Penetrating Neck Injuries

Farrah Siddiqui, M.D.

Discussion: Francis B. Quinn, Jr., M.D., FACS
The University of Texas Medical Branch
Department of Otolaryngology
Grand Rounds Presentation
March 31, 2010
Overview

- Background: History of management of PNI
- Anatomy & classification of neck zones
- Epidemiology
- Morbidity & types of injury
- Diagnosis
- Management
- Clinical cases
- Conclusions
Background: History

- 1944: Bailey—early exploration if deep to platysma
- 1956: Fogelman & Stewart—6% mortality in early exploration vs. 35% if delayed
- 1979: Roon & Christensen—immediate exploration for middle zone vs. angiogram for stable high or low zones → 81% surgery with 53% negative exploration rate
- 1980s +: Selective management
  - Clinical Exam
  - Adjunctive tests: Endoscopy, swallow study
  - Arteriography
  - Duplex Ultrasound
  - Computerized tomography angiography (CTA)

With mandatory exploration, mortality decreased from 15-18% pre WWII to 3-7% during WWII. However, negative exploration increased dramatically—40-60% Roon AJ, Christensen N. Evaluation and treatment of penetrating cervical injuries. J Trauma 1979; 19: 391-7.
Background: History

- **Meyer et al 1987**: prospective zone II study, n = 120
  - 5.8% immediate exploration
  - 94.2% had endoscopy & arteriography before surgery
  - 6% morbidity, 0.8% mortality

- **Biffl WL et al 1997**: 18 year prospective study showed selective management of PNI safe
  - 1978-1996: selective → 66% observed
    - 1 missed esophageal injury
    - 16% negative exploration
    - 3% mortality; 10% morbidity
Sniper injury to neck from Spanish Civil War left him with vocal cord paralysis
Anatomy: Zones I - III

- **Zone I**: sternal notch → cricothyroid membrane
- **Zone II**: cricothyroid membrane → angle of mandible
- **Zone III**: angle of mandible → skull base

Is this classification outdated?

Zone I is treated like thoracic injury.
Anterior neck area classification ant to pos B of SCM; posterior neck not further divided.
Often patients have multiple wounds or GSW tract can involve multiple zones, so some question importance of this classification. Superficial wound does not correspond well to deeper structures injured.
Anatomy: Facial planes

- Hematomas, air tracks
- Bullet, metal tracks
- Carotid space: Carotid, IJV, CN X
- Retropharyngeal space: behind pharynx, anterior to prevertebral muscles
- Perivertebral space: muscles & soft tissue around vertebrae

- Bleeding that displaces prevertebral muscles anteriorly is associated with vertebral body fractures.
- Retropharyngeal carotid artery important for presurgical planning
- Esophageal injury can track air into RP, prevertebral space
- Missed esophageal injuries can present as retropharyngeal abscess, mediastinitis, sepsis
Epidemiology: Adult PNI

- 1% of all trauma patients in USA
- Demetriades et al 1993 GSW more clinical signs & injuries (35% vs. 19% for SW)
- Structures injured: 40% no significant damage
  - Major vein 15-25%
  - Major artery 10-15%
  - Digestive tract (pharynx, esophagus) 5-15%
  - Respiratory tract (larynx, trachea) 4-12%
  - Major nerves 3-8%

Gun shot (GSW) | Stab (SW) | Shotgun
---|---|---
45% | 40% | 4%

- Demetriades prospective study; 97 GSW, 89 SW
Epidemiology: Pediatric PNI

- 40% mortality—zones I & III more common
  - 60% zone I—multiple wounds
  - 29% zone II
  - 56% zone III—multiple wounds

<table>
<thead>
<tr>
<th>Mandatory Neck Exploration</th>
<th>Selective Neck Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoarseness, aphonias, airway</td>
<td>Change in neck exam</td>
</tr>
<tr>
<td>Shock, continued bleeding</td>
<td>Abnormal diagnostic tests</td>
</tr>
<tr>
<td>Blood in aerodigestive tract</td>
<td></td>
</tr>
<tr>
<td>Subcutaneous air</td>
<td></td>
</tr>
<tr>
<td>Neurologic deficits</td>
<td>→ 86% positive exploration</td>
</tr>
<tr>
<td>Multiple major injuries</td>
<td></td>
</tr>
<tr>
<td>→ 100% positive exploration</td>
<td></td>
</tr>
</tbody>
</table>

