Penetrating Neck Trauma

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Introduction

- Management of penetrating cervical injury has undergone major change during the last decade.
- At the end of WWII, surgeons extrapolated routine exploration of penetrating neck injuries into the care of civilian injuries.
- Subsequent studies documented non-therapeutic rates ranging from 40-70%.
Introduction

• The advent of arteriography in the early 1970s helped to better define the site and extent of penetrating neck injury

• Mortality rates for civilian neck injuries now range between 0-11%
Initial Management

• Management depends on hemodynamic stability and the zone injured

• Patients with penetrating injury and hemodynamic instability require emergent operative exploration
Initial Management

- Some are comfortable observing patients with a normal exam
- Vascular studies are reserved for those who have hard/soft signs of injury and hemodynamic stability
- In contrast to extremities, missed injuries in the neck have more serious sequelae – justifying liberal use of Angio
Management Principles

- Early control of airway
- No NGT
- Angio for hemodynamically stable patients with zone I and III injuries
- Hard signs and/or unstable = explore
- Selective management vs mandatory neck exploration
  - with zone II – no difference in outcome
Operative vs Non-operative

- The main factors are:
  - Stability
  - Presence of hard signs
  - Location of injury
Hard Signs

- Ongoing hemorrhage
- Large or expanding hematoma
- Bruit
- Massive blood loss at scene
- Hemiparesis or hemiplegia
- Extensive subcutaneous emphysema
- Stridor
Injury Location

- **I** – sternal notch to cricoid
  - trachea, great vessels, esophagus, thoracic duct, upper mediastinum and lung apices
- **II** – cricoid to angle of mandible
  - carotid and vertebral arteries, jugular veins, esophagus, pharynx, trachea and larynx
- **III** – angle of mandible to base of skull
  - distal extracranial carotid arteries, vertebral arteries and jugular veins
Non-operative Evaluation

• Reserved for patients with zone I or III injuries or zone II without hard signs
  – Arteriography, pharyngoesophagoscopy, tracheobronchoscopy
Arteriography

- Invaluable in excluding injury or planning the operative approach for zone I or III injuries.
- Should visualize the innominate, carotid, subclavian and vertebrals for zone I - carotid and vertebral arteries for zones II and III.
- 4 vessel essential to exclude injury in zone II with signs such as proximity, stable hematoma or h/o significant hemorrhage.
Endoscopy and Esophagoscopy

• Alone, either modality has a sensitivity of 60%
• Combined - 90%
Specific Injuries

• Vascular
  – Carotid
  – Vertebral
  – Subclavian
• Tracheal
• Esophageal
Cervical Vascular Injuries

- Neck trauma damages cervical vessels in 25% of cases
- Penetrating trauma predominates
- 30% have associated injuries in the neck and thorax
Cervical Vascular Injuries

- Blunt trauma accounts for <10% of injuries
- Mortality rate - 10 - 30%
- Permanent neurologic deficit – 40%
- Evolution of approach - ligation to revascularization
General Operative Approach

• Active bleeding should be controlled with digital pressure until direct vascular control is achieved

• Wounds should not be probed, cannulated or locally explored
  – These can dislodge clot and lead to uncontrolled hemorrhage or embolism
Operative Approach

- Zone I - SCM incision +/- sternotomy
- Zone II - SCM incision
- Zone III - postauricular extension with SCM, mandibular subluxation
Carotid Trauma - Management

- Occlusions of the ICA in patients who are neuro intact are anticoagulated
- ICA occlusion + neuro defect = repair
- ICA non-occlusive injury +/- deficit = repair
- Improvement in neuro status with revascularization possible even with profound deficits
- Arteriorrhaphy, patch, IC-EC transposition
No specific injury is pathognomonic
Direct compression between the angle of the mandible and the upper cervical vertebrae
Adduction, extension and rotation of the neck causes stretch-traction injury
Initial injury is non-occlusive and serves as the focus for local thrombus formation and subsequent cerebral embolization
Carotid Injury - Presentation

- Lucid interval
- TIA, lateralizing sign
- Cervical bruit
- Neck contusion – 15%
- Horner’s and/or anisocoria – 6%
Carotid Trauma

- Patients who are initially intact may develop deficit – delay may be hours to months
- Stroke + blunt carotid injury = 30% mortality
- IV heparin lessens the deficit and improves survival
- Up to 60% with dissection can demonstrate healing with anticoagulation
Vertebral Artery Injury

