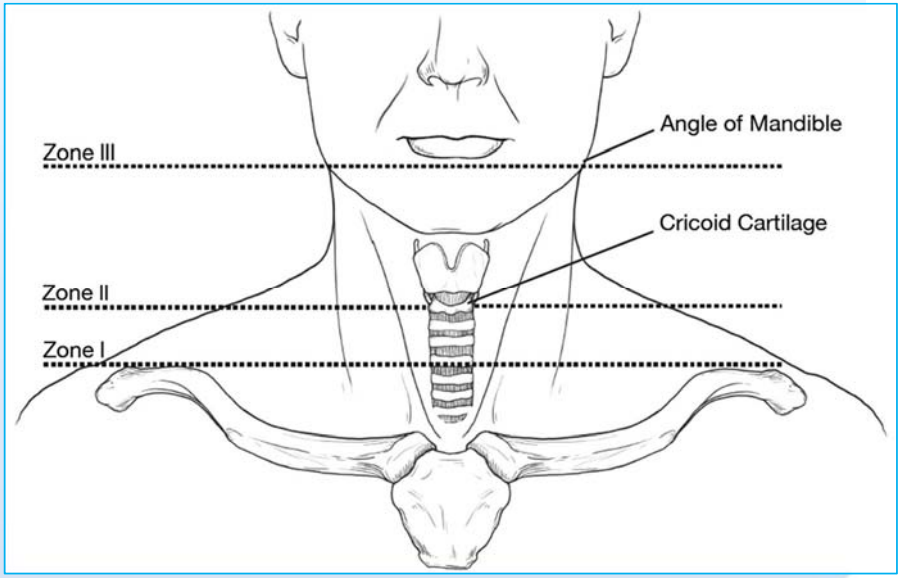
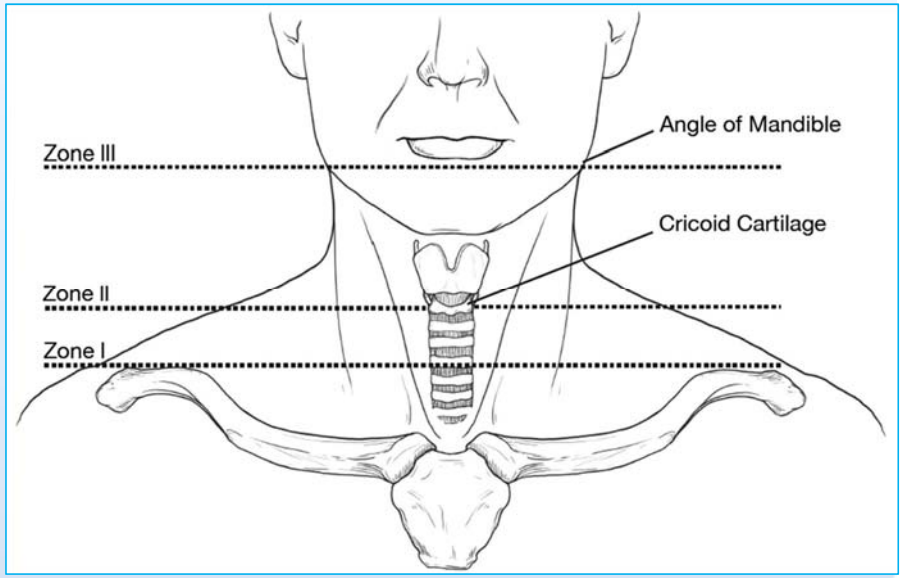
Penetrating Carotid Injuries

- Important factors to consider: type of injury, location, associated injuries to aerodigestive tract, neuro status
- Morbidity caused by 3 mechanisms:
  - Hemorrhage
  - Hematoma compressing airway
  - Brain ischemia (embolization or thrombosis)
- All patients should have CTA if stable