Upenn n = 35 1990-97
Morbidity: Vascular injury

- **Major Signs**
  - Active bleeding
  - Unstable/hypotension
  - Expanding hematoma
  - Pulsatile swelling
  - Bruit, thrill
  - Unilateral CNS deficit
  - Pulse deficit

- **Minor Signs**
  - Parasthesias
  - Nonexpanding hematoma
  - C spine or skull base fractures in MVAs
Morbidity: Vascular injury

- **Carotid artery injury**
  - 22% vascular injuries
  - 10-20% mortality in hospital
  - Repair preferred unless comatose patient
  - Ligate or embolize if high carotid injury
  - Minor injury (intimal flap) → endovascular repair, ? Anti-platelet Tx
  - Anticoagulate blunt injury

- **Vertebral artery injury**
  - 10%
  - 2/3 major neck trauma, especially C spine & esophagus
  - Isolated → 1/3 no signs
  - Sepsis due to missed esophageal injury
  - Endovascular embolization if bleeding
  - Ligation low risk
  - Anticoagulate blunt injury
Morbidity: Esophageal Injury

- Odynophagia, dysphagia, hematemesis
- Airway injury → 25% have esophageal injury
- Transcervical trajectory
- Saliva in wound, subcutaneous emphysema
- Prevertebral air on lateral neck X ray

Kietdumrongwong P & Hemachudha T 2005

Morbidity: Esophageal Injury

- Most commonly missed
- Weigelt JA et al 1987: 30% no signs or symptoms
- Wood J et al 1989: most common cause delayed morbidity
- Asensio JA et al 2001: 34 center study of 405 patients with penetrating esophageal injuries
  - 56% cervical esophagus
  - 19% mortality—most common exsanguination
  - 82% primary repair with 16% requiring muscle flaps
  - 11% drainage
  - 3-4% complex: resection/diversion or resection/anastomosis
  - 41% esophageal complication in delayed repair (vs. 19%)
    - Empyema, abscess, mediastinitis

Morbidity: Esophageal Injury

- Srinivasan et al. 2000: flexible esophagoscopy safe & accurate
  - Sensitivity = 92.4%, specificity = 100%
  - PPV = 33.3%, NPV = 100% → no injuries missed
  - Low PPV because incidence of injury low (3.6%)

- Imaging
  - Water soluble contrast (gastrograffin): ½ missed
    - aspiration pneumonitis: not use if poor gag reflex/cough
  - Barium: ¼ missed
    - increased mediastinitis

Start with gastrograffin if negative, repeat swallow with barium
Morbidity: Esophageal Injury

- **Treatment**
  - Observe 24 hrs if high suspicion but studies negative
  - Pharyngeal injury → NPO, IV antibiotics, NGT
  - Esophageal injury → primary repair vs. drainage/resection/diversion
    - Early diagnosis → primary repair
    - Late diagnosis with sepsis/inflammation → drainage
Morbidity: Airway Injury

- More common in blunt trauma
- 5-15% PNI will have laryngotracheal trauma
- Hoarseness, stridor, hemoptysis, difficulty breathing, pain
- Air leak in wound, difficult airway → surgery!!!
- Majority airways managed by rapid sequence intubation (RSI) at scene or ED

<table>
<thead>
<tr>
<th>Study</th>
<th>Airway Management</th>
<th>N</th>
<th>Intubation Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandavia DP 2000</td>
<td>Retrospective</td>
<td>748</td>
<td>11% emergent intubation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-67% RSI with → 100% success</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-33% fiberoptic → 91% success</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-3 fiberoptic failures → RSI</td>
</tr>
<tr>
<td>Eggen JT 1993</td>
<td></td>
<td>114</td>
<td>60% intubated, 22% ED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No intubation complications</td>
</tr>
<tr>
<td>Shearer VE 1993</td>
<td></td>
<td>107</td>
<td>83% RSI with DL → 100% success</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6% surgical airway → 100%</td>
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<td></td>
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<td></td>
<td>7% awake fiberoptic → 98%</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4% blind nasotracheal → 75%</td>
</tr>
</tbody>
</table>

