Management of Penetrating Neck Injury (PNI)

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22 y/o man, BIBEMS to ED, ETOH (+), s/p stab wound to the left posterior neck, LOC(-).

- PMH- Denies
- PSH- Denies
- Meds.- None
- SH- smokes 1PPD, ETOH occasionally
- Allergy- NKDA
Physical Exam

- **Primary Survey** - GCS 15, ABCD/ WNL
  - VS: BP132/82 T98.4 P100 RR20 O₂100

- **Secondary Survey** -
  - Head: no lacerations, no deformity, no crepitus
  - Neck: 2 cm transverse wound in the posterior cervical triangle at the level of the angle of the mandible (at the junction of zone 2 & zone 3), small hematoma with some external bleeding, trachea central, no subcut. emphysema, no C-spine tenderness
Physical Exam

• Chest: CTAB, no point of tenderness
• Abdomen: SNTND, no ecchymosis
• Pelvis: symmetrical, no crepitus, no tenderness
• Back: no tenderness, no step off def.
• Rectal exam: normal tone, no blood
• Ext: symmetrical, no deformity, intact pulses 2+ B/L, intact motor and sensory
Labs

- CBC- 6.47/14.0/41.6/218
- BMP-139/3.1/100/24/10/0.78/103
- LFTs-7.4/4.7/39/26/86/0.2
- A/L-107/44   Lactate- 2.6
- VBG- 7.36/46/43/74/24/0.4
- Coags-10/27/0.9   ETOH  94.8
- Urinalysis- negative   UTOX- negative
CTA Neck
CTA Neck
OR

• left anterior neck exploration
• Anterior sternocleidomastoid incision
• wound exploration
• Control of muscular bleed
• Discharged home POD#1
Overview

- History
- Epidemiology
- Anatomy
- Diagnosis
- Management
- Clinical Cases
- Conclusions
History

• Ambrose Paré (1510-1590) - First documented surgical intervention by ligating the carotid artery and jugular vein of a wounded French soldier.

• Homer’s Iliad – Achilles delivered a fatal lance to Hector’s neck.

• American Civil War -> 4000 cases of neck injuries

• World War I - expectant management, mortality 35%

• World War II/Bailey (1944) - early exploration if deep to platysma.
History

- **Fogelman & Stewart (1956)** - 6% mortality in early exploration vs. 35% if delayed or no intervention. 56% negative exploration rate.
- **Monson (1969)** - neck zones description.
- **Roon & Christensen (1979)** - Mandatory exploration for zone II and angiogram for stable zone I&III.
- **1980s** - Selective Surgical Management concept (identify patients who would benefit from surgical management), based on clinical exam and adjunctive tests. 86% positive exploration
Epidemiology

- PNIs defined by platysma violation
- PNIs- 5 % of traumatic injuries in adults.
- Stab injuries (40%)- Knife, razor blades, glass.
- Projectile injuries(45%)- Handgun, Rifle, Shotgun.
- Low velocity vs high velocity injuries
- Injuries- 50% GSW vs 10-20% Stab wounds
- Overall mortality- 3-10%
Epidemiology

- Most common (zone II > zone I > zone III)
- Mortality is highest with zone 1.
- Kinetic Energy of Projectile & Muzzle velocity
  -> More energy = More damage
- Most vital structure in the anterior triangle
- PNIs to posterior Triangle → much lower chance of significant injury.

 Platysma violation, mandates careful search for aerodigestive and neurovascular injuries.
Epidemiology

- Structures injured
  - No significant damage 40%
  - Major vein 15-25%
  - Major artery 10-15%
  - Digestive tract 5-15%
  - Respiratory tract 4-12%
  - Major nerves 3-8%

- GSW tract can transgress zone boundaries, superficial wound may not correspond well to deeper structures injured.
Anatomy