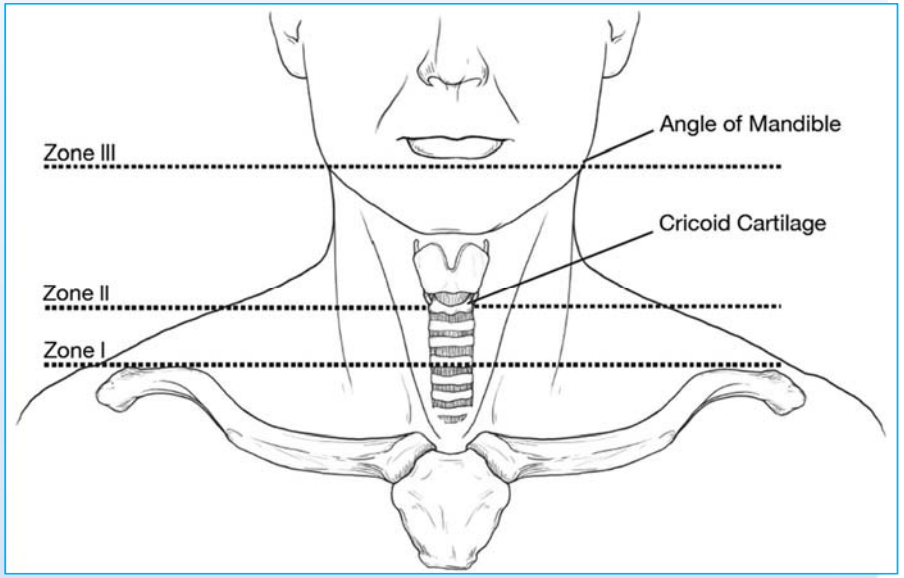
Zone II Penetrating Injuries

- Usually treated surgically – easily accessible
- Prep leg for GSV harvest
- Endovascular repair may be considered



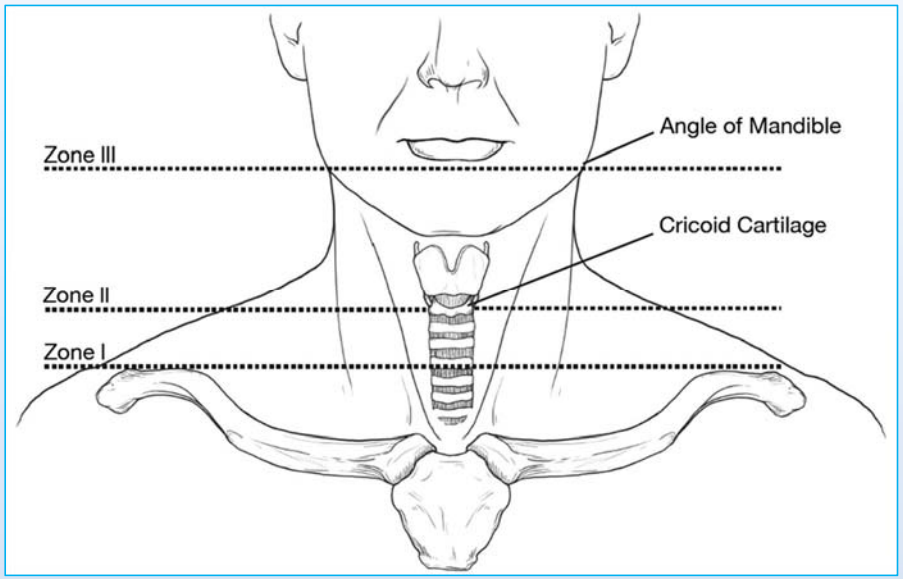
Zone I Penetrating Injuries

- Consider intrathoracic bleeding and/or need for intrathoracic vascular control
- Proximal control may be endovascular



Zone III Penetrating Injuries

- More difficult surgical exposure
- Exposure of base of skull
- Endovascular repair options



Surgical Approach to Carotid Injury

- Exploration of wound – if platysma not violated no further intervention needed
- Simple puncture wound may be treated with direct repair, but may require patch angioplasty or interposition graft
- Total occluded carotid – should be repaired if there is flow in the distal ICA
- Avoid Fogarty catheter – intracranial rupture or carotid cavernous fistula
- Ligation – when patient critically unstable or injury unrepairable

Treatment of Penetrating Extremity Arterial Injuries

- Control bleeding – digital occlusion, tourniquet
- Proximal thigh injuries – control of external iliac artery (division of inguinal ligament or retroperitoneal approach)
- Proximal axillo-subclavian wounds – sternotomy or left anterior thoracotomy with clamping of subclavian artery.