Morbidity: Airway Injury

- High index of suspicion—avoid paralytic agent!
- Trachea most commonly involved (2/3) vs. larynx (1/3)
- 25% have esophageal injury
- Esophageal injury → chances of airway injury double
- Unstable airway → Be prepared for surgical airway
  → tracheotomy safest option
- Stable airway → Flexible laryngoscopy, bronchoscopy
  → CT shows fractures, tracheal injury
  → OR for endoscopy if suspect injury
- Steroids, oxygen, IV Abx, humidified air if no fractures, mucosal disruptions or progressive edema/hematoma
Morbidity: Airway Injury

- Laryngeal fractures in PNI
  - Thyroid cartilage most common
  - Should not delay fixation for > 24 hours since increased risk of scarring

<table>
<thead>
<tr>
<th>Group</th>
<th>Laryngeal Injury</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Minor endolaryngeal hematoma; No fracture; Good airway</td>
<td>Observe; steroids, PPI, humidity</td>
</tr>
<tr>
<td>II</td>
<td>Hematoma/edema compromising airway; Laceration without exposed cartilage; Nondisplaced fracture(s)</td>
<td>OR for tracheotomy, DL &amp; esophagoscopy</td>
</tr>
<tr>
<td>III</td>
<td>Massive edema, exposed cartilage, immobile vocal cord(s), displaced fracture(s)</td>
<td>OR for repair &amp; tracheotomy</td>
</tr>
<tr>
<td>IV</td>
<td>Group III + more than 2 fracture lines</td>
<td>OR for repair &amp; trach</td>
</tr>
<tr>
<td>V</td>
<td>Laryngotracheal separation</td>
<td>OR for repair</td>
</tr>
</tbody>
</table>

Morbidity: Airway Injury

- Groups III- V: OR for repair
  - Repair anterior commissure, TVC lacerations
  - Cover exposed cartilage
  - Repair fractures with stainless steel wire or suture
    - Some prefer absorbable (PDS), others prolene
    - Nonabsorbable & absorbable miniplates also used
  - Stent indicated if unstable larynx after fracture fixation or lacerations involving anterior commissure
    - Remove 10-14 days with endoscopy, remove granulation with CO₂ laser
CT shows right thyroid cartilage fracture & air escape suggesting tracheal tear. Extensive subQ air. Patient managed with tracheostomy, reduction of fracture + fixation with 4-0 prolene. Tracheal partially excised with primary repair of trachea.
Morbidity: Airway Injury

- Outcomes of penetrating laryngotracheal injury
  - $\frac{1}{3}$ delayed diagnosis
  - 10% preventable mortality
  - Many suffer permanent voice & swallowing problems
Diagnosis: Clinical exam

- **Rivers et al 1988**
  - no vascular injury missed by physical exam

- **Demetriades et al 1993, n = 335**
  - 269 negative exam observed
  - 2 later required intervention for vascular injury

- **Demetriades et al 1996, n = 223**
  - All patients with negative clinical exam had arteriogram
  - No vascular injury requiring intervention
  - NPV of clinical exam 100%

- **Biffel et al 1997, n = 312**
  - 105 positive exam → OR
    - 16% negative exploration
  - 207 negative exam → observed
    - 1 esophageal perforation

- **Sekharan J et al 2000, n = 145**
  - 0.7% vascular injury missed

- **Azuaje R et al 2003**
  - 93% sensitive, 97% PPV

- **Inaba K et al 2006, n = 91**
  - 100% sensitive, 93.5% specific

- **Tisherman SA et al 2008**
  - Clinical exam protocol up to 95% sensitive

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Inaba K et al. Prospective evaluation of screening multislice helical computed tomographic angiography in the evaluation of penetrating neck trauma. J Trauma 61: 144-149, 2006. n = 91, prospective
Diagnosis: Clinical Exam

- **Fogelman MJ & Stewart RD** 1956: 43% positive explorations were hemodynamically stable & 70% had no bleeding
- **Carducci et al.** 1985: 1/3 patients with positive exploration had no signs/symptoms on clinical exam
- **Scalafani et al.** 1991: 61% sensitivity for vascular injury
- **Apffelstaedt et al.** 1994: n = 335 SW; 30% positive explorations had no clinical signs
- **Eddy VA et al.** 2000: low sensitivity & NPV with clinical exam but improved in patients when CXR added to physical exam

Apffelstaedt World J Surg, 1994, 18: 917
Diagnosis: Arteriography

- Gold standard for vascular injury
- Diagnostic & therapeutic
- Zones I & III difficult to assess clinically
- Zones I & III often involve complex surgery
- Eddy VA et al 2000
  - N = 138, retrospective review vs. mandatory zone I angio
  - No arterial injuries on arteriogram if normal exam & CXR
- Demetriades et al 1993
  - Cost-effective for zones I & III
  - Decreased surgery rates to 5% in zone I & 13% in zone III
Diagnosis: Arteriography

