Management of Neck Injuries

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UCSF
Various Penetrating Mechanisms
# Penetrating Injuries

223 Patients (%)

<table>
<thead>
<tr>
<th>Injury</th>
<th>All Mech</th>
<th>GSW</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>21.5</td>
<td>26.8</td>
<td>14.6</td>
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<tr>
<td>Aerodigestive</td>
<td>6.3</td>
<td>7.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Spinal cord</td>
<td>6.7</td>
<td>13.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Peripheral Nerve</td>
<td>9.0</td>
<td>12.4</td>
<td>4.5</td>
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<tr>
<td>Hemo/pneumothorax</td>
<td>17.7</td>
<td>15.5</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Blunt Injuries
Blunt Cervical Injury

• Assess spinal cord/skeletal injury
• Once ruled out, then:
  – Incidence of aero-digestive injury: 0.04-0.3%
  – Incidence of vascular injury: 0.7-0.9%
Cervical Spine Assessment

• Awake, alert, lucid, neurologically intact and free of neck pain - cleared

• Radiologic clearance
  – Plain films, flexion/extension views
    • 85-90% sensitive
  – CT scan with sagittal reconstruction
    • 100% sensitive

• Persistent coma or neck pain
  – No additional value of MRI

Arch Surg. 2005; 140:762-766
Diagnosis of Airway Injury

- Physical exam
- Imaging Studies
- Laryngoscopy - bronchoscopy
Signs of Airway Injury

- Dysphonia
- Obstruction
  - Sweating, cyanosis
  - Retraction of respiratory muscles
  - Stridor
- Sucking wounds - air bubbling
- Subcutaneous emphysema
- Hemoptysis
Tracheal Laceration
Emergency Airway Management

- Awake fiberoptic intubation
- ‘Rapid-sequence’ fiberoptic intubation
- Awake orotracheal intubation
- Rapid-sequence intubation
- Cricothyroidotomy
Emergency Airway Management

- 748 consecutive patients with penetrating neck injury
  - 82 (11%) required immediate airway
  - 24/82 were excluded
    - out-of-hospital traumatic arrest or out-of-hospital intubation
  - 58 patients
    - 39 patients had initial rapid sequence intubation using succinylcholine
      - 100% success rate
    - 5 comatose patients had successful orotracheal intubation
      - without paralysis
    - 2 patients underwent successful emergency tracheostomy
    - 12 patients had initial fiberoptic intubation
      - unsuccessful in 3 patients leading to orotracheal intubation
- Oral endotracheal intubation definitive in 81%

Airway Complications of Spinal Cord Injury

- Eighty percent of deaths from spinal cord injury are caused by respiratory issues.
- Respiratory failure is manifest within the first 5 days following injury (22.5%).
- Atalectasis is most common (36%).
- Ventilator-associated pneumonia occurs in 31% of patients.

Airway Compromise

**Impaired Inspiratory Capacity**
1. Decreased respiratory muscle strength and fatigue
2. Paradoxical chest wall movement causing an increase in effort of breathing
3. Decreased inspiratory capacity
4. Atelectasis
5. Chest wall rigidity

**Retained secretions and development of mucus plugs**
1. Increased secretion production
2. Decreased cough effectiveness

**Autonomic nervous system dysfunction**
1. Increased secretions
2. Bronchospasm
3. Pulmonary edema
Criteria for Weaning

Afebrile, vital signs stable
VC at least 15 mL/kg ideal body weight
Inspiratory force > -24 cmH₂O
Respiratory stable for at least 24 hours
PaₐO₂ < 75
Paco₂ = 35–45
pH = 7.35–7.45
No PEEP
FIo₂ no more than 25%
Manageable secretions
Medically stable for at least 24 hours
Chest x-ray clear
Psychologically willing and ready to participate
Need for Tracheostomy After Spinal Cord Injury

Tracheostomies were performed in 107 of 156 patients.