- Superficial (investing) fascia
- Pretracheal fascia
- Buccopharyngeal fascia
- Carotid sheath
- Superficial (investing) layer of deep cervical fascia
- Prevertebral fascia
- Alar fascia
- Retropharyngeal space
- Subcutaneous tissue
- Spine of cervical vertebra
- Deep cervical muscle
- Levator scapulae muscle
- Prevertebral fascia
- Trapezius muscle
- Phrenic nerve
- Anterior scalene muscle
- Sympathetic trunk
- Common carotid artery
- Vagus nerve
- Esophagus
- Internal jugular vein
- Recurrent laryngeal nerve
- Thyroid gland
- Omohyoid muscle
- Sternocleidomastoid muscle
- Sternohyoid muscle
- Sternothyroid muscle
- Platysma muscle
- Trachea
- Spine of cervical vertebra
Anatomy

- **Skeletal** (cervical vertebrae & hyoid bone)
- **Nervous** (spinal cord, IX,X, XI, XII CN, symp. chain )
- **Respiratory** (Oropharynx, larynx, trachea)
- **Gastrointestinal** (oropharynx, esophagus)
- **Vascular** (common, internal and external carotid arteries, vertebral arteries, internal and external jugular veins)
- **Lymphatic** (thoracic duct)
- **Endocrine** (thyroid and parathyroid glands)
- **Immune** (cervical extension of thymus)
Zone I

- Extends from the clavicles to the cricoid cartilage.
- Extra thoracic subclavian, common carotids, innominate vessels, jugular veins and lower vertebral arteries, thoracic duct, trachea, esoph., spinal cord, brachial plexus, Vagus N.
- Mandatory operative exposure not recommended (difficult access).
- Mortality – 12%
Zone II

- Most commonly involved 50-75%
- Extends from the cricoid cartilage to the angle of the mandible.
- common carotid and bifurcation, vertebral arteries, jugular veins, Larynx, trachea, esoph., spinal
- Cord, (CN. X, XI, XII)
- Operative exposure (easy access).
- Selective vs Mandatory.
Zone III

- Dangerous Area due to Proximity of vasculature to skull base.
- Extends from the angle of the mandible to the mastoid process.
- External carotid branches, internal carotid artery, vertebral artery and internal jugular, facial veins, Pharynx, oral cavity, spinal cord, (CR. VII, IX, X, XI, XII).
- Mandatory operative exposure not recommended (difficult access).
Laryngotracheal Injuries

- 10% PNIs will have laryngotracheal trauma
- Trachea most commonly involved (2/3), larynx (1/3)
- Mortality 20%
- 25% have esophageal injury
  - Airway compromise
  - Massive subcutaneous emphysema
  - Air bubbling through wound
  - Hemoptysis
  - Odynophagia, dysphonia
Pharyngoesophageal Injuries

- 10% PNIs will have pharyngoesophageal trauma
- 30% no signs or symptoms
- Leading cause of delayed M&M.
- Mortality 22%
  - Dysphagia
  - Hematemesis
  - Subcutaneous emphysema
Vascular Injuries

- **Soft Signs**
  - Mild Bleeding
  - Nonexpanding hematoma
  - Paresthesia

- **Hard signs**
  - Severe external bleeding
  - Expanding hematoma
  - Pulsatile swelling
  - Bruit, thrill
  - Pulse deficit
  - Neurologic deficit
Nervous Injuries

- CNS- Spinal cord.
- PNS- CN. VII through XII, sympathetic chain, peripheral nerve roots, brachial plexus.

- Neurogenic shock
- Brown-Sequard syndrome
- Horner’s syndrome
- Speech/ movement of the tongue
- Shoulder Shrug
Diagnosis

- Clinical Exam
- Imaging
  - CTA neck
  - IR Angiography
  - Carotid Ultrasound
  - esophagography
- Endoscopy
  - Flexible laryngoscopy, bronchoscopy
  - esophagoscopy
CT Angiography

- **Indications:** Stable patients with PNIs
  - A thorough physical examination is highly sensitive (>95%) for detecting arterial vascular injury but a lower sensitivity for aerodigestive tract injuries.
  - CTA - highly sensitivity for detecting vascular and aerodigestive tract injuries
  - CTA- reduced the need for operative neck exploration
  - Negative CTA, no symptoms ➔ Observation
IR Angiography