Modrall JM et al 1995 meta-analysis: Diagnosis of vascular trauma

- 23% positive zones I & III
- 2.2 to 28% positive zone II → only 1% needs surgery
- 94-100% sensitive
- 90-98% specific
- 54-66% PPV → high false positive rate
- 100% NPV → no false negatives
- 0-3% complication, mostly minor
- $66,420 per positive arteriogram due to high FP

Modrall JM et al. Diagnosis of vascular trauma. 9(4) 1995.
Diagnosis: Arteriography—arterial injury

Left carotid artery occlusion seen in angiogram on right as well as parasagittal helical CTA on left.
Diagnosis: Arteriography

- Specialized team
- Expensive
- 0.16-2.0% complication: hematoma, pseudoaneurysm, spasm, thrombosis, emboli, thrombi, arterial dissection
  - → permanent CNS sequelae

Digital subtraction left cervical carotid angiogram demonstrating traumatic injury of the left internal carotid artery, manifested by pseudoaneurysm formation and an intimal dissection

Morris C 2008.
Diagnosis: Arteriography

- Endovascular therapy
  - Covered stent graft: pseudoaneurysm, lacerations, AVF
  - Embolization or coiling: pseudoaneurysm, AVF
  - Endovascular occlusion: injured vertebral arteries
  - Test balloon occlusion prior to ligation

Diagnosis: Arteriography

Diagnosis: Duplex U/S

- **Bynoe RP et al 1991, n = 198**
  - 95% sensitive, 99% specific
- **Demetraides D et al 1995 (82)**
  - 91% sensitive, 98.6% specific
  - 100% sensitive for clinically significant injuries
- **Montalvo BM et al 1996 (52)**
  - Detected all serious injuries

**Limitations**
- Operator dependent
- No soft tissue/bony detail
- Not useful in zone I & III


- Picture shows Pseudoaneurysm (arrow) of the femoral artery on angiography and on (B) color duplex ultrasound demonstrating communication and flow between the false aneurysm (FA) and the common femoral artery (CFA) via a neck. (C) Characteristic "to-and-fro" Doppler waveform in the neck of the pseudoaneurysm. (D) Absence of flow within the false aneurysm after successful thrombin injection
Diagnosis: CTA

- **Method:**
  - Nonionic contrast in peripheral IV, care in renal or diabetic
  - Exam takes 1 min., postprocessing takes 15 min.
  - Axial usually enough; add multiplanar + 3D for OR plan
- **Direct signs**
  - Irregular vessel margins, filling defects
  - Contrast extravasation, lack of vascular enhancement
  - Vessel caliber changes
- **Indirect:** indistinct perivascular fat plane, bullet/bone fragments within 5 mm of major vessel, hematoma close to vessel
- **Associated Injuries:** C spine, bullet track, aerodigestive

University of Miami, prospective 2 yr. n = 60
Diagnosis: CTA

  - Sensitivity 90% (100%)
  - Specificity 100% (98.6%)
  - PPV 100% (92.8%)
  - NPV 98% (100%)

- **Inaba K et al 2006 (p)**
  - Sensitivity 100%
  - Specificity 93.5%
  - Nondiagnostic 2.2%

- **Woo K et al 2005 (r)**
  - CTA decreased negative exploration & adjunct tests

- **Gonzalez RP et al 2003 (p)**
  - Physical exam missed 2 esophageal injuries seen on CTA
  - Recommend as initial for zone II

- **Mazolewski PJ et al 2001 (p)**
  - 100% sensitive, 91% specific
  - Operative findings in zone II

- **Gracias VH et al 2001 (r)**
  - Initial test in zones I – III
  - Decreased overall adjunct studies

- **MRI/MRA logistics difficult, no bony information**

(1st number compared to arteriography; 2nd number compared to actual intervention—surgery or endovascular or observation)