Statistical analysis revealed a significant relationship between tracheostomy and:

- patient age ($p = 0.0048$)
- preexisting medical conditions ($p = 0.0417$)
- premorbid lung disease ($p = 0.0177$)
- higher cervical ASIA level ($p < 0.0001$)
- presence of pneumonia ($p < 0.0001$)

*J Neurosurg.* 2004, 100:20-3
Penetrating Injuries
Zones of Cervical Injury
Cervical Vascular Injuries

- 25% of penetrating trauma cause vascular injury
  - 80% are carotid injuries
    - Stroke occurs in 15%
    - Mortality is 22%
  - 43% are vertebral injuries

- Vascular injuries include full or partial occlusion, intimal flaps, dissection, narrowing, hematoma of wall, AV fistula pseudoaneurysm and free extravasation
Guidelines for Treatment

Penetrating Neck Injury

Indication for emergency surgery

No

Physical exam
Lateral neck X-ray
Chest X-ray

Normal

Abnormal

Observation
Monitored Setting

Yes

Specific Zone 1 or Zone 3 injury
Treatment
Or
Emergency Surgery

Angiography
CT ± angiography
Ultrasound
Esophagoscopy
Contrast swallow
Laryngoscopy as indicated
Indications for Immediate Surgery

- Exsanguinating hemorrhage
- Expanding hematoma
- Shock
- Airway compromise
- Massive subcutaneous emphysema
Guidelines for Treatment

Penetrating Neck Injury

Indication for emergency surgery

Yes

Specific Zone 1 or Zone 3 injury
Treatment
Or
Emergency Surgery

No

Physical exam
Lateral neck X-ray
Chest X-ray

Normal Abnormal

Observation
Monitored Setting

Angiography
CT ± angiography
Ultrasound
Esophagoscopy
Contrast swallow
Laryngoscopy
as indicated
Zone 1 Injuries

Penetrating Zone 1 Injury

PE CXR

Both NI

Either Abnl

No further evaluation for arterial injury

Arteriography

End

Manage According to Injury

J Trauma 48:208-13, 2000
Is Angiography Mandated for Zone 1 Injuries?

• 138 patients, 36 patients had normal findings at PE and on CXR
• None of these 36 patients had an arterial injury
• The negative predictive value of normal PE and CXR together is 100% in this series
• Conclusions:
  – Patients with penetrating wounds to zone I who have no evidence of vascular injury on PE and who have normal findings on CXR may not require routine arteriography

*J Trauma* 48:208-13, 2000
## Zone I Injuries

<table>
<thead>
<tr>
<th>Parameter</th>
<th>PE (%)</th>
<th>CXR (%)</th>
<th>A’gram (%)</th>
<th>NI PE &amp; CXR (%)</th>
<th>Abnl PE &amp; CXR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>85</td>
<td>61</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specificity</td>
<td>45</td>
<td>58</td>
<td>91</td>
<td></td>
<td></td>
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<tr>
<td>PPV</td>
<td>28</td>
<td>27</td>
<td>73</td>
<td></td>
<td>27</td>
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<tr>
<td>NPV</td>
<td>92</td>
<td>85</td>
<td>100</td>
<td>100</td>
<td>100</td>
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</table>

*J Trauma 48:208-13, 2000*
Vertebral Injuries

Guidelines for Treatment

Penetrating Neck Injury

Indication for emergency surgery

No

Physical exam
Lateral neck X-ray
Chest X-ray

Normal

Abnormal

Observation
Monitored Setting

Yes

Specific Zone 1 or Zone 3 injury
Treatment
Or
Emergency Surgery

Angiography
CT ± angiography
Ultrasound
Esophagoscopy
Contrast swallow
Laryngoscopy as indicated
Physical Exam of Cervical Injuries

• 36 patients presented to our Level I trauma center with penetrating neck trauma
  – Zone II and no definite sign of vascular injury
  – Patients were observed for at least 23 hours
  – During the first year patients had ultrasound

• 2/36 patients had large lacerations requiring operative debridement

• 6/36 patients underwent arteriography
  – Each arteriogram was negative

• 28/36 patients, none had any evidence of a vascular injury during hospitalization or follow-up period (mean of 1.8 months)

• Eighteen of the 28 patients had carotid ultrasounds
  – none of which showed injuries requiring operative intervention

## Physical Exam Alone

### Cervical Injuries

<table>
<thead>
<tr>
<th>Study</th>
<th>Total</th>
<th>Hard Signs/ Exploration</th>
<th>No Hard Signs</th>
<th>Misses Injuries (%)</th>
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<tbody>
<tr>
<td>Biffl et al, ‘97</td>
<td>208</td>
<td>80</td>
<td>128</td>
<td>1 (0.9)</td>
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<tr>
<td>Beitsch et al, ‘94</td>
<td>178</td>
<td>42</td>
<td>136</td>
<td>1 (0.7)</td>
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<tr>
<td>Jarvik et al, ‘95</td>
<td>111</td>
<td>45</td>
<td>66</td>
<td>0</td>
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<tr>
<td>Demetriades et al, ‘93*</td>
<td>335</td>
<td>66</td>
<td>269</td>
<td>2 (0.7)</td>
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<td>Gerst et al, ‘90</td>
<td>110</td>
<td>52</td>
<td>58</td>
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<td>Byers et al, ‘90</td>
<td>106</td>
<td>62</td>
<td>44</td>
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<td>Rivers et al, ‘88</td>
<td>23</td>
<td>1</td>
<td>22</td>
<td>0</td>
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<td>Sekharan et al, ‘00 *</td>
<td>145</td>
<td>31</td>
<td>114</td>
<td>1 (0.8)</td>
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<tr>
<td>Totals</td>
<td>1216</td>
<td>379</td>
<td>837</td>
<td>5 (0.6)</td>
</tr>
</tbody>
</table>