• Gold standard for vascular injury
• Diagnostic & therapeutic
• Zones I & III difficult to assess clinically and often involve complex surgery
• Cost-effective for zones I & III
• Decreased surgery rates to 5% in zone I and 13% in zone III
Endoscopy

Indications:

- Negative CTA imaging but concerning trajectory
- Intra-Operative, concern for aerodigestive injury
  - Expeditious evaluation $\rightarrow$ increased morbidity with delayed esophageal repair
  - Sensitivity 92.4%, specificity 100%
Management

- Clinical exam, ACLS 1ry & 2ry Survey
- Secure Airway (avoid techniques not done under direct vision)
- **modest or moderate symptoms or signs**
  - undergo a diagnostic evaluation (CTA, Endoscopy, IR)
  - Expectant and selective operative management vs IR (zone I & III)
- **“hard signs” or hemodynamic instability**
  - Life threatening bleeding - direct pressure/insert Foley
  - Activate massive transfusion
  - OR
Vascular Operative Exposure

• **Zone II**- anterior SCM incision or Transverse cervical collar incision for transcervical injuries

• **Zone I**- Median sternotomy with extension to an anterior SCM incision or supraclavicular incision with or without clavicular head resection.

• **Zone III**- subluxation, dislocation, or resection of the mandible for distal control.
Vascular injuries Management

- **Carotid artery injury**
  - 22% vascular injuries, 10-20% mortality
  - Repair preferred.
  - Ligate or embolize if high carotid injury
  - Intimal flap- endovascular repair, Anti-platelet

- **Vertebral artery injury**
  - 10% Vascular injuries
  - Endovascular embolization or Ligation.
Airway Injuries management

- **Stable airway:** CTA, Flexible laryngoscopy, bronchoscopy
- **Unstable airway:** Be prepared for surgical airway, tracheotomy safest option
- **Tracheal injury:** debridement, primary repair with absorbable suture, Interposition of well-vascularized tissue between tracheal and esophageal injuries ➔ reduce fistula rate
Esophageal Injuries Management

- 19% mortality, 41% morbidity in delayed repair
- Goals: early operative management, debridement, primary closure with buttressing and adequate drainage
- Esophagoscopy: if high suspicion but studies negative → 24 hrs observation
- Early diagnosis: primary repair
- Late diagnosis: drainage/resection/diversion
- Pharyngeal injury → NPO, IV antibiotics, NGT
Modest or moderate symptoms or signs or an asymptomatic patient

Zone I
- R/o vascular injury
  - Chest x-ray
  - CTA if hematoma or hemothorax

Zone II
- Physical Exam
  - Normal exam r/o injuries if track away from vascular/aerodigestive structures

- CT
  - Demonstrates track of missile and some injuries even without contrast
  - CTA vs. arteriography vs. duplex ultrasound vs. color flow ultrasound
    - Larynx, trachea
      - CT, laryngoscopy, fiberoptic bronchoscopy
    - Esophagus
      - Gastrograin swallow, flexible esophagoscopy, ? CT

Zone III
- R/o vascular injury

Source: Mattox KL, Moore EE, Feliciano DV: Trauma, 7th Edition: www.accesspharmacy.com
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Conclusion

• Mechanism of injury is emphasized
• Thorough physical examination is key
• **CT Angiography**, stable patients (All zones), effective and reliable (less neg. exploration Rate), allow for less utilization of services.
• **Hard signs/unstable patients**, immediate surgical exploration of any zone +/- Angiogram (zone I&III)
• **Esophagram/flexible esophagoscopy/laryngoscopy**, if suspect or see injury on CTA ➔ early repair is a key
• **Stable patients with Zone I and III injury** undergo angiography and endoscopy
• **Stable patients with Zone II injury** CTA, Selective testing, Selective Surgical Exploration
References

Thank You