Diagnosis: CTA

- Woo K et al 2005  Retrospective 1994 – 2004

<table>
<thead>
<tr>
<th>Patient</th>
<th>n = 130</th>
<th>Surgery</th>
<th>Negative Exploration</th>
<th>Angiography</th>
<th>Esophagram</th>
<th>CF Doppler</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTA</td>
<td>34</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3%)</td>
<td></td>
<td>(12%)</td>
<td>(12%)</td>
<td>(39%)</td>
</tr>
<tr>
<td>No CTA</td>
<td>96</td>
<td>32</td>
<td>22%</td>
<td>19</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(33%)</td>
<td>(66%/32)</td>
<td>(29%)</td>
<td>(26%)</td>
<td>(32%)</td>
</tr>
</tbody>
</table>

No CTA 1994-1998:  34% angiogram, 24% esophagram
41% CTA 1999-2004: 11% angiogram, 16% esophagram

Woo Karen et al.  CT angiography in penetrating neck trauma reduced the need for operative neck exploration. The American Surgeon 2005.
Diagnosis: Cost-effectiveness of CTA

- Seamon MJ et al: extremity CTA versus arteriogram saved $12,922 in patient charges & $1,166 hospital cost
- Decreased negative exploration rate cuts OR & patient cost

A Prospective Validation of a Current Practice: The Detection of Extremity Vascular Injury With CT Angiography. Original Article

Diagnosis: CTA—stab wound


Multiple stab wounds to neck; axial CT (c) shows right skin defect with extension down to jugular vein, no hematoma; B) is maximum intensity projection & A) is color 3D volume rendered image → patient taken to OR for debridement & small injury to right IJV repaired
Diagnosis: CTA—arterial injury

Self-inflicted GSW to right neck; axial CTA shows large hematoma with contrast extravasation. MIP & 3D show facial artery branching from ECA & running into hematoma, most likely source of bleeding.

Diagnosis: CTA—arterial injury

Munera F et al 2005

Right common carotid pseudoaneurysm
Diagnosis: CTA—arterial injury

Axial CT images from inferior to superior shows progressive narrowing of right ICA; no contrast enhancement seen in superior most (bottom)

Munera F et al 2000
Diagnosis: CTA—arterial injury

Munera F et al 2000

Left common carotid pseudoaneurysm with fistula to IJV: left = proximal axial CT, right = at bifurcation; see increased collection of contrast into left IJV as compared to normal right; sagittal recon shows extravasation of contrast and increased enhancement of left IJV
Diagnosis: CTA—venous injury

Direct injury with thrombosis of right IJV

Diagnosis: CTA—esophageal injury

Axial CT shows bullet tract through left neck, close to esophagus; esophagus replaced by large posterior mediastinal hematoma

Diagnosis: CTA—esophageal injury

Free air adj to esophagus, traumatic perf
Diagnosis: CTA

Limitations

- 1.1 – 2.2% nondiagnostic
- Large patients: shoulder obscures neck
- Streak artifacts from bullets/metal
- Normal variants may look like injuries
- Subclavian arteries
- Large volume contrast: renal, diabetic patient


GSW to neck, bullet fragments in right carotid space cause streak artifact → nondiagnostic CTA → required angio which showed dissection
# Management Summary

<table>
<thead>
<tr>
<th>Unstable</th>
<th>Stable w/ symptoms</th>
<th>Stable without symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway injury</td>
<td>Hematoma, hemoptysis, hematemesis, dysphagia, dysphonia, peripheral neuro deficit, subcutaneous air</td>
<td></td>
</tr>
<tr>
<td>Hemodynamic instability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncontrolled bleeding</td>
<td></td>
<td></td>
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<tr>
<td>Evolving CVA</td>
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</tbody>
</table>

## Mandatory Exploration

<table>
<thead>
<tr>
<th>CTA in all</th>
<th>Selective testing: endoscopy, esophagography</th>
<th>Arteriography I &amp; III</th>
<th>Observation &amp; Intervention in zone I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foley tamponade</td>
<td></td>
<td>? Mandatory exploration</td>
<td></td>
</tr>
</tbody>
</table>

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Case 1

- 24 M, GSW to right neck
- Intubated at scene
- Vitals currently stable
- Right neck swelling, no bruit/thrill
- SubQ air
- CTA done

What next?