- Incidence = 1-7% (penetrating), <1% (blunt)
- Mortality = 5%
- Massive hemorrhage up to 15%
- Neuro signs rarely found
- Suspect with wounds posterior to SCM
- Suspect with facet joint dislocation of fracture through transverse foramen
Vertebral Artery Anatomy

- **V1** - subclavian origin to C6 TP foramen
- **V2** - interosseous portion C6 – 2
- **V3** - C2 to foramen magnum
- **V4** - foramen magnum to basilar artery
Vertebral Artery Injury

• Attempt angiographic diagnosis and therapy
• Operate if hemodynamically unstable or for IR failure
• Operative exposure is DIFFICULT
Epidemiology of SCA Injuries

- Penetrating neck and chest trauma – 3%
- 20% both artery and vein damaged
- 33-40% brachial plexus injury
- 25% intrathoracic injury
- Injury from blunt trauma rare – 0.4-10%
  - 1st rib = prox SC; clavicle = dist SC
Epidemiology of SCA Injuries

- Overall MR patients reaching hospital = 34-60%
- MR of those reaching OR = 15%
- MR for isolated arterial injuries = 60%
- MR for isolated venous injuries = 82%
Presentation of SCA Injuries

- Hard signs – severe bleeding, unexplained shock, expanding hematoma, pulse deficit, bruit
- Soft signs – stable hematoma, mild hypotension, proximity
- r/o associated aerodigestive tract injuries – subq empysema, hemoptysis, hematemesis, odynophagia
Anatomic Exposures - SCA

- Divided into 3 portions
  - 1\textsuperscript{st} - Aorta/innominate to medial border of anterior scalene, under SCM; branches = vertebral, IMA, thyrocervical trunk
  - 2\textsuperscript{nd} - under anterior scalene, related to middle and upper trunks of brachial plexus; branches = costocervical artery
  - 3\textsuperscript{rd} - lateral to anterior scalene to middle of clavicle; no constant branches
<table>
<thead>
<tr>
<th>SCA exposed</th>
<th>Incision</th>
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<tbody>
<tr>
<td>Proximal R SCA</td>
<td>Median sternotomy/cervical extension +/- clavicular resection</td>
</tr>
<tr>
<td>2nd R or L SCA</td>
<td>Supra + infraclavicular incision +/- clavicular resection</td>
</tr>
<tr>
<td>3rd R or L SCA</td>
<td>Same as above</td>
</tr>
<tr>
<td>Proximal L SCA</td>
<td>L lateral thoracotomy + supraclavicular extension</td>
</tr>
<tr>
<td></td>
<td>L anterolateral thoracotomy + sternotomy + supraclavicular extension</td>
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Because of collaterals – ligation tolerated

Re-establish arterial inflow

If critical – temporary shunting with delayed repair
Tracheal Injury

- Simple lacerations can be repaired in a single layer
- Complex injuries can require tracheostomy
- Extensive injuries can require delayed reconstruction
  - Cartilage graft, fascial flaps
Tracheal Injury

- Mathison and Grillo
  - Avoid searching for recurrent laryngeal nerves
  - Separate tracheal and esophageal suture lines
  - Avoid tracheostomy through the repair
  - Flex the neck to avoid tension on the repair
Esophageal Injuries

- Meticulous operative dissection must be employed to avoid missed injuries
- Injuries should be debrided and repaired in two layers
- Rotation of a muscle flap over the repair will decrease the incidence of fistula formation
- Extensive injury may require cervical esophagostomy
Management

Penetrating Neck Wound
airway control

Unstable or Zone II injury
with hard signs

Immediate Exploration
Management

Penetrating Neck Wound
airway control

Stable

Zone I
Zone I

Angiography
Esophagoscopy +/-
Barium Swallow
Tracheobronchoscopy

Any Positive  
Appropriate Exploration

All Negative  
Observation
Management

Penetrating Neck Wound
airway control

↓

Stable

↓

Zone II
Zone II

Selective Management -
Angiography
Pharyngoesophagoscopy
vs Barium Swallow
Tracheobronchoscopy

Any Positive

All Negative

Neck Exploration
Observation
Management

Penetrating Neck Wound
airway control

Stable

Zone III
Zone III

Angiography
Pharyngoesophagoscopy
Tracheobronchoscopy

Any Positive

All Negative

Appropriate Exploration

Observation
Summary

- Patients with obvious major penetrating cervical injuries need early control of the airway
- Presence of hard signs, radiologic or endoscopic diagnosis and zone of injury dictate operative management
- Appropriate choice of exposure in zone I injuries is essential
Summary

• Significant injuries to the larynx, trachea, carotid or esophagus are not common
• Associated with relatively high morbidity and mortality