* J Vasc Surg 2000;32:483-9*
# Guidelines for Treatment

## Penetrating Neck Injury

### Indication for emergency surgery

- Yes
- No

#### Physical exam
- Lateral neck X-ray
- Chest X-ray

#### Specific Zone 1 or Zone 3 injury
- Treatment
- Emergency Surgery

#### Normal/Abnormal
- Observation
- Monitored Setting
- Angiography
- CT ± angiography
- Ultrasound
- Esophagoscopy
- Contrast swallow
- Laryngoscopy as indicated
Guidelines for Treatment

Penetrating Neck Injury

Indication for emergency surgery

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Physical exam
Lateral neck X-ray
Chest X-ray

Normal
Abnormal

Yes

Specific Zone 1 or Zone 3 injury
Treatment
Or
Emergency Surgery

Observation
Monitored Setting

Angiography
CT ± angiography
Ultrasound
Esophagoscopy
Contrast swallow
Laryngoscopy as indicated
CT for Zone 2 Injuries

- 14 stable patients with zone II penetrating neck injuries
- All had physical examination, infusion CT scan of the neck, and operative exploration
- Pre-op, Surgeon evaluated the CT scan
  - assigned a score of "high" or "low" probability for significant injury

- Three of 14 patients had five significant injuries
  - All these patients had high probability of injury CT scans

- Sensitivity 100% (p < 0.02)
- Specificity 91% (p < 0.02)
- Positive predictive value 75% (p < 0.02)
- Negative predictive value 100% (p < 0.02)

J Trauma 51(2):315-9, 2001
CT Angiography

Axial Image

Maximal Intensity Projection
Comparison of Helical CT and Angiography

- Conventional angiograms showed arterial injuries in 10 (17%) of 60 patients
  - Arterial occlusion (n = 4)
  - Arteriovenous fistula (n = 2)
  - Pseudoaneurysm (n = 3)
  - Pseudoaneurysm with arteriovenous fistula (n = 1)
  - Normal arteries (n = 136)

- Nine of 10 arterial injuries and all normal arteries were depicted adequately at helical CT angiography
  - Sensitivity of helical CT angiography was 90%
  - Specificity was 100%
  - Positive predictive value was 100%
  - Negative predictive value was 98%

Esophageal Injuries

- High index of suspicion
- Endoscopy
- Contrast swallow
Validating Selective Management Penetrating Cervical Injuries

- 188 patients with penetrating wounds to the anterior neck were managed selectively
  - 69 symptomatic patients were explored promptly
    - significant injuries were found in 60 patients (87%)
  - 119 (63%) were observed
    - ancillary diagnostic tests based on injury location and trajectory
    - one patient (0.8%) required delayed exploration for an occult injury

- Average hospital stay
  - after neck exploration - 8.4 day
  - for patients after negative exploration - 4.2 days
  - patients after observation 1.7 days

Overall Guidelines

PENETRATING NECK WOUND
- physical exam
- AP CXR
- AP/lat soft-tissue neck X-ray
- airway control

Overall Guidelines

Refractory shock or evolving stroke

IMMEDIATE NECK EXPLORATION

Patient with symptoms

Zone I → ANGIOGRAPHY

Zone II → NECK EXPLORATION

Zone III → ANGIOGRAPHY

INTERVENTIONAL RADIOLOGY

Asymptomatic patient

Zone I → ANGIOGRAPHY

Zone II → ESOPHAGOSCOPY

LARYNGOSCOPY

+ NECK EXPLORATION

- OBSERVATION

Zone II → DIRECTED EXAM**

+ NECK EXPLORATION

- OBSERVATION

Zone III → ANGIOGRAPHY

+ NECK EXPLORATION

- OBSERVATION

**DIRECTED EXAM: Angiography, esophagoscopy, and/or laryngoscopy based on path of projectile and clinical exam