Woo K et al 2005. CTA allows visualization of bullet tract; carotids are fine; bullet fragments + air in prevertebral + parapharyngeal space → esophagram done, no injury noted
Case 2

• 35 M
• Injury to neck with working with axe
• chip flew into midline
• 1 week ago
• c/o pain, dysphagia
• Vitals stable, no dysphonia
• No fever
• Wound between thyroid & cricoid, no saliva or air

Gulia J et al 2009

• Gulia J et al 2009
Case 3:

- 40 M, stray shot to neck
- c/o pain, some bleeding
- Wound anterior neck
- No exit wound
- No swelling
- Mild dysphonia
- No airway distress
- Vitals stable

Case 3

Flexible laryngoscopy showed airway stable, bilat TVC mobile, right supraglottic edema with bullet lodged OR for DL, bullet removed, no further intervention needed, observed x 24 hrs.
Conclusions

- Immediate exploration for patients with hard signs
  - Hemodynamic instability
  - Uncontrollable bleeding, expanding hematoma
  - Worsening neurological status
  - Air bubbling in wound, need for surgical airway

- Brywczyński JJ et al 2008: meta-analysis shows C spine injury less common in penetrating trauma
  → Remove C collar to examine neck !!!

- Selective management of stable patients
Conclusions: Selective Management

<table>
<thead>
<tr>
<th>Method</th>
<th>Logistics ($, ease)</th>
<th>Reliability</th>
<th>Adjunct Tests</th>
<th>Bonus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Exam</td>
<td>Cheap Quick</td>
<td>Large trauma centers</td>
<td>X rays, Esophogram, Endoscopy</td>
<td>No</td>
</tr>
<tr>
<td>Duplex Ultrasound</td>
<td>Cheap Quick</td>
<td>Operator Zone II only</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Arteriography</td>
<td>Expensive Time</td>
<td>Gold standard vascular</td>
<td></td>
<td>Endovascular Treatment</td>
</tr>
<tr>
<td></td>
<td>Specialized</td>
<td>injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CTA</td>
<td>Mid price Quick</td>
<td>Good Streak artifacts</td>
<td>Lower rate</td>
<td>Bony, tissue, aerodigestive, C spine, bullet tract</td>
</tr>
</tbody>
</table>
Conclusions

<table>
<thead>
<tr>
<th>Zone I</th>
<th>Zone II</th>
<th>Zone III</th>
</tr>
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<tbody>
<tr>
<td>CTA</td>
<td>CTA</td>
<td>CTA</td>
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</tbody>
</table>

Esophagram/flexible esophagoscopy if suspect/see injury on CT
Flexible laryngoscopy if suspect/see injury on CT
Arteriogram if CTA nondiagnostic, need more information for OR or plan endovascular intervention
OR if injury needs to be surgically assessed/repaiired

? Usefulness of whole body CTA in multiple GSW/SW

➡️ Neck Zones Obsolete???
Conclusions

- Zone I-III classification still works for operative management of vascular injuries
  - Zone II easy to get proximal & distal control → surgery
  - Zone I & III may try endovascular therapy
    - Difficult proximal control zone I: median sternotomy
    - Difficult distal control zone III: skull base
Penetrating neck injury: Algorithm

University of Miami, prospective 2 yr. n = 60
Discussion: Francis B. Quinn, Jr., MD

Doctor Siddiqui has given an excellent and up-to-date summary of the diagnosis and treatment of penetrating injuries of the neck, with emphasis on the wide range of approaches made possible by newer imaging techniques. She has pointed out that the earlier "zone" protocol may be soon overwhelmed by the more modern "selective" management strategies.

The question of evaluating various series of cases is made complicated by the several mechanisms of injury as drawn from different cultures and environments. We note that 75% of South African patients present with incised wounds, 50% of U.S. urban patients seek treatment for gunshot wounds, and our military casualties suffer wounds from low-velocity shell fragments, as well as high velocity small caliber rifle bullets, often accompanied by substantial loss of tissue.

Thus, reports of treatment results should allow us to picture the biomechanics of injury, for as has been shown in a previous Grand Rounds (1,2,3), the high velocity projectile creates instantaneous and extensive tissue expansion with shearing stress leading to delayed devitalization and unanticipated late complications. Further, even low velocity (800 fps) bullets are known to tumble and fragment, causing tissue injury far from the missile track. In contrast, stabbing or cutting injury causes tissue injury limited to the track of the weapon.

Doctor Siddiqui's presentation has shown us that the newer treatment methods have laid upon faculty of resident training institutions the requirement to distill the reports of these methods into a doctrine suitable for the instruction of those aspiring young surgeons under our direction, a doctrine which takes into account the local weapons culture as well as the technical and imaging support available.